Postpartum Exercise Regardless of Intensity Improves Chronic Disease Risk Factors

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¹R. Samuel McLaughlin Foundation-Exercise & Pregnancy Laboratory, School of Kinesiology, Faculty of Health Sciences, The University of Western Ontario, London, Ontario, CANADA; ²Division of Food and Nutritional Sciences, Brescia University College, London, Ontario, CANADA; ³Department of Anatomy and Cell Biology, Schulich School of Medicine, The University of Western Ontario, London, Ontario, CANADA; and ⁴Child Health Research Institute, The University of Western Ontario, London, Ontario, CANADA

ABSTRACT

DAVENPORT, M. H., I. GIROUX, M. M. SOPPER, and M. F. MOTTOLA. Postpartum Exercise Regardless of Intensity Improves Chronic Disease Risk Factors. Med. Sci. Sports Exerc., Vol. 43, No. 6, pp. 951–958, 2011. Purpose: Women who are unable to return to a healthy weight by 6 months postpartum increase their risk factors for the development of chronic disease (CD; including metabolic syndrome, obesity, and cardiovascular disease). In a prospective randomized intervention study, we examined the effect of exercise intensity on risk factors for CD in the postpartum. We hypothesized that women receiving an intervention targeting healthy weight loss would have improved CD risk factors compared with women not receiving the intervention. Further, we hypothesized that nutrition control and moderate-intensity exercise would have the greatest improvement in CD risk factors versus low-intensity exercise. Methods: Women were randomly assigned to a nutrition plus low-intensity (30% HR reserve; n = 20) or moderate-intensity (70% HR reserve; n = 20) exercise intervention group. The program consisted of supervised walking for 45 min, three to four times per week for 16 wk. All women were screened for CD at the beginning (7–8 wk postpartum) and at the end (23–25 wk postpartum) of the study. A historical control group of 20 sedentary postpartum women was matched by body mass index, age, and parity. Results: The low- and moderate-intensity groups lost more body mass (−4.2 ± 4.0 and −5.0 ± 2.9 kg, respectively) compared with the control group (−0.1 ± 3.3 kg, P < 0.01). Plasma low-density lipoprotein was reduced for the low- and moderate-intensity groups (−0.29 ± 0.21 and −0.28 ± 0.17 mmol L⁻¹) compared with the control group (0.03 ± 0.18 mmol L⁻¹, P = 0.015). In addition, glucose concentrations were reduced and adiponectin concentrations increased (P = 0.037), regardless of exercise intensity, although the sedentary controls remained unchanged or at increased risk for CD. Conclusions: Women receiving a postpartum intervention targeting healthy weight loss, regardless of exercise intensity, improved CD risk factors compared with women not receiving the intervention. Key Words: SCREENING, PREVENTION, NUTRITION, STROLLER WALKING, POSTNATAL, OBESITY

Women of childbearing age increase their risk for chronic disease (CD; metabolic syndrome, obesity, and cardiovascular disease) when excess weight is gained during pregnancy and a return to a healthy weight in the postpartum period is not achieved (23). Previous studies examining the first year after delivery have demonstrated that moderate-intensity exercise has beneficial effects on weight loss, aerobic capacity, lipid profiles, and infant growth (12,28,29,31). A recent review of the literature found that a lifestyle intervention including nutrition and moderate-intensity exercise was more effective than diet alone at reducing postpartum weight retention (3). Early screening and interventions to prevent CD may have a significant effect on the short- and long-term health of the mother.

Increasing physical activity has profound effects on cardiovascular health through improvements in glucose tolerance, lipid profiles, and vascular function (6,18,27,30,36); however, the minimum threshold of exercise intensity to achieve these benefits in postpartum women is unknown. Previous postpartum exercise studies have only examined moderate-intensity exercise (12,28,29,31); however, literature in other adult populations have suggested that lower exercise intensities may also confer health benefits (9,25,34,38). Because many mothers are sleep-deprived, overweight or obese, and/or have not previously participated in exercise programs, initiating a moderate-intensity exercise program during the early postpartum period may not be feasible.

A baseline CD risk assessment consisting of body mass index (BMI), waist-to-hip ratio, fasted plasma lipid profile, fasted cardiovascular disease blood biomarkers, glucose and insulin response to a fasted oral glucose tolerance test, blood
pressure, and physical activity level was developed. We then undertook a randomized intervention study of 47 women after delivery to determine the effect of a nutrition and low-versus moderate-intensity exercise intervention on CD risk. We hypothesized that women receiving a postpartum intervention targeting healthy weight loss would have improved CD risk factors compared with women not receiving the intervention. Further, we hypothesized that a nutrition and moderate-intensity exercise program would have a greater improvement in CD risk factors versus a nutrition and low-intensity exercise intervention.

METHODS

Study design. Forty-seven healthy, nonsmoking, sedentary (exercising once per week or less in the previous 2 months according to a standardized questionnaire) women with a current BMI $\geq 25.0$ kg m$^{-2}$ and/or had retained $\geq 5.0$ kg from pregnancy (based on prepregnancy weight recall) were recruited at 7–9 wk postpartum to participate in the exercise and nutrition intervention between November 2007 and March 2009. Participants were recruited through physician and midwife referrals, posters, and advertisements in newspapers in London, Ontario, Canada. The participants were randomized using a random numbers table into one of two exercise intensities (low, 30% HR reserve (HRR); moderate, 70% HRR). Seven withdrew from the study (three because of lack of time, two because of postpartum depression, one unknown, and one was unable to complete the postintervention testing because of extended illness), leaving 20 in each intervention group.

A control group of 20 women who delivered between March 2005 and May 2008 was matched to the intervention groups by age, BMI, and parity. Control women were sedentary (exercising once per week or less in the previous 2 months postpartum) at baseline (7–9 wk postpartum) and reevaluation (23–25 wk postpartum), a CD risk assessment was conducted for each participant in the control and intervention groups. The risk assessment included BMI $\geq 25.0$ kg m$^{-2}$ (35), waist-to-hip ratio $>0.80$ (11), fasting plasma lipid profile (HDL-C $<1.3$ mmol L$^{-1}$, LDL-C $\geq 2.59$ mmol L$^{-1}$, total cholesterol (TC) $\geq 5.18$ mmol L$^{-1}$, triglycerides (TG) $\geq 1.7$ mmol L$^{-1}$) (39), fasted blood biomarkers [adiponectin, plasminogen activator inhibitor 1 (PAI-1), soluble vascular cell adhesion molecule 1 (sVCAM-1), and soluble intercellular adhesion molecule 1 (sICAM-1)] (39), fasted blood biomarkers [adiponectin, plasminogen activator inhibitor 1 (PAI-1), soluble vascular cell adhesion molecule 1 (sVCAM-1), and soluble intercellular adhesion molecule 1 (sICAM-1)] were analyzed in duplicate from frozen aliquots using multiplexed biomarker immunoassay kits (Milliplex; Millipore Corp., Billerica, MA).

Cardiovascular disease makers (adiponectin, PAI-1, sVCAM-1, and sICAM-1) were analyzed in duplicate from the frozen aliquots using multiplexed biomarker immunoassay kits (Milliplex; Millipore Corp., Billerica, MA).

Assessment for CD. At baseline (7–9 wk postpartum) and reevaluation (23–25 wk postpartum), a CD risk assessment was conducted for each participant in the control and intervention groups. The risk assessment included BMI $\geq 25.0$ kg m$^{-2}$ (35), waist-to-hip ratio $>0.80$ (11), fasting plasma lipid profile (HDL-C $<1.3$ mmol L$^{-1}$, LDL-C $\geq 2.59$ mmol L$^{-1}$, total cholesterol (TC) $\geq 5.18$ mmol L$^{-1}$, triglycerides (TG) $\geq 1.7$ mmol L$^{-1}$) (39), fasted blood biomarkers [adiponectin, plasminogen activator inhibitor 1 (PAI-1), soluble vascular cell adhesion molecule 1 (sVCAM-1), and soluble intercellular adhesion molecule 1 (sICAM-1)] were analyzed in duplicate from the frozen aliquots using multiplexed biomarker immunoassay kits (Milliplex; Millipore Corp., Billerica, MA).

Protocol to determine exercise intensity in the intervention groups. The exercise participants performed a peak exercise test ($\dot{V}$O$_{2}$peak) to volitional fatigue at baseline screening and reevaluation as described elsewhere (32). On the basis of this protocol target, HRR was determined for prescription of exercise using the equation of Karvonen et al. (22).

Walking exercise program. The intervention groups walked at their calculated target HR zone of 30% HRR or 70% HRR, three to four times per week for 16 wk. To achieve the prescribed HR, some women walked without pushing a stroller, some women walked with a stroller, and some walked with an extra load (i.e., pushed a double stroller with a second child or carried their infant in a sling). The first exercise session consisted of 25 min of exercise (including 5 min of warm-up and 5 min of cool down) at their specific target HR zone. Each subsequent week, exercise sessions increased by 5 min until a maximum time of...
Each participant was required to attend at least one monitored exercise session per week with the study investigator to obtain body mass, submit food intake records, and monitor HR (Polar Electro Oy, Kempele, Finland) to confirm exercise intensity. All women were given a pedometer (Accusplit Eagle 120, San Jose, CA) to wear for the duration of the study. Total pedometer step counts were recorded on a daily basis, and exercise step counts were recorded at every exercise session. Exercise sessions outside of the laboratory session were recorded on home exercise logs. Exercise intensity was verified with provided HR monitors. Women who exercised at least three times per week and handed in at least eight 1-d food intake records, which demonstrated consistent improvements in energy, CHO, and fat intake, as well as improvements in food choices, were considered to have 100% adherence to the program.

Nutrition intervention. At baseline screening, all women in the control and intervention groups completed a 3-d food intake record that was analyzed using the ESHA Food Processor SQL Program, version 9.8.1.0 (including the Canadian Nutrient File). An individualized nutrition intervention program was implemented by a registered dietician for the women in the intervention groups. The program was designed to help meet nutritional needs in the postpartum period and assist with weight management. Recommendations for the dietary program included a total energy intake between 7520 and 8360 kJ/1000 kcal spread over three meals and three to four snacks per day including an evening snack. The women were given a weight reduction goal of 2.0 kg/month (0.5 kg·wk⁻¹) through the combination of a nutrition and exercise program (28). The control group was given literature about Eating Well with Canada’s Food Guide and Canada’s Guide to Physical Activity (19,20).

Sample size calculation. Body mass was selected for sample size calculation because a decrease in body mass has previously been found to improve other CD risk factors (21). To detect a difference of 2% loss in body mass between groups, an SD of 3.5% within groups (28), a type I error of 0.05, and a statistical power of 0.85, the required sample size would be 59 (20 per group). Twenty percent was added to the sample size to allow for attrition; therefore, 71 women were required for recruitment.

Statistical analysis. All data were expressed as mean ± SD unless otherwise stated. The primary analysis compared the two randomized intervention groups using a per-protocol analysis. The effect of the exercise intervention between the groups was performed by ANCOVA where the 6-month postpartum measurements were the dependent variable, group (30% vs 70%) was the fixed factor, and the baseline (2-month postpartum) measurements were the covariate. Bonferroni post hoc analysis was used to compare the main effects found to be significant using ANCOVA. Because there were no significant differences between the two randomized intervention groups, a secondary analysis comparing the three groups (control vs 30% vs 70%) was performed by ANCOVA as described above. Descriptive values between groups at 2 months postpartum and at 6 months postpartum were analyzed using ANOVA. Post hoc analyses were performed using Tukey analysis. Statistical analyses were performed using SPSS Version 16.0 (SPSS, Inc., Chicago, IL).
Chicago, IL). All statistical tests were considered significant at α levels of P ≤ 0.05.

RESULTS

Maternal characteristics. All women who started the study had increased risk factors for the development of CD at baseline (Table 1). Subjects who dropped out of the study (n = 7) were not significantly different from those who remained in the study in terms of age, height, body mass, or CD risk (data not shown).

Nutrition and exercise intervention. The participants in the 70% HRR group exercised at a significantly higher mean HR of 152 ± 7 bpm (73% HRR) compared with the mean HR of 115 ± 8 bpm (36% HRR) for the 30% HRR group, P < 0.01 during their exercise sessions. The frequency of exercise between the two groups was not significantly different (70% HRR, 3.3 ± 0.7 sessions per week; 30% HRR, 3.4 ± 0.7 sessions per week). Eighty-three percent of participants exercised at least 3 d wk⁻¹. Daily step counts were not significantly different between the exercise groups throughout the 16-wk intervention on nonexercise days (30%, 7344 ± 2626 steps; 70%, 7492 ± 2281 steps; P = 0.62), and on structured exercise days, these women took more than 10,000 steps (Fig. 1). None of the participants were diagnosed with high blood pressure during the program (data not shown).

After the 16-wk intervention, the participants in the exercise groups significantly improved their risk for CD through reduction of body mass (F = 14.112, P < 0.00), waist circumference (F = 9.797, P < 0.00) and waist-to-hip ratio (F = 3.463, P = 0.038), glucose (F = 3.26, P = 0.046), LDL-C (F = 4.575, P = 0.015), and increased adiponectin concentrations (F = 3.520, P = 0.037) with no difference between interventions (Tables 1 and 2). Based on DEXA analysis, weight loss in the two intervention groups was a result of a reduction in fat mass and preservation of lean muscle mass (Table 1). In contrast, the women who did not receive an intervention remained at increased risk for CD: HDL-C concentrations decreased and glucose tolerance deteriorated while body mass and plasma lipid profiles remained elevated at 6 months postpartum (Tables 1 and 2). Infant weight and length were not different between the three groups, indicating that fetal growth was not adversely affected by exercise or weight reduction (Table 1).

There was no significant difference between the three groups at 2 or 6 months postpartum on dietary intake (Table 3). There was no significant group × time interaction for energy intake (F = 2.772, P = 0.072), energy intake per kilogram (F = 0.678, P = 0.512), CHO intake (F = 2.738, P = 0.075), percent energy from CHO (F = 0.072, P = 0.931), protein intake (F = 0.715, P = 0.494), percent energy from protein (F = 0.669, P = 0.517), fat intake (F = 1.149, P = 0.325), or percent energy from fat (F = 0.121, P = 0.886). Eighty-one percent of women handed in their weekly food intake records, had a regular eating pattern, were meeting protein intake (F = 0.072, P = 0.931), protein intake (F = 0.715, P = 0.494), percent energy from protein (F = 0.669, P = 0.517), fat intake (F = 1.149, P = 0.325), or percent energy from fat (F = 0.121, P = 0.886). Eighty-one percent of women handed in their weekly food intake records, had a regular eating pattern, were meeting nutrition and exercise intervention. The participants in the 70% HRR group exercised at a significantly higher mean HR of 152 ± 7 bpm (73% HRR) compared with the mean HR of 115 ± 8 bpm (36% HRR) for the 30% HRR group, P < 0.01 during their exercise sessions. The frequency of exercise between the two groups was not significantly different (70% HRR, 3.3 ± 0.7 sessions per week; 30% HRR, 3.4 ± 0.7 sessions per week). Eighty-three percent of participants exercised at least 3 d wk⁻¹. Daily step counts were not significantly different between the exercise groups throughout the 16-wk intervention on nonexercise days (30%, 7344 ± 2626 steps; 70%, 7492 ± 2281 steps; P = 0.62), and on structured exercise days, these women took more than 10,000 steps (Fig. 1). None of the participants were diagnosed with high blood pressure during the program (data not shown).

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their nutritional needs, demonstrated consistent improvements in their food choices, and were reaching short-term nutritional goals.

**DISCUSSION**

The present study examined the effects of a 16-wk nutrition and randomized low- versus moderate-intensity exercise intervention on CD risk factors in postpartum women. The women in all three groups had similar risk for CD at 2 months postpartum. On reevaluation 16 wk later, the women who did not receive an intervention increased their risk for CD. In contrast, the women in the nutrition-plus-low-intensity exercise group significantly decreased their risk factors for CD. There was no further benefit by increasing exercise intensity to a moderate level. In particular, body mass was reduced by a mean of 5.6% and 7.0% for the low- and moderate-intensity exercise groups, respectively. Several reports indicated that a 5%–9% loss in body mass confers significant health benefits and is clinically relevant for the prevention of diabetes and cardiovascular disease (8,24). In addition, plasma LDL-C, TC/HDL-C ratio, adiponectin, waist circumference, and aerobic capacity were significantly improved in both exercise interventions.

In 2002, the American College of Obstetrics and Gynecologists updated their recommendations for exercise in the postpartum period to suggest that prepregnancy exercise routines may be gradually resumed as soon as is medically safe (1). Guidelines developed by the Canadian Society for Exercise Physiologists have been endorsed by the American College of Sports Medicine (ACSM) and suggest that most women can return to their normal exercise programs after receiving medical clearance at their first postnatal check up (approximately 6–8 wk postpartum) (10). As such, there are no specific guidelines for exercise in the postpartum period. The 1998 ACSM Position Stand for the recommended quantity and quality of exercise for cardiorespiratory fitness suggests that unfit individuals should initiate an exercise program between 40% and 49% HRR, whereas fitter individuals are suggested to perform vigorous- to moderate-intensity aerobic training of up to 85% HRR 3–5 d wk⁻¹ between 20 and 60 min to achieve health benefits (2). Mottola et al. (33) found that a low-intensity exercise during pregnancy (equivalent to 30% HRR) resulted in health benefits to overweight and obese pregnant women. The findings of the present study demonstrate that postpartum women can achieve similar health benefits at both low- and moderate-intensity exercise when combined with a nutritional control program. These data indicate that encouraging postpartum women to make lifestyle changes including nutritional control and an active lifestyle will benefit their long-term health.

Borodulin et al. (4,5) demonstrated that physical activity levels declined as gestation progressed. After delivery, physical activity levels rebounded to early pregnancy levels (4). There are many reasons that physical activity levels may decline during pregnancy including medical complications such as bed rest and preeclampsia, overall fatigue, and excessive weight gain. Women who develop a sedentary lifestyle during pregnancy need to restart their exercise routine slowly in the first few months after delivery (1). On the basis of the present study, women can safely begin a controlled nutrition and low-intensity exercise program in the early postpartum period and achieve significant health benefits.

Nonexercise activity thermogenesis (NEAT) is energy that is not expended from sleeping, eating, or prescribed exercise (26). NEAT is considered to be important for weight control, thus maintenance of NEAT activity levels are important. An exciting finding of the present study was that baseline (NEAT) daily step counts were maintained throughout the intervention on nonexercise days, demonstrating that daily activity levels were not affected by the addition of an exercise regimen. Physical inactivity is a risk factor for CD; thus by increasing physical activity through the addition of prescribed exercise resulting in at least 10,000 steps per day (40), 3–4 d wk⁻¹, the intervention groups had a significant reduction in CD risk.

Previous studies in postpartum women have indicated that exercise alone will not result in significant weight loss (12) but will have beneficial effects on reduction of fat mass, maintenance of lean muscle mass and improvement of blood lipid profiles similar to those found in the present study (29). Exercise in combination with energy intake restriction has been demonstrated to be more effective than diet alone in reducing weight retention of postpartum women (3,28,31). In the present study, we found that in addition to improvements in glucose tolerance, aerobic capacity, and adiponectin, a low-intensity exercise in combination with nutritional control was just as effective as moderate-intensity in decreasing
mean plasma LDL-C concentrations. These results are supported by nonpostpartum populations, which demonstrated that low- and moderate-intensity exercises can result in improvements in lipoprotein profiles (9, 13, 25, 38). A previous work by Lovelady et al. (29) examined the effect of a 12-wk moderate-intensity exercise intervention on plasma lipids in postpartum women. The authors found that plasma TG, TC, and LDL-C concentrations decreased by 0.3–0.4, 0.2, and 0.2–0.4 mmol·L⁻¹, respectively, for both the exercise and control groups. In contrast, the plasma HDL-C values increased marginally for the exercising women. The current guidelines for the prevention and management of cardiovascular disease in Canada recommend that the primary target to prevent cardiovascular disease is reduction of plasma LDL-C concentrations and the secondary target is an improvement of the TC/HDL-C ratio (18). In the present study, the decrease in plasma LDL-C significantly reduced the risk for cardiovascular disease. Although TG, TC, and HDL-C concentrations did not change, the ratio of TC/HDL-C significantly improved in the two intervention groups indicating a further reduction in CD risk. The differing results between the two studies require further investigation and may be related to differences in BMI, exercise frequency, and/or diet composition.

The present study has several strengths, most importantly, the strictly monitored exercise and nutrition intervention. We conducted this study in a population who was at high risk for developing CD because of a potential failure to return to a healthy weight after delivery (37). The exercise intervention used a walking program that included the baby, potentially overcoming barriers to being active in new mothers (15). Although the intervention program was not designed around a specific theory to maximize adherence to the program, previous studies have indicated that 89% of women believe that exercise is important in the early postpartum period (15). Further, group dynamics is important in maximizing adherence; thus, group adherence was encouraged. Although the study investigators were not blinded as to which groups the participants were randomized, the technicians conducting the blood analysis and the assistants who collected and entered data were blinded to group allocation. In addition, the dietician was not blinded as to which group the participant was in because it was necessary to ensure that sufficient calories and macro/micronutrients were being consumed to sustain breast-feeding. All women who contacted the laboratory to participate in the study were given the opportunity to participate in the project as long as they met our inclusion criteria. Although we are aware that there is the possibility of a “healthy volunteer” effect, we believe that the results of the study are valid. Finally, we feel that the women in all three groups were well matched because we used three important confounding variables for CD risk (BMI, age, and parity). There were no differences between the groups regarding breast-feeding (Table 1). The two women diagnosed with postpartum depression dropped out of the study, and the remaining women recruited to the study did not have postpartum depression. Socioeconomic status was not directly assessed; the current intervention was free of charge and included child care. All of the women were on maternity leave for the duration of the program; however, predelivery occupations varied widely and included physicians, lawyers, homemakers, and unemployed. High and low SES occupations were balanced between the intervention and control groups. Another strength emphasized the importance of early assessment for CD during the first postnatal visit. There were also limitations to the present study. The first was the lack of a randomized control group; however, there is overwhelming evidence suggesting that women who retain pregnancy weight at 6 months postpartum significantly increases the risk of CD later in life; thus, for comparative purposes, we used a historical control group that was matched by three important confounding factors: BMI, age, and parity (37). A second limitation was that the historical control group did not have body composition measured using DEXA or assessment of aerobic capacity; however, body composition and aerobic capacity are difficult to assess in a clinical setting and would not be used when assessing for CD risk factors. Finally, prepregnancy mass was obtained from maternal recall as the participants were not recruited into this study before pregnancy.

The results of the present study indicate several future directions. The novel findings regarding the effects of exercise intensity on body mass/composition, aerobic capacity, and blood biomarkers necessitate a follow-up study to determine the mechanisms behind these results. Breast-feeding status and time from delivery (i.e., 2 vs 6 vs 12 months) may play an important role and requires further investigation. In addition, determining the effect of various exercise intensities on maternal health in high-risk populations (e.g., women who are overweight/obese, had gestational diabetes, and preeclampsia) is warranted.

**SUMMARY**

Assessment of CD risk factors in the postpartum period may be important for the prevention of CD later in life. We recruited a cohort of women who had increased risk factors for CD because they had a BMI ≥25.0 kg·m⁻² and/or pregnancy weight retention ≥5.0 kg and were physically inactive. The data demonstrated that women who received basic education on healthy eating and physical activity will remain physically inactive, decrease plasma HDL-C, decrease glucose tolerance, and do not reduce weight retention by 6 months. Thus, women who do not receive a structured intervention remain at risk for obesity and other CD (37). In contrast, nutrition control in combination with walking that increased baseline step counts to approximately 10,000 steps per day, three to four times per week regardless of exercise intensity, significantly decreased BMI, minimized weight retention, and improved CD risk factors by 6 months postpartum. In a clinical setting, assessing risks for CD can be conducted with a minimal amount of time at the first
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Postpartum visit (usually 6–8 wk after delivery) through measurement of body mass, height, waist, and hip circumference and a fasted blood draw. Women who are at increased for CD can be encouraged to follow healthy eating and a low-intensity walking program combined with healthy eating to reduce CD risk by 6 months postpartum.

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