Community-based Exercise and Dietary Intervention During Pregnancy: A Pilot Study

Amy L. Hui1 MSc RD, Sora M. Ludwig1 MD FRCPC, Phillip Gardiner2 PhD, Gustaaf Sevenhuysen3 PhD, Robert Murray1 PhD, Margaret Morris5 MD FRCSC, Garry X. Shen1 MD PhD

1Department of Medicine, University of Manitoba, Winnipeg, Manitoba, Canada
2Faculty of Physical Education and Recreation Studies, University of Manitoba, Winnipeg, Manitoba, Canada
3Department of Human Nutritional Sciences, University of Manitoba, Winnipeg, Manitoba, Canada
4Department of Community Health Sciences, University of Manitoba, Winnipeg, Manitoba, Canada
5Department of Obstetrics & Gynecology, University of Manitoba, Winnipeg, Manitoba, Canada

ABSTRACT

OBJECTIVE

To determine the feasibility of implementing a community-based exercise/dietary intervention program targeted at socio-economically deprived pregnant women living in an urban core in an attempt to reduce risks of obesity and diabetes.

METHODS

Fifty-two participants were enrolled and randomized into additional intervention (AI) and standard care (SC) groups. Participants in the AI group undertook group and home-based exercises during pregnancy and received computer-assisted Food Choice Map dietary interviews and counselling. Participants in the SC group received an information package on diet and activity for a healthy pregnancy.

RESULTS

Forty-five participants completed the study (SC group, n=21; AI group, n=24). No adverse effects of exercise were observed during the study. Physical activity levels in the AI group were greater than those in the SC group (p<0.01). Favourable trends in the reduction of excessive weight gain, gestational diabetes mellitus, macrosomia and the need for interventions related to weight gain at birth in the AI group compared to the SC group.

Keywords: diet, exercise, gestational diabetes mellitus, pregnancy, weight gain

Address for correspondence:
Garry X. Shen
Diabetes Research Group
University of Manitoba
835–715 McDermot Avenue
Winnipeg, Manitoba
R3E 3P4 Canada
Telephone: (204) 789-3816
Fax: (204) 789-3987
E-mail: gshen@ms.umanitoba.ca

OBJECTIF

Déterminer la faisabilité de la mise sur pied d’un programme communautaire d’intervention en matière d’exercice et d’alimentation à l’intention de femmes enceintes démunies sur le plan socio-économique habitant en milieu urbain pour tenter de réduire les risques d’obésité et de diabète.

MÉTHODES


RÉSULTATS

Quarante-cinq participantes ont terminé l’étude (groupe SS, n = 21; groupe IS, n = 24). On n’a pas observé d’effet indésirable de l’exercice au cours de l’étude. Le niveau d’activité physique a été plus élevé dans le groupe IS que dans le groupe SS (p < 0,01). On a observé des tendances favorables en ce qui a trait à la réduction du gain de poids excessif, du diabète gestационnel, de la macrosomie et de la nécessité d’interventions liées au poids au moment de la naissance dans le groupe IS par rapport au groupe SS.
INTRODUCTION
The prevalence of type 2 diabetes mellitus and obesity has been rapidly increasing in Canada, and this trend is expected to continue. In 1999/2000, the prevalence of diabetes among Canadians was 5%, with ~90% of those having type 2 diabetes (1,2). Obesity is one of the most important etiological factors for type 2 diabetes, and Aboriginal Canadians are among the populations with the highest prevalence of type 2 diabetes and obesity in the world. In Aboriginal communities, two-thirds of diabetes cases occur in women, and the incidence is closely related to obesity (3-5). As well, the prevalence of obesity in Canadian children increased 4 to 5 times between 1981 and 1996 (6). Previous studies have suggested that excess weight gain during pregnancy and gestational diabetes mellitus (GDM) are associated with obesity and diabetes in later life for mothers, but also with macrosomia and obesity in their children (7). High birth weight is linked to subsequent development of type 2 diabetes in the Canadian Aboriginal population (8). Prevention of obesity and diabetes during pregnancy may greatly benefit the health of this community in subsequent generations.

Excess intake of unhealthy foods and lack of physical activity have been recognized as etiological factors for the epidemics of obesity and type 2 diabetes (9-11). Mild physical activity has recently been recommended for pregnant women who have no contraindications for exercise (12,13). Exercise was used in a pilot study of 8 Aboriginal women with a history of GDM in Saskatoon, Saskatchewan, Canada, but a low referral rate (n=20 over a 2-year period) was considered to be the major limitation for enrollment in that study (14). A diet and activity program was also carried out in pregnant women living in 4 Aboriginal communities in Quebec, Canada; no significant changes in pregnancy outcomes were detected in the participants receiving intervention in that study as compared with a group of women who had had their pregnancy during an earlier period in the same communities (15). The protocols for undergoing physical exercise in pregnant women have not been standardized. The efficacy or safety of exercise in pregnant women as a means of preventing obesity or GDM must be examined in randomized, controlled trials.

We conducted a pilot randomized, controlled trial using exercise and dietary intervention in pregnant women living in urban Winnipeg, Manitoba, Canada. The objectives were to demonstrate the feasibility, safety and potential benefits of a community-based lifestyle intervention to improve pregnancy outcomes.

METHODS
Subjects
Pregnant women (<26 weeks of pregnancy) with no pre-existing diabetes were recruited on a voluntary basis from July to December 2004 from attendees in Healthy Start for Mom & Me prenatal class, Youville Community Challenge (a community nurse-managed centre) and the Manitoba Clinic, both in urban Winnipeg, Manitoba, Canada. A total of 101 women expressed interest in participating in the exercise and dietary intervention program. The risk for each candidate for exercise during pregnancy was assessed using PARmed-X for Pregnancy (16). Approval from a family physician or other prenatal caregiver was required for every participant. Candidates were excluded if they had medical, obstetric, skeletal or muscular disorders that could contraindicate physical exercise during pregnancy. Seventy-two women were found to be eligible for the study; 52 participants in weeks 20 to 30 of pregnancy were enrolled and randomized to either the additional intervention (AI) or standard care (SC) group. The remaining women were not enrolled due to late arrival of approvals (>30 weeks of pregnancy) or lost contact. Study protocol and consent were approved by the Research Ethics Board of the University of Manitoba, Winnipeg.

Assessment of physical activity and food intake
Recreational physical activities of participants were assessed using the PARmed-X for Pregnancy form based on Health Canada recommendations (17). Low levels (physical activity=0) are defined as either no physical activity or activity <1 to 2 times per week and for <20 min per session; moderate levels (physical activity=1) are defined as activity 1 to 2 times per week for >20 min per session or >2 times per week but for <20 min per session; high levels (physical activity=2) are defined as activity >2 times per week and for >20 min per session (16). All participants’ regular food intake was also assessed using a Food Frequency Questionnaire from the Manitoba Heart Health Project (18). Physical activity levels and food intake at entry to the program and late in the third trimester (32 to 36 weeks’ gestation) were determined using the same approaches.

CONCLUSIONS
The results of this pilot study demonstrated the feasibility of the lifestyle intervention during pregnancy and its potential to improve pregnancy outcomes in urban communities.
Exercise intervention
Lifestyle intervention was conducted between August 2004 and April 2005. Participants in the AI group were instructed in group-session exercises and in home-based exercise. Recommended activities included walking, swimming, mild aerobics, stretching and strength exercise (such as lifting a 500 g food can with each hand). Weekly group sessions were held in an air-conditioned gymnasium in a community centre in the urban core provided by the government of the city of Winnipeg. Floor aerobics, stretching and strength exercises in group sessions (~45 min/session) were led by professional trainers. Student assistants taught participants to correctly use a pedometer, self-monitor their heart rate and record daily physical activities in a diary before or after the sessions. Exercise 3 to 5 times per week for 30 to 45 min per session was recommended for participants in the AI group. Video exercise instruction was produced in both VHS and DVD formats and provided to participants to assist with home-based exercise. Information about daily physical activity, including a self-recorded activity diary, were collected and analyzed by student research assistants. Physical activity was recommended for participants in the SC group, but they were not instructed in the group exercise sessions or on home-based exercise.

Nutrition intervention
The Food Choice Map (FCM) interview (19) served as a tool for both assessment and intervention at an early stage of the program for participants in the AI group using FCM software (designed by G. Sevenhuyzen) and accessories (Northern Technical Data Inc., Winnipeg, Manitoba, Canada). During the interview, participants recalled their usual food intake during 1 week. Registered dietitians placed magnets with food images and bar codes on a board with spaces for meals or snacks in a regular week, based on information received during the interview. The bar codes on the magnets, representing various food items and portion sizes, were scanned into a computer. FCM software analyzed total energy and macronutrients in daily intake, as well as gestation week-related weight gain based on information received during the interview. Dietitians provided a personalized plan for participants, including recommended changes in food choice, frequency, portion size and pattern of intake, if required. For participants in the SC group, an information package of dietary recommendations for a healthy pregnancy.

Follow-up and data collection
A post-gestational visit was arranged for all participants to collect information on the general health of mothers and infants. Information on delivery method, gestational weeks, newborn weight and birth-weight-related obstetrics (induction, manoeuvres, forceps or cesarean section) was collected from medical charts in hospitals after delivery. Diagnosis of GDM or impaired glucose tolerance (IGT) was made based on the Canadian Diabetes Association’s clinical practice guidelines (20). Excess weight gain was assessed based on pre-pregnancy body mass index (BMI). For women with a pre-pregnancy BMI of <20 kg/m², recommended normal weight gain during pregnancy ranged from 12.5 to 18 kg; for those with a pre-pregnant BMI of 20 to 27 kg/m², the upper limit of weight gain was 16 kg; and for those with a pre-pregnant BMI of >27 kg/m², the upper limit of weight gain was 11.5 kg (21).

Outcomes
Primary outcomes of this pilot study included the feasibility of the study; the safety of the lifestyle intervention program; and the compliance and adherence of participants to the program. Secondary outcomes were weight gain and rate of excessive weight gain; birth weight and rate of macrosomia; incidence of GDM; and need for weight-related birth procedures. Assessment of secondary outcomes was expected to be limited by sample size; however, outcomes from the present pilot study will contribute to the design of subsequent trials.

Statistical analysis
Data from the 2 groups were analyzed for differences using the Student t test. Differences between observed and expected numbers were analyzed using a Chi-square test. Linear regression analysis was performed using SigmaPlot software (Systat Software Inc., Point Richmond, California, United States). Sample sizes were calculated using power analysis (2-tailed test, 1-beta=0.8, alpha=0.05) as previously described (22). Significance level was preset as p<0.05.

RESULTS
Fifty-two participants were enrolled and randomized into additional intervention (AI) and standard core (SC) groups. Forty-five women completed the lifestyle program; their sociodemographic information is summarized in Table 1. No significant differences were found in age, pre-pregnancy BMI or family income between the AI and SC groups. Average family incomes were estimated from residential postal codes in Winnipeg in 2001. Among participants from visible minority groups, two-thirds were Aboriginal and the remainder were Asian. The percentages of visible minority or Aboriginal participants in the AI and SC groups were not significantly different. The vast majority of participants (89%) were from low-income (<$30 000 per year) or low-middle-income (<$60 000 year) families, and no significant difference in family income was found between the 2 groups (Table 1).

Seven pregnant women dropped out due to school or work commitments (19.7±3.3 years, p<0.01 vs. women who completed the study). Four of those were teenagers, and 2 were members of visible minorities. The average family income ($27 404±8272/year) of those who dropped out was significantly lower than that of those who completed the program (p<0.01). Levels of pre-pregnant BMI (28.4±8.6 kg/m²; 3 were <27 kg/m², 4 were ≥27 kg/m²)
and education (10.0±0.9 years) in those who dropped out were not significantly different from those who completed the program.

Weight gain during pregnancy and weight of the newborn were not significantly different between the 2 groups (Table 2). Levels of recreational physical activity at entry were not significantly different between the 2 groups. Level of physical activity near the end of pregnancy (32 to 36 weeks) was significantly higher than baseline in the AI group (p<0.01), but not in the SC group (Table 2). Two-thirds of the participants in the AI group went to group exercise sessions ≥3 times; several participants attended group sessions until the last week before delivery. No adverse effects or accidents occurred during exercise in the present study. Nutritional intake (total calories and macronutrients) at entry and late third trimester was not significantly different between the AI and SC groups.

Incidence of excessive weight gain, based on the recommendations of Health Canada according to pre-pregnancy BMI (16) was 33% (7/21) in the SC group and 21% (5/24) in the AI group (p=0.70) (Figure 1). Incidence of GDM was 10% (2/21) in the SC group and 4% (1/24) in the AI group (p=0.50). Incidence of the need for birth-weight-related obstetric procedures, including induction, manoeuvres, forceps and cesarean section, was 14% (3/21) in the SC group and 4% (1/24) in the AI group (p=0.91). Incidence of babies >4000 g (macrosomia) was 19% (4/21) in the SC group and 8% (2/24) in the AI group (p=0.79). No trend of difference was detected in rate of preterm delivery between the 2 groups (Figure 1). Power analysis indicated that significant differences in the rate of excessive weight gain, GDM, macrosomia or weight-related birth procedures in the same population and using identical procedures in subsequent trials would require sample sizes of ≥315 to 700 for 2 equal-sized groups.

Pearson correlations were calculated for age, pre-pregnancy BMI, average income, baseline physical activity, late third-trimester physical activity, gestation week, pregnancy weight gain, newborn birth weight, excessive weight gain, GDM/IGT and weight-related birth procedures in all participants (n=45, except for GDM/IGT, which was n=41 due to 4 participants missing data for the oral glucose tolerance test). Correlations were found between newborn birth weight and gestational week (r=0.42, p=0.004) and weight-related birth procedures (r=0.34, p=0.021); between pre-pregnancy BMI and late third-trimester physical activity (r=−0.37, p=0.013), GDM/IGT (r=0.32, p=0.04) and weight-related birth procedures (r=0.49, p=0.001); between GDM/IGT late third-trimester physical activity (r=−0.55, p<0.001) and weight-related birth procedures

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**Table 1. Sociodemographic data of participants**

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<th>Parameters</th>
<th>SC group (n=21)</th>
<th>AI group (n=24)</th>
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</thead>
<tbody>
<tr>
<td>Age (years)*</td>
<td>26.2±5.7</td>
<td>26.2±5.4</td>
</tr>
<tr>
<td>Pre-pregnant BMI (kg/m²)*</td>
<td>25.7±6.3</td>
<td>23.4±3.9</td>
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<tr>
<td>Visible minority (%)†</td>
<td>67</td>
<td>61</td>
</tr>
<tr>
<td>Aboriginal (%)</td>
<td>57</td>
<td>38</td>
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<tr>
<td>Average family income ($/y)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;30 000 (%)</td>
<td>40 620±33 820</td>
<td>41 383±16 287</td>
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<td>30 000–60 000 (%)</td>
<td>33</td>
<td>29</td>
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<td>60 000–80 000 (%)</td>
<td>62</td>
<td>54</td>
</tr>
<tr>
<td>Education (years)*</td>
<td>11.8±2.6</td>
<td>13.4±3.2</td>
</tr>
</tbody>
</table>

*Values are mean±SD
†Including Aboriginal
AI = additional intervention
BMI = body mass index
SC = standard care

**Table 2. Comparison of weight gain, newborn weight, pregnancy duration and physical activity between AI and SC groups**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>SC group (n=21)</th>
<th>AI group (n=24)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight gain during pregnancy (kg)</td>
<td>14.2±6.3</td>
<td>14.2±5.3</td>
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<tr>
<td>Weight of newborn (g)</td>
<td>3428±493</td>
<td>3402±473</td>
<td>0.55</td>
</tr>
<tr>
<td>Pregnancy duration (weeks)</td>
<td>39.0±1.64</td>
<td>39.3±1.15</td>
<td>0.86</td>
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<tr>
<td>Physical activity level, baseline*</td>
<td>1.52±0.68</td>
<td>1.17±0.87</td>
<td>0.14</td>
</tr>
<tr>
<td>Physical activity level, end of study†</td>
<td>1.48±0.68</td>
<td>1.96±0.20†</td>
<td>0.005</td>
</tr>
</tbody>
</table>

*At study entry
†Between 32 and 36 weeks’ gestation
‡Significant difference from baseline, using the Student t-test
All values are mean±SD

AI = additional intervention
SC = standard care
Community-based prenatal programs may attract women of multicultural backgrounds with low or low-middle family income—populations with relatively poor pregnancy outcomes and high incidences of obesity and diabetes. The results of this pilot study suggest that collaboration with a community prenatal program provides an infrastructure that facilitates recruitment and encourages the involvement of pregnant women in lifestyle intervention to prevent diabetes and obesity in mothers and their children. This pilot study has received extensive support from both local communities and pregnant women. Our preliminary results demonstrate that community-based lifestyle intervention is feasible for pregnant women living in the urban Winnipeg region. Required human resources or facilities for the lifestyle intervention program—including dietitians, exercise trainers, students and local community-research assistants, gymnasium, video/audio equipment and dietary interview instruments—are available or accessible to other Canadian urban communities. This lifestyle intervention program for pregnant women is expected to be feasible for other urban communities in Canada.

In the past, there has been a concern for the safety of the fetus as a result of the practice of exercise during pregnancy. However, recently published guidelines from both the American College of Obstetricians and Gynecologists and the Society of Obstetricians and Gynaecologists of Canada indicate that moderate physical activity in pregnant women without contraindications to exercise is safe for both mother and fetus (12,13). Nevertheless, such recommendations remain to be verified in clinical trials. The results of our pilot study support the recommendations for mild exercise in pregnant women without contraindications. Lifestyle interventions for pregnant women are difficult to maintain due to the physiological changes of pregnancy, particularly in the late third trimester. The structure of a community program may provide peer and other supports, as well as a healthy environment for pregnant women to improve their sense of well-being and sustain their lifestyle intervention. The majority of the enrolled participants (45/52, 87%) completed the program. The activity level of participants in the AI group was significantly increased compared with baseline. Participants in the AI group also altered their dietary pattern to meet nutritional advice. These changes were not seen in the SC group, suggesting good adherence and compliance with the lifestyle intervention program on the part of participants in the AI group. We plan to increase the sites and frequency (e.g. weekends) of group exercise sessions and to provide more follow-ups for pregnant women (particularly teenagers) in our future study to improve program adherence.

The results of the present study indicate that moderate exercise plus dietary intervention did not affect average weight gain in pregnant women. However, lifestyle intervention did moderately reduce excessive weight gain in the AI group. Food intake appeared to change in the direction of recommended intakes for the 16 women in the AI group who provided complete data on the FCM and food frequency questionnaires. The difference between reported energy intake and recommended energy intake, as assessed with the FCM on entry to the study, showed a significant negative correlation with the food frequency questionnaire completed at entry \( r=0.59, p=0.012 \). The correlation of this difference in reported and recommended intake with the food frequency questionnaire completed in the late third trimester became not significant, indicating that participants in the AI group had changed their energy intake to more closely reflect recommended intake. In addition, there were trends in increased milk consumption and decreased beverage consumption (e.g. soft drinks and juices) among some of the participants in the AI group. Such a change or trend was not detected in the SC group.

**DISCUSSION**

**Figure 1. Incidence of excessive weight gain, GDM, macrosomia, preterm delivery and need for weight-related birth procedures in participants in the SC (n=21) and AI (n=24) groups**

*Values are expressed by percentage for each group. Number of cases for each outcome are displayed above the corresponding bars. No significant differences were detected between the 2 groups.

AI = additional intervention
EWG = excessive weight gain
GDM = gestational diabetes mellitus
MAC = macrosomia (birth weight >4000 g)
PTD = preterm delivery (<37 weeks of pregnancy)
PRO = weight-related birth procedures (induction, manoeuvres, forceps or Cesarean section)
SC = standard care

\( r=0.86, p<0.001 \) in the participating pregnant women.
group compared with the SC group (21% vs. 33%). The difference did not reach a significant level with the sample size in the present study. Excessive weight gain during pregnancy is associated with GDM, future obesity and type 2 diabetes; the impact of lifestyle intervention on excessive weight gain could be detected in a larger trial.

Benefits of physical activity with respect to glucose metabolism in GDM have been found by some investigators (23-27), but not by others (28-30). A retrospective study published recently indicates that lower recreational physical activity is a risk factor for GDM (31). Three cases of GDM (6.7%) were found in this pilot study, an incidence that is relatively higher than that of the general population (3.5%), but it is not unexpected given the high percentage of recognized high-risk participants in this study, such as Aboriginal and Asian women (32). The incidence of GDM among those receiving additional exercise and diet intervention (4%) was lower than that of women who received current standard care (10%, p>0.05). Power analysis suggests that a total sample size of 2 equal-sized groups of ≥700 participants would be required to detect a significant difference in GDM incidence in a subsequent study with similar design.

The need for birth-weight-related obstetric procedures reflects not only an oversized baby but also the physical capacity of the mother. In the pilot study, macrosomia was found in 2 participants in the AI group (8%) and in 4 in the SC group (19%). One of 24 women (4%) in the AI group required a birth-weight-related obstetric procedure, a number that was evidently, but not significantly, lower than in the SC group (14%). Birth-weight-related obstetric procedures increase the risk of obstetrical complications and socio-economic burden. We hypothesize that exercise/dietary intervention during pregnancy may significantly reduce the incidence of weight-related birth procedures and macrosomia in a larger trial (total sample size ≥315 to 375).

CONCLUSIONS
The results of this pilot study demonstrated the feasibility and safety of a randomized, controlled trial using community-based lifestyle intervention in pregnant women from urban communities. The preliminary data indicated that exercise and diet intervention have the potential to reduce adverse pregnancy outcomes, including excessive weight gain, GDM, macrosomia and birth-weight-related obstetric procedures. Further clinical trials with achievable sample sizes should help to corroborate these findings.

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AUTHOR DISCLOSURES
No duality of interest declared.

REFERENCES


