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Combination of a structured aerobic and resistance exercise improves glycaemic control in pregnant women diagnosed with gestational diabetes mellitus. A randomised controlled trial

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ABSTRACT

Problem: Gestational diabetes mellitus, defined as any carbohydrate intolerance first diagnosed during pregnancy, is associated with a variety of adverse outcomes, both for the mother and her child.
Aim: To investigate the impact of a structured exercise programme which consisted of aerobic and resistance exercises on the parameters of glycaemic control and other health-related outcomes in pregnant women diagnosed with gestational diabetes mellitus.
Methods: Thirty-eight pregnant women diagnosed with gestational diabetes mellitus were randomised to two groups. Experimental group was treated with standard antenatal care for gestational diabetes mellitus, and regular supervised exercise programme plus daily brisk walks of at least 30 min. Control group received only standard antenatal care for gestational diabetes mellitus. The exercise programme was started from the time of diagnosis of diabetes until birth. It was performed two times per week and sessions lasted 50–55 min.
Findings: The experimental group had lower postprandial glucose levels at the end of pregnancy ($P < 0.001$). There was no significant difference between groups in the level of fasting glucose at the end of pregnancy. Also, there were no significant differences in the rate of complications during pregnancy and birth, need for pharmacological therapy, maternal body mass and body fat percentage gains during pregnancy, and neonatal Apgar scores, body mass and ponderal index. Neonatal body mass index was higher in the experimental group ($P = 0.035$).
Conclusion: The structured exercise programme had a beneficial effect on postprandial glucose levels at the end of pregnancy.

Statement of significance

Problem or issue

Gestational diabetes mellitus is associated with an increased rate of perinatal complications and long-term morbidity.

What is already known

Aerobic or resistance exercise programmes from previous trials proved beneficial effects of exercise on the course and outcomes of pregnancy. Combination of aerobic and resistance exercise has synergistic effects in patients with type 2 diabetes.

What this paper adds

Combining aerobic and resistance exercises has beneficial effects on glycaemic control. Furthermore, it is a safe therapeutic strategy for pregnant women with gestational diabetes mellitus.

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1. Introduction

Gestational diabetes mellitus (GDM) is defined as any carbohydrate intolerance first diagnosed during pregnancy.[1] It accounts for 90–95% of all cases of diabetes in pregnancy and is the most common metabolic disorder encountered during pregnancy.[2] The prevalence of GDM is rising, and it is directly related to the prevalence of type 2 diabetes in a given population.[2,3]

GDM is associated with a variety of adverse outcomes, both for the mother and for the fetus. Possible consequences for the mother include an increased rate of perinatal complications, hypertension during pregnancy and preeclampsia. Long term, there is an increased risk of developing type 2 diabetes, metabolic syndrome, obesity, cardiovascular morbidities and recurrent GDM.[2,4] Maternal hyperglycaemia causes an excessive transfer of nutrients – specifically glucose – to the fetus, resulting in fetal hyperinsulinaemia, fetal adiposity, macrosomia and perinatal complications. Long term, these children are also at increased risk of developing obesity, metabolic syndrome, type 2 diabetes and hypertension.[5]

The primary aim of treating GDM is to optimize glycaemic control and improve pregnancy outcomes.[6] Changes in diet and lifestyle are usually recommended as the primary therapeutic strategy to achieve acceptable glycaemic control.[3] If these measures fail to establish adequate glycaemic control within 1–2 weeks, pharmacological therapy is introduced. It is also recommended to continue or initiate exercise at moderate intensity for all pregnant women without contraindications.[2,3]

Exercise is associated with significant, beneficial physiological and metabolic changes and responses to exercise are not different in comparison to the non-pregnant population.[7] Today, physical activity is recommended as a part of antenatal care.[8] Furthermore, exercise leads to improved insulin sensitivity and blood glucose levels in patients with type 2 diabetes.[9] Both aerobic and resistance exercises, especially in combination, have shown beneficial effects in patients with type 2 diabetes.[10] Studies have shown a correlation between higher levels of physical activity before and during early pregnancy with a lower risk of developing GDM.[11]

While the use of exercise in the treatment of type 2 diabetes is supported by plenty of evidence, there is a limited body of evidence exploring the effects of exercise on the course and outcomes of GDM. Only nine prospective trials were found that investigate this subject, seven randomised,[12–18] and two non-randomised.[19,20] Seven of these trials examined the effects of aerobic exercise programmes,[12–14,17–20] whereas only two examined the role of resistance exercises.[15,16] None of the trials examined the effects of combining aerobic and resistance exercises.

Hence, the purpose of this trial was to investigate the health-related effects of implementing a supervised, individualised, structured exercise programme, consisting of aerobic and resistance exercises, on the course and outcomes of GDM. We hypothesized that this exercise programme would improve: glycaemic control, the rate of complications during pregnancy, weight gain and body fat percentage changes during the pregnancy, the rate of complications and mode of birth, and the health status and weight of the newborn.

2. Participants, ethics and methods

2.1. Design and ethics

A randomised controlled trial was conducted between July 2014 and January 2015 comparing an exercise programme with standard antenatal care for GDM. Ethical approval was obtained from the University Hospital Centre Zagreb and the University Hospital Merkur, Zagreb, Croatia and the trial was registered with Clinicaltrials.gov (NCT 02196571). Written, informed consent was obtained from every participant. The trial was conducted in accordance with the Declaration of Helsinki.

2.2. Participants

Participants were recruited by direct contact at two university hospitals in Zagreb, Croatia. Inclusion criteria were: an established diagnosis of gestational diabetes according to the criteria published by the International Association of the Diabetes and Pregnancy Study Groups,[21] aged between 20 and 40. The upper limit for gestational age at the time of inclusion was set at 30 weeks, to allow a minimum exercise period of 6 weeks, until at least the 36th week of pregnancy. Exclusion criteria were: a medical history of diabetes and miscarriages, pharmacological treatment prior to enrolment in the trial, existing comorbidities, and contraindications for exercise as outlined in criteria published by the American College of Obstetricians and Gynecologists (ACOG).[22]

Participants were randomized by block randomisation using a web-based computerized procedure into two groups: experimental and control. The staff involved with the exercise sessions and assessments had no influence on the randomisation procedure. Due to the nature of the study, participants were not blinded. Physicians and laboratory staff were blinded.

2.3. Assessments and measurements

Baseline information taken at the initial interview included: demographic data, medical history including obstetric history, lifestyle habits, physical activity levels and body height and mass at the start of the pregnancy. Pregnant women randomised to the experimental group (EG) were scheduled for their first exercise session. In the 30th, 33rd and 36th week, anthropometric measurements were taken from both groups. Relevant medical documentation was also reviewed in order to assess the course of pregnancy and glycaemic control. Following childbirth, data was gathered on: glycaemic control during the final weeks of pregnancy, the course of birth, neonatal health status and anthropometric information.

All anthropometric measurements were performed by a blinded physiotherapist. These included body mass, arm circumference and skinfold thickness. Body mass was measured using a medical grade digital scale, measuring to the nearest 0.1 kg. This was used to calculate body mass index. Skinfold thickness and arm circumference were measured as recommended by the Manual of International Standards for Anthropometric Assessment.[23] Skinfold thickness was measured using a skinfold caliper (Harpendem Skinfold Caliper, Baty International, Burgess Hill, UK) at the biceps brachii and triceps brachii muscles, and in the subscapular area. Measurements of arm circumference, skinfold thickness and height were fed into the equation by Kannieappan et al.[24] specifically developed and validated for use in pregnant women in order to calculate body fat percentage. Data on neonatal weight, length, Apgar score and health status was extracted from the hospital discharge letter, and used to calculate neonatal body mass index and ponderal index according to the standard equations. Participants' physical activity levels were assessed at baseline and in the 30th and 36th weeks of pregnancy using the Pregnancy Physical Activity Questionnaire.[25]

An oral glucose tolerance test was performed and blood glucose profiles calculated in the medical biochemistry laboratory at the above mentioned hospitals. Analyses were done according to standard operating protocols for the accredited laboratory (International Standards Organization (ISO) 15189 Medical

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