Physical and psychological changes with vigorous exercise in sedentary primigravidae

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ABSTRACT

MARQUEZ-Sterling, S., A. C. Perry, T. A. Kaplan, R. A. Halberstein, and J. F. Signorile. Physical and psychological changes with vigorous exercise in sedentary primigravidae. Med. Sci. Sports Exerc., Vol. 32, No. 1, pp. 58 – 62, 2000. Purpose: The present study examined the effects of exercise on physical and psychological variables in sedentary primigravidae (PRA). Methods: A total of nine women randomly assigned to an exercise (E) (mean age = 31.3 ± 3.1 yr) and six subjects randomly assigned to a control (C) group (mean age = 27.8 ± 3.1 yr) fulfilled all requirements for the study. Exercise included a variety of exercise activities performed to a target heart rate of 150 – 156 beats·min⁻¹, three times per week for 15 wk. Results: Results showed no significant differences between E and C groups in physical characteristics initially. A repeated measures ANOVA showed a significant group effect (P < 0.05) and a significant group by time interaction (P = 0.001) with the E group showing a significantly longer amount of time on the PWC₁₅₀ test than the C group. There was no significant group, time, or group by time interaction for lactate accumulation. This occurred, despite the fact that the E group spent 56% longer on the PWC₁₅₀ test and the C group spent 30% less time on the same test at the conclusion of the study. Finally, the E group in comparison to the C group showed more favorable improvements in several items related to health and well-being on the Body Cathexis Scale. There were no significant differences between E and C groups in any pregnancy outcome measures. All babies were delivered healthy at term. Conclusions: These data suggest that a vigorous exercise program can lead to significant improvements in aerobic fitness at similar lactate concentrations compared to a control group and can be well tolerated by low risk sedentary PRA without any deleterious effects occurring to herself or unborn child. Key Words: TRAINING, PREGNANCY, SERUM LACTATE, FITNESS, SELF-ESTEEM

The processes of pregnancy and childbirth place tremendous physical and psychological stresses and great physiological demands upon a woman’s body. Yet research has consistently shown that previously active women can continue to exercise at levels equal to or even exceeding the American College of Obstetrics and Gynecology guidelines (ACOG) (2) and still enjoy favorable cardiovascular changes and pregnancy outcomes (3–6,9,10,16,17,20,25).

In contrast, there is much controversy regarding the issue of exercise during pregnancy in previously sedentary women (14,27,28). In fact, many experts recommend great caution for previously sedentary primigravidae (PRA) initiating an exercise program, whereas others advise against any exercise training at all for these women (2,14,27). As such, there are no specific exercise guidelines for the sedentary, unfit PRA.

Although several studies have targeted exercise programs for sedentary PRA, many of these studies have had some methodological problems in their design. These problems included relying upon self-reported heart rates, lack of supervision, and sample heterogeneity combining previously conditioned sedentary women with women who had never exercised at all (3,4,10,20,25). Furthermore, these studies (3,4,10,20,25) were generally conducted within or slightly above previous ACOG guidelines which recommend that maternal heart rates not exceed 140 beats·min⁻¹ and strenuous exercise not exceed 15-min duration (1).

The physical changes occurring during pregnancy result in dramatic increases in body weight and body fat that take a woman further from the ideal body size than she has been before. There is a paucity of information examining the changes in body image and maternal self-esteem in the sedentary woman initiating an exercise program during pregnancy (26). Therefore, it would also be important to examine the psychological changes that accompany the physical demands of an exercise program in women who are unaccustomed to exercise. The purpose of this study was to examine the physical and psychological changes in sedentary PRA initiating an aggressive exercise program during their second trimester of pregnancy.
Subjects. Volunteers were recruited from local radio stations and advertisements placed in the local papers. Before admission, all subjects were required to complete a thorough medical questionnaire, provide a sonogram of the fetus, be classified as low risk by their physicians, be approved to participate in the study by their personal physician, be approved by the medical director of the study, and be sedentary, having not exercised on a regular basis for at least 1 yr before conception.

Written informed consent was obtained from volunteers in accordance with the guidelines set forth by the University of Miami Office of Research Standards for the Protection of Human Subjects. A total of 20 subjects volunteered to participate in the study with 10 subjects randomly assigned to the experimental (E) and 10 subjects randomly assigned to the control (C) group. Subjects in the C group were to be provided individualized exercise prescriptions in the postpartum period. One subject discontinued in the E group due to a change in geographic location; two subjects left the C group due to a lack of flexibility in test scheduling and two others left the C group and could not be contacted. A total of nine subjects in the E group and six subjects in the C group fulfilled all requirements for completion of the study.

Evaluations. All women were weighed on a Detecto balance scale (Detecto Scales, Inc., Brooklyn, NY) without shoes. Height was taken using a stadiometer that was attached to the scale. Triceps and subscapular skin-fold measurements were taken on the right side of the body using a Lange skin-fold caliper (Cambridge Scientific Industries, Cambridge, MD). Two measurements were taken, and if the difference between the two was more than 2 mm, a third measurement was taken. The mean of the two closest measurements was recorded.

The Body Cathexis Scale (21) was administered to all subjects after collecting anthropometric data. This instrument is used to determine the amount of satisfaction or dissatisfaction a woman feels about her body. By rating 40 aspects of their body (i.e., complexion, posture, legs, hips, etc.) according to a 5-point scale (one being very positive and five being very negative), attitude toward the physical self and perception of body image can be evaluated.

All subjects performed a graded exercise test to 150 beats min\(^{-1}\) (PWC\(_{150}\)) on a Quinton treadmill (Quinton Instruments Co., Seattle, WA). Such tests have been previously used to evaluate aerobic fitness (28), and because walking was a more natural activity that women felt more comfortable performing, this type of exercise was selected. After a familiarization period with the treadmill, each subject completed a warm-up at 2.5 mph and 0% grade for 2 min, at which time speed was increased to 3.75 mph. Thereafter, the incline was increased 2.5% every 2 min until subjects reached a target heart rate of 150 beats min\(^{-1}\). After the last workload, speed was immediately slowed to 2 mph and grade was reduced to 0% to begin the 5-min recovery period. Blood pressure was taken at baseline, once during each stage of the test and every other minute during recovery. Heart rates were monitored using a Polar Vantage XL heart rate monitor (Polar CIC, Inc., Port Washington, NY).

Lactate analyses were performed at rest and within 30 s of attaining target heart rates using a 2300 Stat Glucose/L-Lactate Analyzer (Yellow Springs, Inc., Yellow Springs, OH). Whole blood was obtained from the middle finger using a finger stick, and lactate was measured by use of a probe that collects blood from a capillary tube. All lactates were analyzed upon completion of the GXT.

Training. The training program consisted of a series of 1-h sessions, held three times per week for 15 wk. Subjects were taught to use their heart rate monitors so that they could adhere to their target heart rates during each training session.

Each session started with a (5-min) warm-up on the stationary bicycle ergometer or treadmill, after which time subjects were introduced to a combination of rowing, stationary cycling, and walk-jogging as part of the aerobic portion of their training. During the initial 2 wk of the program, heart rates were kept between 120–130 beats min\(^{-1}\), after which time heart rates increased to 140–150 beats min\(^{-1}\), and finally to 150–156 beats min\(^{-1}\). After the acclimation period, a rhythmic calisthenics class that was a modification of the Fitness Canada program (18) and a step class were added to the aerobic workout. After 6 wk, the StairMaster (StairMaster Sports/Medical Products, L.P., Kirkland, WA) was included as part of the aerobic workout and alternated with other equipment. On brisk nights, the aerobic program was modified and brisk walks were performed instead to add diversity to the aerobic program. These were done using quick marching steps, long deliberate strides, leg kicks, and knee kicks. All exercise sessions ended with standing and floor-supported stretches and were conducted by certified personnel.

Statistical analysis. A Students t-test was performed for independent samples to compare physical characteristics of subjects at the beginning of the study. A repeated measures ANOVA was performed to determine significant differences in PWC\(_{150}\) time and lactate accumulation between groups before and after the 15-wk program. Finally, a Students t-test for independent samples was used to compare groups in pregnancy outcome measures and psychological variables.

RESULTS

As shown in Table 1, there were no significant differences in physical characteristics between E and C groups at the start of the study. There was, however, a trend for the C group to be younger than the E group (\(P = 0.056\)).

Shown in Figure 1 are the results of the repeated measures analysis. An ANOVA showed a significant group effect (\(F = 5.50\) (1,13); \(P = 0.035\)) for PWC\(_{150}\) time. The E group went from a mean of 428 ± 185 s to a mean 648 ± 251 s at the end of the program. In contrast, the C group started at a mean of 379 ± 181 s initially and dropped to a mean of 280 ± 160 s at the end of the program. As illustrated in Figure 1, this resulted in a significant group × time interaction for PWC\(_{150}\) time.
TABLE 1. Physical characteristics of exercise (E) and control (C) groups.*

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>E (N = 9)</th>
<th>C (N = 6)</th>
<th>P*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>31.3 ± 3.1</td>
<td>27.8 ± 3.1</td>
<td>0.056</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>162.8 ± 5.8</td>
<td>164.3 ± 6.6</td>
<td>0.656</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>60.8 ± 12.9</td>
<td>66.3 ± 13</td>
<td>0.439</td>
</tr>
<tr>
<td>Body Mass Index (kg·m⁻²)</td>
<td>22.8 ± 4.0</td>
<td>24.5 ± 4.5</td>
<td>0.462</td>
</tr>
<tr>
<td>Skinfolds (m)</td>
<td>47.0 ± 14.4</td>
<td>55.8 ± 14.0</td>
<td>0.404</td>
</tr>
<tr>
<td>Gestational Age (wk)</td>
<td>18.2 ± 1.8</td>
<td>20.0 ± 2.5</td>
<td>0.137</td>
</tr>
</tbody>
</table>

*a Values are means ± SD.
* Indicates differences between groups using Student’s t-test for unpaired samples.
* Indicates sum of triceps and subscapular skin folds.
* Age of fetus calculated from date of last reported menstrual cycle to study entry.

interaction (F = 17.65 (1,13); P = 0.001) for PWC150 time. As shown in Figure 2, there was no significant group effect, time effect, or group × time interaction for lactate accumulation. Mean lactate accumulation went from 2.34 ± 1.02 mmol·L⁻¹ initially to 2.54 ± 1.6 mmol·L⁻¹ at the end of the program in the E group and from 1.78 ± 0.9 mmol·L⁻¹ initially to 2.86 ± 1.5 mmol·L⁻¹ at the end of the program for the C group.

As shown in Table 2 are the change scores in significant items of the Body Cathexis Scale. With the exception of sex activities and sleep, the E group showed favorable changes on items related to their health, physical self, and well-being. In contrast, the C group showed no changes in any items of the Body Cathexis Scale with the exception of sex activities that showed a significant decrease at the completion of the study (P < 0.05). A between-group analysis showed significant differences between E and C groups in perceived changes in their physical stamina (P = 0.047), muscular strength (P = 0.009), energy level (P = 0.002), and body build (P = 0.01).

Table 3 demonstrates pregnancy outcome measures in both E and C groups. It can be seen that there were no significant differences between E and C groups in maternal weight gain, skin-fold thickness at posttesting, infant birth weight, or Apgar scores. Interestingly, three of nine, or 33.3%, of the E group had Cesarean sections and two out of six or 33.3% of the C group had Cesarean sections. This further illustrates the similarity in pregnancy outcome measures between E and C groups.

DISCUSSION

In the past few decades, there has been a dramatic increase in the number of women engaging in regular physical exercise activities. This may be the case for pregnant women as well. Typically, aerobic fitness is expected to decline during the course of pregnancy (28). Expectedly, as depicted in Figure 1, the present study showed a 30% reduction in mean PWC150 time in the C group. In contrast, the E group showed a 56% increase in PWC150 time, which translated into an additional 3.7 min on the treadmill after training. In accordance with the literature (3,4,10,16,20,25), our results indicated that a vigorous exercise program initiated during the second trimester of pregnancy can lead to substantial improvements in aerobic fitness in previously sedentary women (Fig. 1). Subjects in this study exercised at a far greater heart rate (150–156 beats/min⁻¹) and longer duration (1 h) than that recommended by previous ACOG guidelines (1).

There were no significant differences in lactate accumulation across time between E and C groups (Fig. 2). This occurred despite the fact that the E group spent a significantly greater amount of time on the PWC150 test during posttesting (Fig. 1). Typically, as work or power output increase, lactate levels are expected to rise either in a continuous fashion during exercise or exponentially after a specific threshold level (19). One could speculate that the pre-post-test changes in this relationship were a positive sign sign the E group accumulated similar lactate and performed a greater amount of work on the treadmill during posttesting. According to Erkkola and Rauramo (13), trained PRA show an increased ability to eliminate CO₂ during periods of work, which would help to maintain pH levels. An increase in lactic acid accumulation and decrease in pH have been documented during the first and second stages of labor (12,15). Therefore, similarities in lactate accumulation between E and C groups concomitant with increased work output for the E group may translate into a desirable outcome for women during labor (13).
Given the aggressive nature of the training program, it was important to determine whether sedentary women could safely and effectively adhere to the program. Our results indicated that they can. First, there was only one dropout in the E group and her failure to continue was solely due to a change in her geographic location. Second, there were no differences between E and C groups in maternal weight gain, infant birth weight, or Apgar scores.

Earlier research had indicated that women who exercised near preconception levels during pregnancy gained less weight, delivered earlier, and had lighter-weight offspring than those who discontinued exercise (6,8). In contrast, our results are similar to those of Ohtake et al. (20), showing no significant differences between E and C groups in weight gain or skin-fold thickness at posttesting. More recent work has shown that active women deliver lighter weight babies that are actually leaner, tolerate labor better, and require less medical intervention with fewer instances of fetal distress (7,9,11,17,22,23) than sedentary women. The present study showed no differences between E and C groups in any reported pregnancy outcome measures (Table 3) including the incidence of Cesarean section. Therefore, the rigorous nature of the exercise was well-tolerated by previously sedentary PRA without any deleterious effects to herself or unborn child.

It is important to note that the exercise training was conducted on a small group (N = 9) of apparently healthy PRA. It was also carefully designed to slowly and progressively increase in intensity and duration throughout the first few weeks of training and was closely monitored by certified personnel. This may account, in part, for the subjects’ ability to effectively tolerate the exercise with no injuries occurring and no health problems developing during the course of training.

Psychological changes often occur concurrently with physiological changes that accompany pregnancy. In general, the items that significantly increased in positive rating in the E group tended to be items impacted by physical exercise (see Table 2). On four items (physical stamina, muscular strength, energy level, and body build), there were significant differences in change scores between E and C groups reflective of the increased body satisfaction and improved sense of well-being reported by the exercising participants. The significant decrease in sleep in the E group (P < 0.05) may have been related to the large increases in body weight and body mass index that typically occur as gestation advances or to the fact that the exercising group may have felt more energetic as a result of training. The C group failed to show a significant decrease in sleep. The C group showed no changes in any items of the Body Cathexis Scale with the exception of a decrease in sex activities (P < 0.05). This may be related to the decline in physical attractiveness that some women express and/or the lack of energy that many women experience during the final stages of pregnancy (24,26). The favorable changes in body satisfaction that occurred in the E group attest to the positive role exercise may play in contributing to maternal health and psychological well-being. These benefits extend to the later stages of pregnancy and may be particularly relevant because most PRA experience the most negative feelings about their physical appearance during the last trimester of pregnancy (24).

There are several limitations that should be considered when examining the results of the study. First, the small number of participants in both E and C groups greatly reduced the power of the statistical analyses decreasing the likelihood of obtaining statistical significance. The large number of tests performed, however, increased the likelihood of committing a Type I error. Second, exercise training was initiated during the second trimester of pregnancy when physical complications and risk of spontaneous abortions were at a minimum. Finally, women were considered healthy, low-risk patients and were required to be approved

### Table 2. Pregnancy outcome measures in exercise (E) and control (C) groups (means ± SD)

<table>
<thead>
<tr>
<th>Variable</th>
<th>E (N = 9)</th>
<th>C (N = 6)</th>
<th>P*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight gain** (kg)</td>
<td>16.2 ± 3.4</td>
<td>15.7 ± 4.0</td>
<td>0.649</td>
</tr>
<tr>
<td>Skin-fold Thicknessa</td>
<td>53.7 ± 19.5</td>
<td>55.8 ± 18.9</td>
<td>0.649</td>
</tr>
<tr>
<td>Infant birth weight (g)</td>
<td>3515.4 ± 274.9</td>
<td>3722.3 ± 504.6</td>
<td>0.319</td>
</tr>
<tr>
<td>Apgar scoresc</td>
<td>9.2 ± 0.2</td>
<td>9.0 ± 0.3</td>
<td>0.624</td>
</tr>
</tbody>
</table>

* Indicates differences between groups using Student’s t-test for paired samples.

** Indicates difference between the pre-pregnant weight and weight at term.

* Represents sum of triceps and subscapular skin-fold measured at posttesting.

* Indicates Apgar scores at 5 min.

** Indicates significant difference from pretest at P < 0.01 using Student’s t-test for paired samples.
by their personal obstetrician before participating in the study. Therefore, this sample may not be representative of the population at large of sedentary PRA.

Given the aforementioned limitations, our study suggests that an aggressive exercise program can be safely and effectively tolerated in sedentary PRA without any deleterious effects occurring to herself or unborn child. All babies were delivered healthy at term. Exercising subjects experienced significant improvements in aerobic fitness, lactate hemodynamics, and psychological measures of health and well-being that were not observed in the nonexercising group. It is recommended that sedentary PRA with low risk pregnancies can effectively participate in vigorous exercise programs when conducted by certified personnel in a supervised setting.

This study was written in loving memory of Sylvia Marquez-Sterling. Ms. Marquez-Sterling personally designed, implemented, and performed an outstanding and innovative exercise program that was incredibly well-received by our participants. Although Ms. Marquez-Sterling became ill at the end of the study, she never missed a day of training nor lost a moment of enthusiasm for her work. We were all deeply saddened by her tragic death but her perseverance, fervor, and devotion to our field will forever serve as an inspiration to all who knew her.

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REFERENCES


