



Original Research—CME

Effects of Exercise During Pregnancy on Maternal Heart Rate and Heart Rate Variability

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Abstract

Background: Pregnancy is associated with an increased sympathetic state, which can be exacerbated by gestational conditions. Research has shown that exercise during pregnancy lowers heart rate (HR) and can attenuate the symptoms of gestational conditions associated with increased sympathetic control. However, changes in maternal heart autonomic function in response to exercise have not been reported across multiple time points during pregnancy. This analysis is designed to address this gap.

Objective: To determine if exercise throughout gestation improves maternal cardiac autonomic nervous system functioning, as evidenced by decreased HR and increased heart rate variability (HRV) indices.

Design: Case control study.

Setting: Academic medical institution.

Participants: A total of 56 women with healthy, singleton, low-risk pregnancies.

Methods: Participants were asked to complete 3 resting 18-minute HRV recordings at 28, 32, and 36 weeks' gestation, along with a physical activity questionnaire.

Main Outcome Measures: HRV indices were calculated for time (R peak to R peak interval standard deviation and root mean squared of successive differences) and frequency (very low, low, and high frequency) domain measures. The differences between groups were compared for HRV indices at 28, 32, and 36 weeks.

Results: Resting HR was significantly lower in the exercise group at 28 weeks ($P < .01$) compared with the control group. The exercise group had significantly ($P < .05$) increased measures of resting HRV time domain measures at 28, 32, and 36 weeks' gestation compared with the control group. Resting HRV power was significantly increased ($P < .05$) in all frequency domain measures at 32 weeks in the exercise group relative to the control group. No differences occurred in sympathovagal balance (low frequency/high frequency ratio) between groups.

Conclusion: Exercise throughout pregnancy can significantly improve cardiac autonomic control. More research is needed to determine if this adaptation to exercise may reduce the risk of adverse outcomes associated with gestational conditions with poor autonomic control, such as diabetes, hypertension, pre-eclampsia, and excessive weight gain.

Introduction

As a result of recent advances, the use of heart rate variability (HRV), or beat-to-beat fluctuations in heart rate (HR), is expanding outside of cardiology into other fields, such as rehabilitation medicine and obstetrics [1,2]. Obesity and diabetes, for example, are associated with increased sympathetic activity, decreased HRV, and poor health outcomes [3]. For example, increased HR and decreased HRV has been shown to be associated with hypertension [4-6]. Conversely, relaxation

programs to help cope with stress are associated with slight increases in resting HRV measures and decreased symptom burden [7]. Similarly, long-term exercise training results in improved autonomic control, as evidenced by increased measures of HRV at rest [8,9]. Evidence is growing to support the use of HRV in determining health or disease and overall competence of the autonomic nervous system [1,10,11].

HRV is a low-cost, noninvasive clinical measure that is effective in distinguishing between healthy physiology and pathophysiology and determining autonomic

maturation. For example, fetuses compromised by nicotine during development have low HR and lower HRV than do nonexposed fetuses of the same age, which is indicative of decreased autonomic maturation [12,13]. Furthermore, fetuses that have lower HR and little to no HRV as a result of exposure to alcohol are associated with poor pregnancy outcomes [14]. On the other hand, fetal exposure to maternal exercise is associated with lower HR and increased HRV relative to fetuses of women who do not exercise [15,16]. Similar to adults, fetal HR and HRV measures demonstrate a dose response to the level of maternal exercise throughout pregnancy [2]. Therefore, HRV can be used to safely assess cardiac autonomic competence in the mother and child during pregnancy.

Because of the physiologic changes during pregnancy, these women have a naturally occurring increase of sympathetic input, although we do not know how this increase influences maternal HRV. We know that approximately 50% of women in the United States are overweight or obese [17,18] prior to pregnancy. This excess weight is also associated with increased sympathetic control [3,18,19] and an increased risk of pregnancy complications, such as gestational diabetes, gestational hypertension, pre-eclampsia, eclampsia, and HELLP (Hemolysis, Elevated Liver enzymes, Low Platelet count) syndrome [20]. Research further demonstrates that obese pregnant women have increased risk of preterm delivery, increased rate of cesarean section, and increased length of hospital stay compared with pregnant women of a normal weight [21-23]. Thus many women who become pregnant have a substantially higher risk of developing pregnancy complications as a result of their increased weight, as well as the physiologic changes of pregnancy.

Exercise has been used in rehabilitative medicine as a safe, nonpharmacologic treatment for people of various ages for reasons including, but not limited to, obesity, osteoarthritis, aging, musculoskeletal problems in children, athletes with disabilities, and pregnancy [24]. Exercise during pregnancy is safe for the mother, fetus, and child [25-28]. Maternal exercise during pregnancy can improve cardiovascular function in women during pregnancy without adverse effects on fetal growth [27-29]. For example, research has shown that pregnant women who exercise have a lower HR at rest and during exercise, increased stroke volume, and increased oxygen uptake [27,28]. Additionally, fetuses of women who exercise demonstrate advanced gestational age related to a lower fetal HR [27,28].

We previously reported that exercise during pregnancy is associated with lower fetal HR and increased fetal HRV at rest across 3 gestational ages [15]. However, changes in maternal heart autonomic function in response to exercise have not been reported across multiple time points during pregnancy. To safely train women during pregnancy and help reduce the risk of

complications, physicians need be cognizant of the naturally occurring increased sympathetic state of pregnancy and the change that results from exposure to exercise. One method to safely monitor autonomic control of the mother and fetus during pregnancy is by measuring HRV. Therefore, the purpose of this retrospective analysis is to determine if exercise throughout gestation improves functioning of the maternal cardiac autonomic nervous system, as evidenced by decreased HR and increased HRV indices at 3 time points.

Methods

Subjects

This project is part of a longitudinal study to assess differences in fetal heart development in response to maternal exercise during pregnancy [2,15]. The initial power analyses were performed with preliminary fetal HRV data. The initial study was approved by the Institutional Review Boards at Kansas City University of Medicine and Biosciences and University of Kansas Medical Center. Women were recruited through advertisements placed in local magazines. Participation was limited to healthy 20- to 39-year-old pregnant women, <28 weeks' gestation, with uncomplicated singleton pregnancies. All women were nonsmokers, with no history of alcohol or drug use. Informed consent was obtained prior to study participation. Each subject completed a comprehensive physical activity questionnaire and underwent a simultaneous maternal-fetal magnetocardiogram. Women were classified as being part of the exercise group if they continued at least moderate aerobic exercise for a minimum of 30 minutes, 3 times per week, throughout their pregnancy [2,15]. This criterion is based on minimum recommendations for women who were previously sedentary prior to pregnancy [30]. Moderate intensity is based on women's rate of perceived exertion of at least 12-14 (on a 6-20 scale) and/or the talk test—that is, the ability can converse while exercising [31]. Women in the non-exercising control group reported that they did not participate in consistent aerobic exercise activity throughout their pregnancy.

Procedures

The Modifiable Physical Activity Questionnaire is a reliable and valid instrument for assessing the intensity and duration of exercise performed during the preceding 12 months in various populations, including pregnant women [32-39]. The activity questionnaire was completed twice by each subject to assess frequency, intensity, and duration spent participating in aerobic exercise in the 3 months prior to conception and throughout the pregnancy. The questionnaire data from all 3 trimesters of pregnancy were used for classification

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