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Ten-Year Meta-Analysis on Exercise Interventions for Gestational Diabetes Mellitus

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Niu, XY; Wang, KW; Li, L; Zhang, L.

Corresponding author:
Xiaying Niu

niuxy156@mail.ccmu.edu.cn

Author Affiliation:
Beijing Obstetrics and Gynecology Hospital, Capital Medical University, Beijing Maternal and Child Health Care Hospital.

ADMINISTRATIVE INFORMATION

Support - Government.

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 3 August 2025 and was last updated on 3 August 2025.

INTRODUCTION

Review question / Objective To analyze the impact of exercise therapy on pregnant women with gestational diabetes using meta-analysis.

Rationale To analyze the impact of exercise therapy on pregnant women with gestational diabetes using meta-analysis.

Condition being studied Gestational diabetes mellitus (GDM) is a glucose intolerance disorder that first appears during pregnancy and seriously affects the health of both mother and baby. The prevalence of GDM varies significantly worldwide, influenced by a variety of factors such as diagnostic criteria, race, region and lifestyle. Studies show that the prevalence fluctuates greatly between 2% and 38%. Many factors are closely associated with the onset of GDM. In terms of age, older pregnant women are at higher risk. For example, a national multicenter prospective study in Turkey showed that the average age of GDM patients was 32±5 years, higher than 28±5 years for non-GDM pregnant women ($P < 0.001$). Body mass index (BMI) is also an important factor. Obese pregnant women have an increased risk of the disease, as in some studies, the risk of GDM has significantly increased in obese pregnant women before pregnancy. In addition, a family history of diabetes, a previous history of GDM, and excessive weight gain during pregnancy are all high-risk factors for GDM. There are significant differences in the prevalence of GDM among different races and regions. For example, Pacific Island-born women have a relatively high prevalence of GDM, and there are also significant racial differences in clinical features such as BMI and blood glucose levels.

The pathogenesis of GDM is complex, involving multiple aspects such as genetics, metabolism and hormonal changes. Insulin resistance and β -cell dysfunction are key factors. A variety of hormones secreted by the placenta during pregnancy, such as human placental prolactin, estrogen, progesterone, etc., can lead to increased insulin resistance and reduced insulin sensitivity in the

mother. At the same time, pancreatic beta cells may be unable to secrete enough insulin to maintain normal blood sugar levels due to insufficient compensation.

METHODS

Participant or population Pregnant women diagnosed with GDM by oral glucose tolerance test; No other complications.

Intervention The experimental group adopted aerobic exercise, resistance exercise, and aerobic combined with resistance exercise; The control group received conventional treatment for GDM or different exercise interventions from the control group. Exercise categories were classified based on the Prescription of physical activity, with walking, calisthenics for pregnant women, aerobics, cycling, etc. classified as aerobic exercise; Dumbbell, upper body weight-bearing, etc. are classified as resistance exercises, as there are only two studies on flexibility exercises, and they are classified as aerobic exercises after consideration.

Comparator The experimental group adopted aerobic exercise, resistance exercise, and aerobic combined with resistance exercise.

Study designs to be included Randomized controlled trials (RCTS) or similar trials from 2015 to the present. ② Study subjects: Pregnant women diagnosed with GDM by oral glucose tolerance test; No other complications.

Eligibility criteria

Inclusion criteria

① Study type: Randomized controlled trials (RCTS) or similar trials from 2015 to the present. ② Study subjects: Pregnant women diagnosed with GDM by oral glucose tolerance test; No other complications. ③ Interventions: The experimental group adopted aerobic exercise, resistance exercise, and aerobic combined with resistance exercise; The control group received conventional treatment for GDM or different exercise interventions from the control group. Exercise categories were classified based on the Prescription of physical activity, with walking, calisthenics for pregnant women, aerobics, cycling, etc. classified as aerobic exercise; Dumbbell, upper body weight-bearing, etc. are classified as resistance exercises, as there are only two studies on flexibility exercises, and they are classified as aerobic exercises after consideration. ④ Outcome measures: fasting blood glucose, 2-hour postprandial blood glucose, fasting insulin level, 2-hour postprandial insulin level, glycated hemoglobin, incidence of cesarean section, incidence of premature rupture of membranes, incidence of macrosomia, incidence of preterm birth, and incidence of neonatal hypoglycemia.

Exclusion criteria

Non-english literature; Republished literature; References for which full text is not available; Data cannot be extracted, there are obvious errors or incomplete references.

Information sources Computer search PubMed, Web of Science, the Cochrane Library for RCTS or similar trials on exercise interventions for patients with GDM. The search period was from 1 January 2015 to 10 June 2025. Search using a combination of subject terms and free terms, adjusted according to the characteristics of the database. Also search the references included in the studies to supplement the relevant information. Search terms included gestational mellitus, diabetes pregnancy induced, GDM, exercises, physical activity, training.

Main outcome(s) The results of this study show that the FPG level of GDM patients in the experimental group was significantly lower than that in the control group ($P < 0.0001$), indicating that no matter what kind of exercise it is, it will improve the FPG level of GDM patients. Exercise improves GDM mainly by enhancing insulin sensitivity and regulating energy metabolism. Muscle contractions during exercise activate a range of signaling pathways, increase the expression and translocation of glucose transporter 4 (GLUT4), promote glucose uptake, and this process does not rely on insulin, thereby effectively lowering blood sugar. [21]However, the analysis showed significant heterogeneity in FPG. Although we later conducted sensitivity analysis and subgroup analysis to identify the source of heterogeneity, we found that heterogeneity remained significant after excluding any one literature or each subgroup. This situation can also be explained by the relevant literature as follows: ① Each included study was different, and there were significant differences in the overall comparison of pre-intervention FPG for GDM included in each study. [22, 23]Although the subjects were all GDM patients. ② The exercise patterns and intervention times were completely inconsistent, which is also the uniqueness of exercise therapy as a treatment approach. In the studies included in this analysis, the start and end times of the intervention were very inconsistent. In some studies, the intervention lasted until the end

of pregnancy. Some studies have intervened for 4 weeks, 6 weeks, or even 12 weeks. And the duration of exercise varies each week.

Additional outcome(s) The results of this study showed that the 2hPG of GDM patients in the experimental group was significantly lower than that in the control group ((P 0.05). And subsequent subgroup analyses showed homogeneity in the "Comprehensive exercise mode" subgroup. We do not want to draw the conclusion that the so-called different exercise modes have a consistent and stable regulatory effect on postprandial blood glucose in GDM. And the combined exercise modalities have better and more stable effects. Since only seven articles were included in this study, the sample size is too small. Even if subgroup analysis or sensitivity analysis could lead to some so-called "homogeneity conclusions," we still consider this argument untenable.

Quality assessment / Risk of bias analysis If there are less than 10 included studies, a risk of bias assessment does not need to be conducted.

Strategy of data synthesis Statistical analysis was performed using RevMan 5.4. Numerical variables were represented by mean difference (MD), binary variables by relative risk (RR), and 95% confidence intervals were used. I2≥50% indicated significant heterogeneity. The I2 statistic is used to select the appropriate combination method: I2 < 50% uses the fixed effects model, and2 I≥50% uses the random effects model. Conduct a sensitivity study on the impact on the overall estimate. Publication bias was not assessed due to the limited number of included studies. P < 0.05 indicated a statistically significant difference.

Subgroup analysis Although sensitivity analyses have revealed to some extent the reasons for the significant heterogeneity. The reasons for the significant heterogeneity of FPG outcome indicators remain unanswered. Subgroup analyses were conducted. Two subgroups, "Single mode of exercise" and "Comprehensive exercise mode", were set up in FPG and 2hPG respectively for subgroup analysis.
FPG subgroup analysis: Test for subgroup differences showed that there was no statistically significant difference (I2=0%, P=0.56) in heterogeneity between subgroup studies, indicating homogeneity between the two subgroups. There was still significant heterogeneity between the "Single mode of exercise" and "Comprehensive exercise mode" subgroups (see Figure 3). This result shows significant heterogeneity in FPG outcome indicators for this meta-analysis.
2hPG subgroup analysis: Test for subgroup differences showed significant heterogeneity among subgroup studies (I2=92.1%, P=0.004). There was significant heterogeneity in the "Single mode of exercise" subgroup (I2=57%, P=0.0004). There was no heterogeneity in the Comprehensive exercise mode subgroup (I2=0%, P=0.45). See Figure 4.

Sensitivity analysis Significant heterogeneity was observed in both FPG and 2hPG in the included studies. By analyzing FPG and 2hPG using the one-by-one exclusion method, significant heterogeneity remained in FPG outcome indicators. Shown in Figure 1. The 2hPG outcome measure showed that there was no statistically significant difference in heterogeneity among the studies after excluding Huifen[15] (I2=40%, P=0.17 > 0.05), suggesting homogeneity in the analysis after excluding this study.

Country(ies) involved 1.Beijing Obstetrics and Gynecology Hospital, Capital Medical University, Beijing Maternal and Child Health Care Hospital, Beijing, China.

Keywords GDM; Meta-analysis; Aerobic exercise; Resistance exercise; Combined exercise.

Contributions of each author

Author 1 - Xiaying Niu.
Email: niuxy156@mail.ccmu.edu.cn
Author 2 - Kaiwen Wang.
Email: wangkaiwen@mail.ccmu.edu.cn
Author 3 - Li Li.
Email: lily1888@mail.ccmu.edu.cn
Author 4 - Lin Zhang.
Email: zhanglinbjfcyy@ccmu.edu.cn