Title: Home-Based Exercise Improves Fitness and Exercise Attitude and Intention in GDM Women.

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Abstract

Purpose: To determine the effect of a home-based cycling program for women recently diagnosed with gestational diabetes mellitus (GDM) on aerobic fitness, weight gain, self-reported mobility, attitude and intentions towards maternal exercise, and obstetric and neonatal outcomes. **Methods:** Forty women (28.8 ± 0.9 weeks gestation) were randomized to either a supervised, home-based exercise program, combining continuous steady-state and interval cycling at various intensities, in combination with unsupervised moderate intensity aerobic activity and conventional diabetic management (EX; $n = 20$), or to conventional management alone (CON; $n = 20$). The program began following diagnosis until week 34 of pregnancy (mean duration of training 6 ± 1 weeks). **Results:** Mean compliance to the training program was 96%. Maternal aerobic fitness, and attitude and intentions towards exercise were improved in response to the home-based exercise intervention compared with CON ($p < 0.05$). No differences were observed between groups with respect to maternal weight gain or obstetric and neonatal outcomes ($p > 0.05$). **Conclusion:** A home-based exercise program of 6 ± 1 weeks in duration commenced following diagnosis of GDM can improve aerobic fitness and attitude and intentions towards exercise, with no adverse effect on maternal and neonatal pregnancy outcomes.

Key Words: pregnancy, supervised-exercise training, weight gain, health outcome

Introduction

Paragraph Number 1 Gestational diabetes mellitus (GDM) is one of the most common obstetric complications, affecting up to 14% of all pregnancies (2). The condition places women at risk of pregnancy-induced hypertension, preeclampsia, induced labor and operative delivery, with a postpartum risk of glucose intolerance, insulin resistance, beta-cell dysfunction, recurrent GDM, and progression to type 2 diabetes (30, 31). For the child, there is an increased risk for macrosomia (birth weight > 4000 g), shoulder dystocia, associated birth trauma and neonatal metabolic and respiratory complications (22, 30), as well as an increased risk of obesity, type 2 diabetes, and metabolic dysfunction later in life (25). Importantly, women diagnosed with GDM are more likely to be overweight and sedentary (21, 39). This presents a risk of further consequences for both mother and child, as excess gestational weight gain is an independent risk factor for macrosomic infants (18). Excess gestational weight gain is also a risk factor for long-term weight gain and obesity (23), and together with maternal physical inactivity, is a predictor of poor obstetric outcomes, recurrent GDM, and type 2 diabetes (6, 14). We have recently shown that regular home-based exercise training (consisting of three supervised cycling sessions, plus two unsupervised aerobic sessions per week) commenced upon diagnosis of GDM can improve daily postprandial glycaemic control (15). More specifically, mean daily 2 h postprandial glucose concentrations were significantly lower in women participating in the exercise program compared with a control group of women managed with standard care. Whether such a program also influences maternal weight, aerobic fitness, perceived mobility, attitude, intentions and beliefs towards maternal exercise participation, as well as obstetric and neonatal labor and delivery outcomes in GDM pregnancies, is not known.

Paragraph Number 2 Prior research has shown that exercise participation during the first and second trimesters of an uncomplicated pregnancy can reduce gestational weight gain (17, 26, 29, 36). However, there is limited research examining the effect of structured aerobic exercise on maternal weight gain and obstetric and neonatal outcomes when implemented during the third trimester of pregnancy following diagnosis of GDM (3, 5, 8, 10, 19). To our knowledge, only one such aerobic exercise investigation has been successful in limiting maternal weight gain and improving incidence of neonatal macrosomia (3). In this study, overweight (BMI > 25 kg/m^2) women with GDM participated in a partially supervised aerobic exercise program (20 min/day at ≤ 60% maximal aerobic capacity) plus medical nutritional therapy (MNT) or continued with MNT alone from ~ 29 weeks gestation to term (3). Compared with women managed with diet only, women in the exercise group gained less weight over the intervention period and had a reduced incidence of macrosomia in their offspring. This was despite a 50% compliance rate to the recommended program. No other improvements in obstetric or neonatal outcomes were observed.

Paragraph Number 3 While there is some evidence that commencing exercise upon diagnosis of GDM may limit excessive weight gain, only one study has investigated the effect of exercise on maternal fitness in pregnancies complicated by GDM (5). These authors reported improvements in maternal fitness in response to an aerobic exercise program (30 min at 70% of age-predicted maximal heart rate [HR_{max}], 3-4 times/week [2 supervised]) continued from ≤ 34 weeks gestation to term, compared with a non-exercise control group. The impact of a structured exercise program on other aspects of maternal wellbeing such as mobility, and attitudes and intentions towards exercise in women with GDM have not been examined previously. Therefore, we sought to determine the effect of our home-based exercise program on aerobic fitness, maternal weight gain, self-reported mobility, attitude and intentions towards maternal exercise participation and obstetric and neonatal outcomes. This exercise program has been specifically designed to overcome many of the perceived barriers to exercise during pregnancy reported in previous research, including lack of time, work commitments, taking care of children, fatigue, and no access to exercise equipment (9, 13, 33). Hence, this study is important in determining the efficacy of home-based exercise programs in improving health outcomes of GDM women and their offspring following diagnosis of the condition.

Methods

Participants

Paragraph Number 4 Forty women were recruited from the Diabetes Service at King Edward Memorial Hospital, Perth, Western Australia, within 1 week of GDM diagnosis (fasting venous plasma glucose level ≥ 5.5 mmol·L^{-1}, or 75 g oral glucose tolerance test [OGTT] 2 h venous plasma glucose level ≥ 8.0 mmol·L^{-1} [16]). Inclusion criteria were; a singleton pregnancy, between 26-30 weeks gestation, normal 18 week anatomy scan, body mass index (BMI) ≤ 45 kg·m^{-2}, non-smokers who were not currently engaged in a structured exercise program and were medically cleared for exercise participation. Women were ineligible if they were: less than 18 years of age; unable to understand the implications of participation; on any medications at the time of recruitment or had a low-lying placenta, pre-existing diabetes (type 1 or 2), or cardiac disease. The study was approved by the King Edward Memorial Hospital Human Ethics Committee and The University of Western Australia Human Ethics Committee, and written informed consent was attained from all participants.

Experimental Design

Paragraph Number 5 After recruitment, each participant was visited at their home by the first author (R.E.H) for a baseline assessment. At this visit, standard medical and obstetric data, including maternal date of birth, estimated date of delivery, pre-pregnancy weight, personal and emergency contact details, as well as doctor and hospital contact information were confirmed. Women then completed a series of questionnaires (as subsequently detailed). Maternal blood pressure, height, and body mass were then measured. To assess aerobic fitness, each participant completed an Aerobic Power Index submaximal exercise test (34). This involved graded exercise performed on an upright stationary ergometer (Nordic Fitness, MaXx Series; KH-805) that was transported to each woman's house. Participants cycled at 25 Watt (W) workload increments until a HR equivalent to 75% of age-predicted maximum was attained in order to determine the mean cycling power output (per kg of body mass) that could be achieved at this intensity. Reliability of this protocol has been demonstrated in sedentary (37) and obese (38) populations, and the test has been applied to pregnant women previously (27). Women were then randomized to receive a home-based exercise intervention, in combination with conventional management (EX; *n* = 20), or to continue with conventional management alone until week 34 of gestation (CON; *n* = 20), with the use of concealed, sequentially numbered opaque envelopes that were selected by each participant (12). Conventional management of GDM for both groups involved assessment of glycaemic control and counseling by a diabetes educator and accredited dietician, in combination with self-monitoring of daily fasting and postprandial blood glucose concentration using personal glucometers to ensure capillary glucose targets were achieved.

Paragraph Number 6 Perceived mobility was assessed using the Pregnancy Mobility Index (PMI; 35), which consists of items concerning daily mobility across three scales: daily mobility in the house, ability to perform normal household activities and mobility outdoors. Attitudes and intentions towards exercise were assessed using items that were developed according to Theory of Planned Behavior (TBP) guidelines (1). The attitude scale included four items reflecting experiential (e.g., unenjoyable-enjoyable) and instrumental (e.g., worthless-valuable) attitudes across a seven-point Likert scale. Intention to exercise was assessed using a seven-point Likert scale with two items (i.e., 'I intend to exercise for at least 30 minutes each day for the remainder of my pregnancy'; 'I will try to exercise for at least 30 minutes each day for the remainder of my pregnancy'). Responses to these intention items were made on a 1-7 scale anchored by extremely unlikely/extremely likely (item 1) and definitely false/definitely true (item 2). Cronbach-α coefficients obtained for the attitude and intention scales (both at baseline and week 34 of gestation) indicated that the measures were internally consistent (α ranged from 0.75 to 0.80). Self-reported exercise beliefs (advantages, social influences, and barriers) were also obtained via an open-ended questionnaire.

Exercise Intervention

Paragraph Number 7 The characteristics of the supervised home-based exercise program have been described previously (15). Briefly, participants randomized to the EX group completed three supervised, home-based exercise sessions each week, in addition to two unsupervised exercise sessions completed on alternate days of the week. The exercise program began upon baseline assessment (28.8 ± 0.9 weeks gestation), following the diagnosis of GDM and referral to the diabetes outpatient clinic. Supervised exercise sessions were monitored by an exercise physiologist on an upright stationary cycle ergometer (Nordic Fitness, MaXx Series; KH-805) which was provided to each participant to keep in their home for the duration of the exercise intervention (6 ± 1 weeks). Each session started with a 5 min warm-up of low-intensity (55-65% age-predicted HR_{max}; RPE 9-11) pedaling on the cycle ergometer, followed by a conditioning period that consisted of a combination of continuous steady state cycling at 65-75% age-predicted HR_{max} (RPE 12-14) and intervals consisting of 15-60 s higher intensity (75-85% age-predicted HR_{max}; RPE 15–16) bouts interspersed with lower-intensity (55-65% age-predicted HR_{max}; RPE 9-11) recovery pedaling. The program commenced with 25-30 min sessions at the lower end of the calculated HR ranges during week 1 to familiarize participants with the structured exercise. The intensity and duration of exercise were progressively increased according to individual ability, with the aim of achieving a 45 min session performed at the upper end of the calculated HR ranges by week 4. Each session concluded with 5-10 min of low-intensity (55-65% age-predicted HR_{max}; RPE 9-11) pedaling and gentle static stretching of all major muscle groups.

Paragraph Number 8 Maternal HR (Polar Heart Rate Monitor, Finland) and rating of perceived exertion (RPE) (7) were measured at regular intervals throughout exercise to monitor intensity. If the prescribed target exercise intensity was perceived as hard (> 14 RPE during continuous cycling; >16 RPE during higher effort interval bouts), maternal HR exceeded the 65-75% age-predicted target ranges (> 85% of age-predicted HR_{max} during higher effort interval bouts), or maintaining a conversation was not possible during moderate exercise (talk test) (11), the intensity was reduced accordingly. Exercise sessions were suspended if any warning signs were observed (4). In addition, participants were instructed to engage in 30 min of unsupervised moderate intensity aerobic activity (target RPE 12 to 14) of their choice on two alternate days each week. The mode, duration and intensity of unsupervised sessions were recorded in an exercise diary to allow for compliance and the exercise mode of choice to be monitored.

Follow-Up Assessment of Maternal Health and Fitness Outcomes

Paragraph Number 9 Each participant was reassessed at 34.6 ± 0.3 weeks gestation during a follow-up home-visit. At this time, women completed a duplicate series of questionnaires, and measures of maternal blood pressure, body mass and aerobic fitness were repeated (as described previously).

Assessment of Obstetric and Neonatal Outcomes

Paragraph Number 10 Following delivery, obstetric and neonatal outcomes in the antenatal, intrapartum and postpartum periods were obtained from hospital records. Obstetric outcomes included onset of labor (spontaneous, induced or no labor [caesarean]), duration of labor and mode of delivery (spontaneous vaginal, instrumental or caesarean). Neonatal outcomes included gestational age at delivery, incidence of preterm birth (< 37 weeks gestation), newborn anthropometrics (weight, length, head circumference) and Apgar score at 1 and 5 min.

Data Analysis

Paragraph Number 11 Main treatment effects and interactions for each dependent variable (aerobic fitness, blood pressure, body mass, perceived mobility and attitude and intentions towards maternal exercise) were compared between the two groups and within groups over time using two-way ANOVA (group x time). Obstetric and neonatal outcomes were compared between groups using one-way ANOVA for continuous variables and the chi-square test and Fisher's Exact test for categorical variables. Of the 40 participants recruited, one CON declined to participate in the follow-up testing session for personal reasons and was therefore excluded from further analyses. Statistical significance was accepted as a *p* value of

< 0.05 (SPSS 19.0 for windows computer software package). Continuous variables are presented as mean (± SD) and categorical variables as number (%).

Results

Participant Characteristics

Paragraph Number 12 The CON and EX groups were well matched at baseline, with no difference in maternal age, gestational age, gravidity, parity, body mass, or BMI ($p > 0.05$; Table 1). There was also no difference in the degree of glucose intolerance at diagnosis with similar fasting, 1 and 2 h venous plasma glucose in response to the diagnostic OGTT between groups ($p > 0.05$; Table 1).

Supervised Home-Based Exercise Program

Paragraph Number 13 As detailed previously (15), mean compliance to the supervised cycling program was 96%, with a mean of 1 ± 1 supervised sessions missed over the duration of the intervention for each woman. No adverse effects were reported in response to the exercise intervention. Participants cycled an average of 10.0 ± 1.3 km during the first week of the program (exercise duration 25-30 min), progressing to 14.8 ± 1.4 km during the last week of the program (40-45 min) ($p < 0.001$). Mean maternal HR during the conditioning phase of each session was 138 ± 9 bpm (74 ± 4% of age-predicted HR_{max}) and mean RPE was 14 ± 1, indicating the exercise to be perceived as “somewhat hard”. These variables decreased during the 5 min recovery pedaling to a HR of 115 ± 8 bpm and an RPE of 11 ± 2 (“fairly light”), respectively ($p < 0.001$).

Unsupervised Exercise Sessions

Paragraph Number 14 Participants completed 2 ± 1 unsupervised exercise sessions per week during the intervention. This was in addition to their three scheduled, supervised cycling sessions. The mean duration of exercise was 35 ± 8 min at an RPE of 12 ± 1. Walking and stationary cycling were the most common activities reported (accounting for 52% and 40% of all unsupervised exercise sessions respectively), with participants also engaging in aquatic exercise (5%) and prenatal yoga classes (3%).

Maternal Health and Fitness Outcomes

Paragraph Number 15 Maternal body mass and BMI were similar between groups at baseline ($p = 0.808$, $p = 0.425$, respectively) and increased over the intervention period with advancing gestation for both CON and EX ($p < 0.05$; Table 2). Mean intervention weight gain was similar between CON and EX (1.0 ± 1.8 versus 0.8 ± 1.3 kg respectively, $p = 0.622$). Week 34 systolic and diastolic blood pressures did not differ between the two groups ($p = 0.459$, $p = 0.268$, respectively), or within groups when compared to baseline values ($p > 0.05$).

Paragraph Number 16 Aerobic fitness based on the cycling power output at 75% HR_{max}, was similar at baseline between groups ($p = 0.339$) and remained unchanged at the end of the intervention for CON ($p = 0.716$). However, the EX group significantly improved maternal fitness in response to the home-based exercise training compared with baseline levels ($p < 0.001$), achieving significantly higher power output at the end of the intervention compared with the CON group ($p = 0.012$; Table 2).

Perceived Mobility, and Attitude, Intentions and Beliefs Towards Maternal Exercise

Paragraph Number 17 There was no difference in the component of self-reported daily mobility based on the PMI between the CON (33 ± 16) and EX groups (27 ± 17; $p = 0.219$) at baseline. However, both groups perceived a significant increase in difficulty with daily mobility in the house as pregnancy progressed over the intervention (CONpost 46 ± 20, EXpost; 38 ± 20; $p < 0.05$), with no difference between the two groups ($p = 0.256$). The other two scales of the PMI (experiences with normal household activities and mobility outdoors) were similar between groups at week 34 of gestation and within groups compared with baseline ($p > 0.05$).

Paragraph Number 18 At baseline, there were no differences between groups with respect to attitude (CONpre 6 ± 1, EXpre 6 ± 1) or intentions towards maternal exercise participation (CONpre 6 ± 2, EXpre 6 ± 1) ($p > 0.05$). However, following the intervention, the EX group reported significantly more favorable attitudes towards maternal exercise (7 ± 0) and intention to exercise (6 ± 1), compared with the CON group (6 ± 1 and 5 ± 2, respectively; $p < 0.05$). At baseline, the most frequently reported advantage of maternal exercise for the CON group was to improve maternal health (50%); a husband/partner was the strongest social influence (50%) and the strongest barrier related to having no time (21%). Post-intervention, improving the health of their baby was the greatest advantage of exercise (50%), while a husband/partner and lack of time remained the strongest social influence (100%) and greatest barrier (29%) to exercise participation, respectively. For the EX group, improving labor/delivery, maternal health and wellbeing/energy were equally important at baseline (23%); the husband/partner was the greatest social influence (44%) and having no time to exercise was the greatest barrier (21%). Post-intervention, controlling blood glucose concentrations was the most frequently reported advantage of exercise (36%), an exercise trainer was the strongest social influence (57%) and lack of access to an appropriate exercise facility was the most commonly reported barrier to exercise (24%; Table 3).

Obstetric and Neonatal Outcomes

Paragraph Number 19 No differences were observed between the CON and EX groups with respect to onset, mode or duration of labor ($p > 0.05$, Table 4). Gestational age at delivery, incidence of preterm birth and mean neonatal anthropometrics and Apgar scores at 1 and 5 min were also similar between groups ($p > 0.05$, Table 4).

Discussion

Paragraph Number 20 The diagnosis of GDM may present a unique opportunity for the implementation of lifestyle interventions given the frequent patient interaction with the health care system, as well as the woman's concern with the increased risks of adverse health outcomes for herself and her child. Yet, regular structured exercise is not currently part of routine antenatal diabetic care, with many GDM women not meeting current exercise recommendations despite the perceived benefits of remaining active during pregnancy (33). We have recently shown that a structured home-based exercise program can overcome many barriers to exercise in GDM women, providing for enhanced program compliance, and benefiting management of the condition through improved daily postprandial glucose control (15). The present study aimed to determine the efficacy of this program for maternal weight control, improving aerobic fitness and perceived mobility, together with attitudes, intentions and beliefs towards maternal exercise participation and the impact on obstetric and neonatal outcomes. We found that as little as 6 weeks of structured exercise improved maternal aerobic fitness and enhanced attitudes and intentions towards exercise, compared with a standard care control group. No differences in maternal weight gain, blood pressure, perceived mobility or pregnancy outcomes were noted.

Paragraph Number 21 With respect to maternal fitness, we observed a 0.3 W/kg increase in power output at 75% of HR_{max}. This translates to a > 20 W increase in cycling power output for a 75 kg woman (based on the mean body mass of the participants in the present study), which in turn translates to a 20% improvement in absolute power output. Indeed, there is evidence to suggest that improving cardiorespiratory fitness during pregnancy, independent of changes to body mass, may benefit labor and delivery outcome, ease the demands of caring for a new baby and have a protective effect against postpartum adverse health outcomes and all-cause mortality (20, 24, 28). Our findings confirm previous research reporting the cardiorespiratory benefits of a regular exercise program for GDM pregnancies (5). Importantly, we have shown that improved fitness can be achieved with just 6 weeks of exercise training commenced during late gestation in GDM women.

Paragraph Number 22 Despite the improvement in aerobic fitness in the EX group, there was no difference between groups with respect to maternal weight gain over the intervention period. This is consistent with previous exercise interventions in GDM pregnancies (5, 8, 10, 19), but does not support Artal et al. (3), who found that aerobic exercise was successful in limiting maternal weight gain. However, it is important to note that the latter study was restricted by self-selection to the intervention based on pre-existing contraindications and personal preference to exercise, and therefore may not have the comparable strength of a study in which women are randomized to an exercise intervention. For instance, it is possible that women who self-select to engage in an exercise program may be more proactive in their diabetic management compared with women who do not. Furthermore, women in the study of Artal et al. (3) continued the exercise plus diet intervention from 29.4 ± 4.9 weeks gestation to term (~ 9 weeks), compared with our 6 week intervention period. Perhaps a difference in weight between the two groups in the present study may have emerged if the duration of the intervention was extended. It is also possible that exercise alone may not impact weight gain, perhaps as a result of compensatory eating, compensatory reductions in lifestyle physical activity or other important regulating factors for maternal weight such as genetics. However, in the present study, average daily energy intake during the last week of the intervention and weekly physical activity (i.e. physical activity outside of the intervention; excluding sports/exercise participation which was significantly higher in EX; CON 8 ± 9 $MET \cdot h \cdot wk^{-1}$; EX 25 ± 9 $MET \cdot h \cdot wk^{-1}$; $p < 0.001$) were similar between CON and EX post-intervention and did not change significantly over the duration of the intervention for either group (15).

Paragraph Number 23 The exercise program was not sufficient to overcome late pregnancy-related limitations, with both groups reporting an increase in difficulty with daily mobility with advancing gestation. This may relate to the weight-supported exercise modality used in the present investigation (stationary cycling), whereas the PMI is a measure of mobility across a range of physical activities that may not be improved from cycling alone. The home-based exercise program also had no effect on maternal blood pressure, which is not surprising given that all women studied were normotensive at the start of the intervention. Furthermore, despite an improvement in aerobic fitness, no impact on mode of delivery, duration of labor, gestational age at delivery, incidence of preterm birth or newborn anthropometrics was observed in response to the exercise intervention. Overall health status of the newborn was also unaffected by exercise training, as reflected by the similar Apgar scores in both groups. The lack of difference in obstetric and neonatal outcomes observed in our study is consistent with previous exercise interventions implemented upon diagnosis of GDM (5, 8, 10, 19), with Artal et al. (3) the only investigation to report a difference between groups; specifically a lower incidence of macrosomic neonates in physically active GDM women. Studies utilizing a longer intervention period (perhaps extended until term) and a larger sample size are required to confirm the effect of regular exercise on obstetric and neonatal outcomes in women diagnosed with GDM. In addition, since the present investigation only examined neonatal birth weight, it will be important for future studies to make more detailed analysis of body composition by calculating neonatal fat mass or ponderal index. Nonetheless, the similar pregnancy outcome observed between the two groups is reassuring regarding the safety of such an exercise program for women with GDM.

Paragraph Number 24 Of particular interest, we found that women's attitudes and intentions towards exercise were improved following the home-based exercise program. This finding is important as continued participation in physical activity during pregnancies complicated by GDM may benefit the health of women and their offspring, as well as improve overall public health by lowering the burden of other chronic diseases (14). However, it should be acknowledged that physical activity levels were not monitored past the cessation of the intervention period in the present study, so whether the changes in attitudes and intentions translated into a sustained increase in physical activity levels remains to be determined. The strongest perceived advantage of exercise participation for the CON group at baseline was to improve maternal health outcome, while at the end of the intervention it was to improve the health of their baby. For the EX group, perceptions of improving labor/delivery, maternal health, and wellbeing/energy were of equal importance at baseline, while controlling blood glucose concentrations was perceived as the strongest advantage of exercise at the end of the intervention. This change is might be attributed to the women directly seeing the acute pre- to post-exercise decline in blood glucose concentrations in response to the exercise training as detailed in our previous study (15). Based on these findings, GDM diagnosis may be an opportune time to intervene as women may be more receptive to a recommendation of physical activity to improve outcomes for themselves and/or their baby. The women's husband/partner was the strongest influence to exercise participation for both groups at baseline and remained the strongest influence at week 34 of gestation for CON. However, upon completion of the intervention, the EX group reported an exercise trainer to be the strongest influence to continuing exercise participation. This highlights the important influence that providing support and supervision throughout exercise training may have for exercise adherence and should be considered when designing and implementing exercise programs for GDM pregnancies. At baseline, having no time was the strongest barrier to exercise participation for both groups and remained the strongest barrier for CON at the end of the intervention. Interestingly, the home-based program appeared to overcome this barrier, perhaps through the convenience of a trainer visiting the home, thereby reducing travel time to exercise facilities and allowing for the incorporation of home-responsibilities (i.e. caring for other children). Having no access to an appropriate exercise facility was the strongest barrier to continuing exercise participation reported by the EX group at the end of the intervention. This may be attributed to the removal of the exercise bike following the study training period, which suggests that continued support after the intervention is important during the later stages of pregnancy if such a program is put into practice.

Paragraph Number 25 In summary, these findings demonstrate the efficacy of a supervised, home-based exercise program to improve third trimester aerobic fitness, in addition to attitude and intentions towards maternal exercise following the diagnosis of GDM. Importantly, this is added to the benefit of such an exercise program for maternal glycaemic control, as we have demonstrated previously. Accordingly, utilizing exercise interventions in combination with standard diabetic care following the diagnosis of GDM may be an effective adjunctive strategy to overcome common barriers to maternal exercise, increase participation adherence and establish lifestyle changes for women with the condition.

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