Supervised home-based exercise may attenuate the decline of glucose tolerance in obese pregnant women

M.J. Ong a, K.J. Guelfi a,*, T. Hunter b, K.E. Wallman a, P.A. Fournier a, J.P. Newnham b

a School of Sport Science, Exercise and Health, The University of Western Australia, 35, Stirling Highway, Crawley WA 6009, Australia
b School of Women’s and Infants’ Health, The University of Western Australia, Subiaco, WA, Australia

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Abstract

Aim. – The significant deterioration of insulin sensitivity and glucose tolerance during pregnancy can have serious health implications for both the pregnant woman and her baby. Although it is well established that regular exercise benefits insulin sensitivity in the nonpregnant population, the effect on glucose tolerance in obese pregnant women is not known. The purpose of this study was to investigate the effect of a supervised 10-week, home-based, exercise programme, beginning at week 18 of gestation, on glucose tolerance and aerobic fitness in previously sedentary obese women.

Methods. – Twelve sedentary obese women were randomized into an exercise (EX; n = 6) or control (CON; n = 6) group at 18 weeks of gestation. Those randomized to EX engaged in 10 weeks of supervised home-based exercise (three sessions a week of stationary cycling), while those in the CON group maintained their usual daily activity. Their glucose and insulin responses to an oral glucose tolerance test (OGTT), as well as their aerobic fitness, were assessed both pre- and postintervention.

Results. – Reduced glucose tolerance in the CON, but not EX, group was indicated by a tendency postintervention towards higher blood glucose levels at 1 h of the OGTT (P = 0.072). Furthermore, at 2 h of the postintervention OGTT, blood glucose tended to remain elevated from baseline in the CON (P = 0.077). There was also a trend towards increased fitness in the EX (P = 0.064), but not the CON group.

Conclusion. – Regular aerobic exercise begun during pregnancy may have favourable effects on glucose tolerance and fitness in obese women, and warrants further investigation in a larger sample population.

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Keywords: Physical exercise; Training; Pregnancy; Gestational diabetes mellitus; Glucose tolerance; Aerobic fitness

Résumé

L’exercice physique à domicile sous supervision peut ralentir le déclin de la tolérance au glucose chez la femme enceinte obèse.

But. – Une détérioration marquée de la sensibilité à l’insuline et de la tolérance au glucose pendant la grossesse peut avoir des conséquences négatives sur la santé de la femme enceinte et son enfant. Bien qu’il soit bien établi que la sensibilité à l’insuline s’améliore en réponse à l’exercice physique régulier, il restait à le démontrer chez la femme obèse enceinte. Le but de cette étude était d’examiner les effets de dix semaines d’exercice supervisé à domicile commençant après 18 semaines de grossesse sur la tolérance au glucose et les capacités aérobies de la femme auparavant sédentaire et obèse.

Méthodes. – Après 18 semaines de grossesse, 12 femmes obèses et sédentaires ont été assignées par randomisation dans deux groupes, l’un pratiquant un exercice (n = 6), l’autre un groupe témoin (n = 6). Les participantes du groupe exercice ont réalisé durant dix semaines un exercice supervisé à domicile (trois sessions par semaine d’exercice sur vélo d’appartement), les femmes du groupe témoin gardant leurs activités habituelles. La réponse de la glycémie et de l’insulinémie à une hyperglycémie provoquée par voie orale (HGPO), ainsi que les capacités aérobies ont été mesurées avant et après exercice.

Résultats. – Une tendance à une détérioration glycémique a été observée dans le groupe témoin, avec une tendance à une augmentation de la glycémie une heure et deux heures après HGPO (respectivement P = 0.072 et P = 0.077). Une tendance à de meilleures capacités aérobies (P = 0.064) a été observée dans le groupe des femmes pratiquant un exercice physique, mais non chez les femmes témoins.

* Corresponding author.
E-mail address: kym.guelfi@uwa.edu.au (K.J. Guelfi).

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1. Introduction

Pregnancy is associated with a natural resistance to insulin caused by hormonal changes in the expectant mother [1]. This natural resistance to insulin is managed throughout a healthy pregnancy by an intrinsic compensatory rise in insulin secretion to maintain blood glucose levels within a desirable range. However, if this compensatory action fails and resistance to insulin becomes dominant, then impaired glucose tolerance, with progression to overt gestational diabetes mellitus (GDM), may result. This can have serious acute and long-term health implications for both the pregnant woman and her child, including the increased risks of the subsequent development of type 2 diabetes in the mother, and of obesity, type 2 diabetes and the metabolic syndrome in the child later in life [2,3].

Regular exercise has been reported to potentially benefit the incidence of GDM in lean women [4]. However, to the best of our knowledge, the effect of regular aerobic exercise on glucose tolerance in obese pregnant women is not known, despite the fact that the risk of developing GDM is closely linked to obesity [5]. Therefore, the purpose of the present study was to investigate the effect of 10 weeks of supervised home-based exercise on glucose tolerance and aerobic fitness in previously sedentary obese pregnant women.

2. Methods

Twelve sedentary obese women (age ± S.D. = 30 ± 4 years; body mass index [BMI] = 35.1 ± 3.5 kg/m²) were recruited, each with a singleton pregnancy, a normal 18-week anatomy scan and no evidence of cardiovascular disease or preexistent diabetes. Ethics approval was obtained from the King Edward Memorial Hospital Ethics Committee, and written consent was obtained from each participant.

At 18 weeks of gestation (preintervention), each woman completed a 75 g oral glucose tolerance test (OGTT) at 07 h 30 in a fasted state. On a different day, each participant also completed an Aerobic Power Index test at submaximum level to assess maternal aerobic fitness [6]. Briefly, this involved incremental cycling, starting with a workload of 25 W and increasing by 25 W increments each minute until the heart rate reached 75% of the age-predicted maximum (HRmax). This establishes the workload at which the target heart rate (75% HRmax) is achieved, which can then be compared between trials; with higher workloads indicating higher levels of aerobic fitness. This test has been proven to be a highly reliable protocol in both sedentary [7] and obese [8] populations.

Each participant was then randomly allocated into either an exercise intervention group (EX; n = 6) or a control group (CON; n = 6). Participants randomized to CON continued with their usual daily activities, while those in EX engaged in 10 weeks of home-based supervised exercise (three sessions per week). Exercise training was performed on an upright stationary cycle ergometer (Marquee Series, Healthstream) that each participant kept in her home for the duration of the intervention. Each session involved a 10 min warm-up followed by one or two 15 min bouts of cycling (with rest periods if necessary) at an intensity of 50–60% HRmax. As the weeks progressed, the exercise intensity was increased to 60–70% HRmax, while the duration was increased to 40–45 min. Sessions ended with a 10 min cool-down period of easy pedalling.

All of the women involved in the study received regular antenatal care throughout the intervention period. At the end of the intervention (week 28 of gestation), another OGTT and Aerobic Power Index submaximum test were performed. Insulin sensitivity was determined from the OGTT using the oral glucose insulin sensitivity (OGIS) index devised by Mari et al. [9] and previously validated in an antenatal population [10]. In addition, all participants completed the Pregnancy Physical Activity Questionnaire [11] before and after the intervention to monitor any changes in physical activity levels over the 10-week study period.

Data were analyzed using repeated measures of ANOVA, followed by paired- and independent-sample t tests to identify any significant differences over time and between groups, respectively. All analyses were performed using SPSS® version 15.0 software for Windows®. Statistical significance was accepted at the level of P < 0.05.

3. Results

Age, height, body mass and BMI were similar between the two study groups at baseline (P > 0.05). There was a main effect of time on both body mass (P = 0.0001) and BMI (P = 0.001), with an increase observed over the 10-week intervention period. Although the gain in body mass was greater in CON (5.2 ± 1.3 kg) compared with EX (3.7 ± 3.4 kg), the difference was not statistically significant (P = 0.155). No negative effects were reported as a result of exercise: heart rate was maintained at below 70% HRmax; and the mean rating of perceived exertion of 12 during each session indicated that the exercise training was considered “not too hard” [12]. Compliance rate was excellent, with EX completing 94% of all scheduled sessions during the 10-week study period. In addition, there were no significant differences in total self-reported physical activity levels outside of the intervention over time (P = 0.813) or between groups (P = 0.910).

The responses of blood glucose and insulin levels during the preintervention OGTT were similar in both groups (P > 0.05; Fig. 1) and, following the 10-week intervention,
the blood glucose response to OGTT in EX remained similar to preintervention levels. In contrast, the glucose tolerance in CON worsened, as indicated by a trend towards higher blood glucose levels at 1 h postglucose ingestion compared with preintervention levels ($P = 0.072$). Furthermore, at 2 h of the postintervention OGTT, there was a tendency for blood glucose to remain elevated from baseline (0 min) in CON ($P = 0.077$), whereas glucose levels returned to baseline in EX ($P = 0.480$). Although insulin levels were higher postintervention in both groups, the difference was not significant. Despite these observations, there were no significant differences between groups in glucose or insulin after the intervention. Likewise, there was no significant interaction of time and group on insulin sensitivity based on the OGIS model ($P = 0.638$), despite a noticeably greater decline over the intervention period in CON (preintervention: $354 \pm 29 \text{mL.min}^{-1}\text{m}^{-2}$; postintervention: $324 \pm 44 \text{mL.min}^{-1}\text{m}^{-2}$) compared with EX (preintervention: $369 \pm 50 \text{mL.min}^{-1}\text{m}^{-2}$; postintervention: $363 \pm 62 \text{mL.min}^{-1}\text{m}^{-2}$). As for maternal aerobic fitness, there was a trend towards increased fitness following the intervention (indicated by higher cycling power output at 75% $HR_{\text{max}}$) in EX ($P = 0.064$), but not in CON ($P = 0.699$; data not shown).

4. Discussion

Although the benefit of regular exercise on the incidence of GDM has been established in lean women [4], its effect on glucose tolerance in obese pregnant women has not been previously examined. Yet, this is an important issue as impaired glucose tolerance, with or without progression to overt GDM, may be linked to the development of the metabolic syndrome, postpartum diabetes and adverse pregnancy outcomes [13]. We found that 10 weeks of supervised home-based exercise, commenced at 18 weeks of gestation, may attenuate the decline of glucose tolerance in obese pregnant women. More specifically, women who completed the exercise programme maintained a similar blood glucose response to OGTT throughout the exercise intervention period, while those in the control group experienced worsening of glucose tolerance, as indicated by a trend towards higher blood glucose levels in response to OGTT postintervention.

However, the favourable response to exercise training was not associated with marked changes in levels of circulating insulin to OGTT. Indeed, the tendency in CON towards higher blood glucose levels at 1 h post-OGTT at 28 weeks of gestation compared with preintervention levels may have important implications, given that impaired glucose tolerance at 1 h of the OGTT has been associated with postpartum hyperglycaemia, insulin resistance and beta-cell dysfunction, in the same way as GDM [13]. This suggests that regular aerobic exercise may be a promising strategy for attenuating the decline of glucose tolerance, as well as its associated future health consequences, in obese pregnant women.

We also observed a trend towards increased aerobic fitness in EX, but not in CON, as indicated by the higher cycling
power output at 75% HRmax postintervention achieved by the EX women. Although others have reported improved aerobic fitness during pregnancy in lean [14] and in overweight [15] women, we are not aware of any such study in obese pregnant women. It is also important to note that there were no adverse effects reported by the participants involved in the exercise intervention, suggesting that previously sedentary obese women can be safely encouraged to take up structured exercise during pregnancy. In addition, the high rate of compliance was probably due to the supervised home-based setting of the intervention, allowing the exercise to be undertaken in a comfortable and familiar environment.

Overall, these findings suggest that regular aerobic exercise may be a promising strategy for attenuating the decline of glucose tolerance during pregnancy in women at high risk of developing GDM. These favourable trends warrant further investigation using a larger number of participants and a longer period of intervention. A positive outcome may have profound implications for the prevention of obesity, type 2 diabetes and the metabolic syndrome at its very roots.

Conflicts of interest

No potential conflicts of interest relevant to this article was reported.

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