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Research

Exercise improves glycaemic control in women diagnosed with gestational diabetes mellitus: a systematic reviewAnne L Harrison^{a,b}, Nora Shields^{a,c}, Nicholas F Taylor^{a,d}, Helena C Frawley^{a,e}^aSchool of Allied Health, La Trobe University; ^bPhysiotherapy Department, Werribee Mercy Hospital; ^cNorthern Health; ^dAllied Health Clinical Research Office, Eastern Health; ^eCentre for Allied Health Research and Education, Cabrini Health, Melbourne, Australia

KEY WORDS

Exercise
Gestational diabetes
Blood glucose
Pregnancy
Systematic review

ABSTRACT

Question: Does exercise improve postprandial glycaemic control in women diagnosed with gestational diabetes mellitus? **Design:** A systematic review of randomised trials. **Participants:** Pregnant women diagnosed with gestational diabetes mellitus. **Intervention:** Exercise, performed more than once a week, sufficient to achieve an aerobic effect or changes in muscle metabolism. **Outcome measures:** Postprandial blood glucose, fasting blood glucose, glycated haemoglobin, requirement for insulin, adverse events and adherence. **Results:** This systematic review identified eight randomised, controlled trials involving 588 participants; seven trials (544 participants) had data that were suitable for meta-analysis. Five trials scored ≥ 6 on the PEDro scale, indicating a relatively low risk of bias. Meta-analysis showed that exercise, as an adjunct to standard care, significantly improved postprandial glycaemic control (MD -0.33 mmol/L, 95% CI -0.49 to -0.17) and lowered fasting blood glucose (MD -0.31 mmol/L, 95% CI -0.56 to -0.05) when compared with standard care alone, with no increase in adverse events. Effects of similar magnitude were found for aerobic and resistance exercise programs, if performed at a moderate intensity or greater, for 20 to 30 minutes, three to four times per week. Meta-analysis did not show that exercise significantly reduced the requirement for insulin. All studies reported that complications or other adverse events were either similar or reduced with exercise. **Conclusion:** Aerobic or resistance exercise, performed at a moderate intensity at least three times per week, safely helps to control postprandial blood glucose levels and other measures of glycaemic control in women diagnosed with gestational diabetes mellitus. **Registration:** PROSPERO CRD42015019106. [Harrison AL, Shields N, Taylor NF, Frawley HC (2016) Exercise improves glycaemic control in women diagnosed with gestational diabetes mellitus: a systematic review. *Journal of Physiotherapy* XX: XX-XX]

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Introduction

Gestational diabetes mellitus (GDM) is carbohydrate or glucose intolerance of variable severity that has its onset during pregnancy.^{1,2} It is diagnosed through laboratory screening, using a pregnancy oral glucose tolerance test that is performed between 24 and 28 weeks gestation.^{1,3} GDM is a common complication of pregnancy, with an incidence ranging from 3.5 to 12%; it also has an increasing prevalence.^{1,4–7} If poorly controlled, GDM results in hyperglycaemia,^{1,2} which affects both the mother and the developing baby. The short-term adverse consequences of hyperglycaemia may include hypertension and pre-eclampsia for the mother, and birth trauma from macrosomia (ie, excessive birth weight) for the baby.^{1,7} GDM also has longer-term health implications. For the mother, these include a 35 to 50% increase in risk of recurrence of GDM in subsequent pregnancies,⁸ with a seven-fold increased risk of developing type 2 diabetes mellitus.⁹ For the child of a GDM pregnancy, there is an increased risk of obesity and type 2 diabetes mellitus later in life,^{10,11} and those born with macrosomia have an increased lifetime risk of cardiovascular disease¹² and an increased risk of leukaemia.¹³

For these reasons, the increasing rate of GDM has public health ramifications.^{14,15}

Glycaemic control is a critical factor in combatting the adverse effects associated with poorly controlled GDM.⁶ Management of GDM typically consists of dietary modifications, regular self-monitoring of postprandial (ie, post-meal) acute capillary blood glucose levels³ and – where diet modification does not achieve euglycaemia – insulin therapy.^{16–18} There is strong evidence that exercise, particularly structured aerobic and/or resistance training, is a beneficial adjunctive therapy in the management of type 2 diabetes mellitus through its ability to increase glucose uptake and improve insulin sensitivity.^{19–24} Exercise, particularly activation of large muscles such as the quadriceps, stimulates glucose uptake in muscle, increases energy expenditure and improves glucose transportation, which results in improved glucose tolerance.^{22,25} Exercise is associated with a reduction of glycated haemoglobin (HbA1c), a measure of the average plasma glucose in the longer term (2 to 3 months), in people with type 2 diabetes mellitus;^{26,27} it is optimised by training of 150 minutes or more per week at moderate intensity.^{21,28} Exercise is also recommended as beneficial for women with uncomplicated pregnancies.^{29–31}

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However, to date, the evidence regarding the benefits of exercise for the management of GDM has been equivocal – largely due to small sample sizes and heterogeneity of exercise type and outcome measures. In addition, the synthesis of the evidence on the benefits of exercise for the management of GDM has been limited to a review completed almost a decade ago.³²

Several international guidelines and reviews recommend exercise in the management of GDM.^{4,16,33–35} While these guidelines recommend exercise as an adjunct to standard GDM care, there has not been supporting evidence from a systematic review with meta-analysis of the effects of exercise on postprandial blood glucose levels. There is good justification for postprandial glucose levels to be the main outcome of interest among this population due to the continuous relationship with macrosomia and birth defects.^{1,2,7,16} Fasting blood glucose levels and HbA1c are, however, important as secondary outcomes because, other than their established physiological relevance to complications of diabetes,¹⁵ some trials may only include these measures rather than an oral glucose tolerance test (OGTT).

Therefore, the research questions for this systematic review were:

1. Can adjunctive exercise improve the acute postprandial control of blood glucose in women diagnosed with GDM when compared with standard GDM care?
2. Does adjunctive exercise improve fasting blood glucose levels and the longer-term measure, HbA1c, in women diagnosed with GDM when compared with standard GDM care?
3. What are the characteristics of exercise programs that are effective in lowering postprandial blood glucose levels for women with GDM and the variables affecting adherence to exercise?

Method

The review was reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.³⁶

Identification and selection of studies

One reviewer (AH) performed a search of the following electronic databases from the earliest possible date (ie, from database inception) until November 2015: AMED, CINAHL, Medline, Embase, PsycInfo, Cochrane Library, PEDro, SPORTDiscus, Joanna Briggs Institute and Trip. To ensure full representation of the evidence, no search limitations were used. The search strategy consisted of four key concepts: GDM, physical activity, blood glucose and randomised, controlled trials. For each concept, key words and MeSH search terms were combined with the 'OR' operator. The results of the searches of the four key concepts were combined with the 'AND' operator. An example of the search strategy is presented in Appendix 1 on the eAddenda. Reference lists from the included studies were manually searched and relevant articles were screened and reviewed for possible inclusion. Using Google Scholar and Web of Science, citation tracking was also performed on the included articles to identify any additional, relevant articles.

Two reviewers (AH and HF or NT) independently reviewed the title and abstracts of the articles yielded by the search, according to the inclusion criteria presented in **Box 1** and the exclusion criteria outlined below. If eligibility was unclear from the review of title and abstract, full text was obtained and reviewed by two researchers working independently. Disagreements were resolved by discussion between reviewers.

Assessment of characteristics of studies

Participants

Trials were excluded if the participants had existing type 1 or type 2 diabetes. This was because the aetiologies are somewhat

Box 1. Inclusion criteria.

Design

- Randomised, controlled trial
- Full-text articles published in English in a peer-reviewed journal

Participants

- Pregnant women diagnosed with GDM^a during the current pregnancy

Intervention

- Cardiovascular exercise or strengthening exercises sufficient to achieve aerobic effect or changes in muscle metabolism^b
- Exercise performed more than once a week^c
- Exercise in any setting

Primary outcome measure

- Self-monitored postprandial blood glucose levels

Secondary outcome measures

- Fasting blood glucose levels
- HbA1c
- Requirement for insulin

Comparisons

- Standard care of GDM, including diet and/or insulin

^a GDM, as diagnosed by a pregnancy oral glucose tolerance test performed at 24 to 28 weeks^{1,3}

^b Based on the American College of Sports Medicine & American Diabetes Association joint position statement¹⁹

^c Chosen to exclude single bouts of exercise but to keep search broad, as aiming to identify sufficient exercise to improve self-monitored postprandial blood glucose levels.

different or, at least, the aetiology may be only transient in GDM and because the chronic physiological effects of longer-term diabetes could confound findings.^{1,35}

Intervention

As the minimum level of exercise to improve self-monitored postprandial blood glucose levels is not well established, the inclusion criteria for this review were set broadly to include trials of interventions with exercise frequency greater than weekly. If individual studies provided an exercise intervention dosage that met the recommended guidelines,¹⁹ then it was considered that the exercise intervention would provide sufficient stimulus to achieve aerobic effect or changes in muscle metabolism. It was acceptable for the exercise intervention to be combined with dietary modification and insulin, as required, along with self-monitoring of blood glucose; this is considered standard care for women diagnosed with GDM.^{7,16,33,35}

Outcome measures

As outlined in **Box 1**, postprandial glucose levels, fasting blood glucose levels and HbA1c were the outcome measures chosen to reflect treatment of existing GDM. Because the primary aim of this review was to evaluate the treatment effect of exercise on postprandial control of glycaemia in women with GDM, not to prevent it, trials were excluded if prevention of GDM was an outcome measure.

Risk of bias

Risk of bias was assessed using the Physiotherapy Evidence Database (PEDro) scale.³⁷ This scale scores the risk of bias of studies out of 10, providing a comprehensive description for each item to improve inter-rater reliability³⁷ and is considered a valid and reliable tool for measuring methodological quality.^{38,39} For the purposes of this review, trials achieving a PEDro score of ≥ 6 were considered as being at low, or slightly greater than low, risk of bias.⁴⁰ Two reviewers (AH and NS) assessed the risk of bias independently. Disagreements between allocated scores were resolved by discussion.

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