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Review Article

Effect of exercise on glycaemic control and pregnancy outcomes in women with gestational diabetes mellitus: A review

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ABSTRACT

The prevalence of gestational diabetes mellitus (GDM) is increasing and is known for its adverse effects on maternal and neonatal health. Physical exercise during pregnancy has been demonstrated to be useful for women without diabetes. However, it is unclear whether exercise can improve glycaemic control, and thereby prevents the unwanted effects of GDM. This review examines the evidence from recent literature, in which various exercise interventions were used to improve glycaemic control and the pregnancy outcomes of women with GDM. For this purpose, literature was searched through Medline, PubMed, Web of Science, Cochrane Library, and Scopus, and relevant studies published between 2009 and 2019 were retrieved. In total, 11 studies met the inclusion criteria and were reviewed. The findings collated consistently suggest that exercise in women with GDM is not only safe but also is strongly recommended, providing there are no other complications. Exercise for 15–30 min in low to moderate intensity improves glycaemic control and reduces maternal or neonatal complications. However, despite its reported benefits, it is advisable to perform exercises under supervision. In addition, certain intense exercises should be avoided as they can create complications for the mother and/or the foetus.

Keywords: Pregnancy, Gestational diabetes, Exercise, glycaemic control, Pregnancy Outcomes

INTRODUCTION

During pregnancy, a significant number of women suffer from gestational or pre-existing type 1 or type 2 diabetes.[1-3] Of these three types, gestational diabetes mellitus (GDM) is the most common, with a worldwide prevalence rate of 16.4%, and is constantly on the rise.[4] GDM is defined as *'carbohydrate intolerance resulting in hyperglycaemia of variable severity with onset or first recognition during pregnancy.'*[5] The recent World Health Organization report[6] suggests that the diagnosis of GDM should be considered positive if the pregnant women have either a plasma glucose level between 5.1 and 6.9 mmol/L under fasting conditions, or more than 10.0 mmol/L 1 h after 75 g glucose intake, or between 8.5 and 11.0 mmol/L 2 h after glucose intake.

Pregnancies with GDM are usually high risk and the condition can trigger many adverse outcomes for the mother as well as the neonate.[7] Some of the most common are pre-eclampsia, perineal trauma, pregnancy-induced hypertension, and increased chances of caesarean section.[8-10] In addition, it is expected that almost half of the mothers with GDM will eventually develop diabetes mellitus type 2 later in their lives.[11] Further, possible neonatal complications include macrosomia, shoulder dystocia, birth trauma, hypoglycaemia, hyperbilirubinemia, polycythaemia, respiratory

distress syndrome, and jaundice.[12,13] Despite its severe repercussions, GDM is preventable, and if detected at an early stage, it can be reversed through appropriate interventions, and consequently, the majority of the associated risks can be avoided.[14-16]

The management of GDM varies depending upon the resources available. In daily practice, physicians use various medical and non-medical (or combination of both) interventions to treat GDM. The most common medical interventions include oral hypoglycaemic drugs and insulin therapy.[17] Although insulin therapy is the preferred pharmacological treatment modality, it has its own challenges.[18] For this reason, non-pharmacological intervention should be recommended as the first-line treatment option. This involves adopting lifestyle modifications such as diet control and exercise.[19] Women with GDM are usually advised to first try controlling their glucose levels through diet control alone or in combination with physical exercise.[20] The literature suggests that over 75% of GDM cases achieve glycaemic control with lifestyle modifications alone.[15,21]

Exercise is defined as *'physical activities consisting of planned and repetitive body movements to improve physical fitness.'*[22] Physical exercise is considered essential to maintain a healthy lifestyle during pregnancy.[23] Most gynecological and obstetrical guidelines recommend 25–30 min of mild to moderate exercise per day during pregnancy.[24,25]

Exercises which are considered safe and acceptable during an uncomplicated pregnancy are: Walking, running or jogging, swimming, stationary cycling, low-intensity aerobics, modified Pilates, yoga, resistance training, and stretching exercises.[24] Exercise in cases of uncomplicated pregnancies has been known to be beneficial and may have long-term positive effects on maternal health.[26] The potential benefits include reduced stress and depression, improved cardiorespiratory fitness, reduced likelihood of urinary incontinence and lumbar pain, less gestational weight gain, better glycaemic control, and minimal risk of diabetes during pregnancy.[26-28] However, these reported that the benefits of exercise might not be generalizable to pregnant women with GDM.

Although it is well known that exercise is beneficial during an uncomplicated pregnancy, certain challenges exist that might restrict women from exercising. The known barriers are fatigue, nausea, inactivity prior to pregnancy, and/or restricted mechanical movements at a later stage of pregnancy.[29] In addition, the support of a qualified physical trainer may not be readily available at all antenatal centres, and the attending physician may recommend exercises that are neither based on evidence nor on standard guidelines.[30,31] In women with diabetes, it is usually recommended to take certain precautions because of the differences in physiology and possible interaction with anti-diabetic drugs taken during pregnancy. This complicated and sensitive condition demands the application of evidence-based exercise guidelines to improve maternal and neonatal health outcomes.[32]

To realize the optimal benefits of exercise without any complications or risks, it is essential to understand which type of exercise should be used, and with what regularity, duration, and intensity.[32,33] Several interventional studies have sought to clarify the impact of exercise on GDM and its effects on pregnancy outcomes. However, due to the disparity in reported results, there is currently no consensus on recommendations for the type, duration, and intensity of the known exercises. Therefore, this review aims to consolidate the evidence in the literature concerning the various exercise interventions used so far by women with GDM and their possible effects on glycaemic control and pregnancy outcomes.

MATERIALS AND METHODS

To achieve the objectives of this study, a literature search was performed using Medline, PubMed, Web of Science, Cochrane Library, and Scopus. All the peer-reviewed articles published in the past 10 years (2009–2019) were retrieved and their abstracts screened. Abstracts were screened by using the following inclusion criteria: (1) The study should be randomized controlled trials (RCTs) involving human female subjects with GDM in both exercise and control group (CG), (2) the trial should be aiming to assess the impact of different exercise interventions, (3) the study should report any maternal or newborn outcome, (4) the article should be written in English, and (5) the article should be published in a peer-reviewed journal and within the decided timeframe (2009–2019). This timeline was selected because the objective of this review study was to give a literature update on what has been reported in the past decade while exploring the effect of exercise on glycaemic control and pregnancy outcomes. Those articles in which other medical or non-medical interventions were studied in combination with physical exercise were excluded from the study. Furthermore, excluded were studies which were not randomized. Papers written in languages other than English were also excluded from the study. The keywords used when exploring the literature included 'non-pharmacological strategies,' 'non-medical strategies,' 'non-medical treatment,' 'pregnancy,' 'gestational diabetes,' 'GDM,' 'exercise,' 'glycaemic control,' 'pregnancy outcomes,' 'maternal outcomes,' and 'neonatal outcomes.'

RESULTS

A total of 11 studies were identified, all of which met the inclusion criteria for this review [Table 1].[34-44] In all the

Table 1: Summary of studies evaluating the effect of exercise on gestational diabetes mellitus and pregnancy outcomes.

Author and year of study	Sample size	Study objectives	Components of exercise interventions					Summary of findings
			Type	Duration (in minutes)	Frequency	Intensity	Total period (in weeks)	
Bambicini *et al.*[34]	17 (EG=11, CG=06)	glycaemic control	Combination of aerobics and resistance	60	NA**	Moderate	NA**	No significant difference was observed in glycaemic levels between the EG and CG up to 1 h of exercise session
Barakat *et al.*[35]	428 (EG=210, CG=218)	Pregnancy outcomes	Combination of aerobics and resistance	50	Thrice/ week	Moderate	25–28	With respect to the gestational period, average birth weight, and average Apgar score, no significant difference was found between the exercise and CGs. A significantly lower rate of macrosomic babies and less chances of caesarean section were observed in the EG as compared to the CG
Bo *et al.*[36]	200 (EG=99, CG=101)	Glycaemic control, pregnancy outcomes	Brisk walk	20	Daily	Light	10-12	A significant reduction in maternal postprandial glucose, CRP, HbA1c, and triglycerides was recorded. Furthermore, the occurrence and severity of maternal/neonatal complications were less in EG than CG
Cordero *et al.*[37]	257 (EG=101, CG=156)	Glycaemic control	Combination of aerobics and stretching	50–60	Twice/ week	Moderate to heavy	16–20	A reduction in the prevalence of GDM was recorded in the EG as compared to the CG. Furthermore, a significant improvement in glucose tolerance test was recorded in EG as compared to the CG
de Barros *et al.*[38]	64 (EG=32, CG=32)	Glycaemic control	Resistance training	30	Thrice/ week	Moderate to heavy	6–16	A significant reduction in insulin requirement was observed in EG as compared to the CG. The amount of time spent within the targeted glucose range was significantly higher in EG as compared to the CG
Halse *et al.*[39]	40 (EG=20, CG=20)	Pregnancy outcomes	Aerobics	20-30	Daily	Moderate	6	With respect to maternal weight gain and maternal/neonatal outcomes, no significant difference was observed between the two groups. However, an attitudinal and motivational improvement toward exercise and wellbeing was observed in EG, as compared to the CG
Ramos *et al.*[40]	06 (EG=02, CG=04)	Glycaemic control	Aerobics	50	Thrice/ week	Light to moderate	10	A decrease in mean HbA1c and HOMA was observed in EG as compared to the CG. Furthermore, the EG delivered lighter and smaller babies as compared to the CG
Downs *et al.*[41]	65 (EG=40, CG=15)	Glycaemic control	Aerobics	70	Twice/ week	Moderate	16	The face-to-face EG showed significantly higher motivational determinants than both the CG and the home group. The face-to-face group also spent more exercise time and pedometer steps/ day than the home group. Moreover, the face-to-face group started insulin later in gestational period than the home and CGs
Coe *et al.*[42]	08 (EG=N/A, CG=N/A)	Glycaemic control	Walking (postprandial treadmill)	30	Daily	Moderate	0.30*	A greater postprandial glucose control was observed in EG as compared to the CG of women with GDM
Kokic *et al.*[43]	38 (EG=18, CG=20)	Glycaemic control, pregnancy outcomes	Combination of aerobics, resistance, and stretching	50	Twice/ week	Light to moderate	6	Significantly lower postprandial glucose levels were recorded in EG than the CG. No significant difference was recorded in fasting glucose levels between both groups. The neonatal body mass index was significantly higher in the EG
Kokic *et al.*[44]	18 (EG=09, CG=09)	Glycaemic control	Combination of aerobics, resistance, and stretching	50	Twice/ week	Light to moderate	6	A significant drop in glucose levels was recorded in EG as compared to CG. No harmful effects were recorded in women with GDM who used a combination of aerobic and resistance exercise during their gestational period

*The exercise intervention was only for 2 days. **Not available (required information is not explicitly given in the article, hence, not available). EG: Exercise group, CG: Control group, GDM: Gestational diabetes mellitus

extracted articles, standard antenatal care was given to all the patients in the intervention group, in addition to performing different physical exercises; whereas, only standard antenatal care was given to the CG during the trial.

Types of interventions

Interventions included aerobics,[39-41] resistance training,[38] walking,[36,42] a combination of aerobics and resistance,[34,35] a combination of aerobics and stretching,[37] and a combination of aerobics, resistance, and stretching.[43,44] In these studies, the duration of the exercises varied from 20 to 70 min. The intensity was from light to heavy intensity and the total period of the intervention varied from 0.3 to 28 weeks. The frequency of the exercise sessions varied from daily to thrice weekly. The duration, intensity, and frequency of the interventions used in each study are given in [Table 1].

Purpose of interventions

Of these 11 clinical trials, seven[34,37,38,40-42,44] studied the effect of exercise on glycaemic control, two[35,39] studied pregnancy outcomes, and two[36,43] studied both glycaemic control and pregnancy outcomes.

Effect on glycaemic control

Nine of the 11 RCTs included evaluated the effect of exercise on glycaemic control in women with GDM. Ramos *et al*.[40] reported a significant decrease in mean HbA1c and HOMA levels in their exercise group (EG), when compared to CG. Bo *et al*.,[36] Coe *et al*.,[42] Cordero *et al*.,[37] Kokic *et al*.,[43] and Kokic *et al*.[44] noticed a significant reduction in glucose levels in their EG, whereas Bambicini *et al*.[34] observed no change in glucose levels between the two groups. In another clinical trial, Downs *et al*.[41] found their EG started insulin at a much later stage of pregnancy than the home and CGs. Similarly, de Barros *et al*.[38] reported a decrease in insulin demand in the EG, as compared to their CG. Furthermore, the EG had a longer gestational period within the targeted glucose range, as compared to the CG.

Effect on maternal and neonatal outcomes

Four of 11 of the included RCTs studied the effects of exercise on maternal and neonatal outcomes, either exclusively or alongside glycaemic measures. In one study, Barakat *et al*.[35] was unable to find a significant impact of exercise on the gestational period, average birth weight, and average Apgar score when comparing the EG with the CG. However, a significantly lower rate of macrosomic babies and a reduced probability of caesarean section were observed in the EG, as compared to the CG. In another study, Kokic *et al*.[43] found that the neonatal body mass index was significantly higher in EG than the CG. Although slightly delayed labour was observed in the CG, this difference was not statistically significant. Another non-significant finding was that more CG cases went through labour induction than EG cases. Furthermore, no significant differences were found between the two groups in terms of neonatal length, Apgar score, and ponderal index. In another study, Bo *et al*.[36] observed a reduced occurrence rate and severity in terms of maternal and neonatal complications in the EG than the CG. However, the nature of these complications has not been explicitly mentioned in the study. On the other hand, Halse *et al*.[39] compared the two groups with respect to mode, onset, or duration of labour, gestational period, chances of preterm birth, and Apgar scores. Surprisingly, the researchers did not experience any differences in the outcomes of both groups. In addition, none of these studies observed maternal complications such as duration and the induction of labour, rates of pre-eclampsia, or maternal mortality. With respect to neonatal outcomes, none of the studies observed neonatal morbidity or mortality, preterm births, or neonatal hypoglycaemia.

DISCUSSION

GDM is a metabolic problem with known negative effects on maternal and neonatal health. In this review, the researcher aimed to consolidate the literature reporting the effect of exercise on glycaemic control and pregnancy outcomes. The findings suggest that exercise is safe for women with GDM and that it may offer almost similar fitness benefits to suffering individuals as it does to those without diabetes. Furthermore, exercising women with GDM acquire better glucose control than non-exercising women. It can also be derived from the findings in the literature that an exercise intervention during pregnancy can surely help to avoid or at least delay the necessity for insulin.[38,42] Studies also suggest exercise alone can reverse GDM and reduce the chances of developing diabetes mellitus type 2 in the long term.[11,32]

While the current literature offers reassurance that exercising women with GDM might not experience hypoglycaemia, the possibility of its occurrence cannot be ignored as it is seriously harmful to both the mother and the foetus. Therefore, women with GDM should seek the professional support of a certified trainer, or at least avoid exercising without supervision.[45] In addition, workout measuring devices (ActiGraph and Omron) with known reliability and validity for use in pregnancy can be worn to keep physical activities in check.[46] Nowadays, many commercial companies offer wearable activity trackers and smart watches, which can help to monitor calorie consumption. These smart watches are also known as a source of motivation and commitment to exercise goals.[47]

After critically analysing the reported interventional studies, it can be concluded that an exercise of 15–30 min in low

to moderate intensity is ideal in women with GDM. This is in line with the Canadian guidelines for physical activity throughout pregnancy,[48] and the recommendations of the American Diabetes Association.[49] GDM is typically diagnosed between 24 and 28 weeks of gestation, which offers an exercise window of 12–16 weeks duration. Between different types of exercises, it is up to the patient to choose according to her preference and practical options. However, certain high risk or high-intensity exercises raise safety concerns, and therefore these should be avoided, that is, skiing, road cycling, surfing, football, hockey, boxing, hot yoga, scuba diving, sky diving, and non-modified Pilates.[24]

It should be noted that the available evidence on which these recommendations have been based is limited. Moreover, few studies have evaluated the effect of exercise on pregnancy outcomes, which further restricts our understanding of the topic under discussion. Future researchers should convene longitudinal clinical trials at various gestational time points as a way to investigate in detail the effects of different exercise interventions on pregnancy outcomes. Another interesting factor would be to investigate the impact of emerging technologies, such as fitness trackers and smart watches, when monitoring glycaemic control among exercising women with GDM.

Certain limitations of this review need to be reported. In this study, the literature from the past 10 years has been reviewed and trials reported before 2009 have been excluded from the study. This review focuses on the effect of exercise in pregnant women with gestational diabetes only and does not include type 1 and 2 diabetes. A further limitation is that studies reporting the effect of exercise interventions only were included in the study. Trials involving mixed interventions (diet control and exercise), with or without pharmacological support, were not included in the study. Although all the reviewed articles were RCTs, assessment of the risk of bias was not performed, as it went beyond the objectives of this review.

CONCLUSION

For women with GDM, exercise is beneficial as a means of achieving better glycaemic control, thereby improving maternal and neonatal outcomes. It is recommended that pregnant women should exercise for 15–30 min from GDM diagnosis until the end of the gestational period. Patients can choose the type of exercise intervention they prefer, considering factors such as comfort, available resources, and providing the exercise chosen is of light to moderate intensity.

Declaration of patient consent

Patient's consent not required as patients identity is not disclosed or compromised.

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Conflicts of interest

There are no conflicts of interest.

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