Vigorous exercise and birth outcomes in a sample of recreational exercisers: A prospective study across pregnancy

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Abstract

Objective: This study examined the question of whether vigorous exercise undertaken by recreational exercisers across pregnancy, defined in two ways, were associated with reduced infant birthweight and gestational age at birth.

Methods: A prospective approach was implemented. A total of 148 pregnant women participated. Average intensity duration and frequency of vigorous exercise reported were examined and compared with two existing definitions of vigorous exercise. Participants completed questionnaires (including retrospective reports on 3 months prepregnancy) and an exercise diary at 16–23 weeks pregnancy, 24–31 weeks pregnancy and 32–38 weeks pregnancy, and at 7 to 14 days post-partum a birth outcomes questionnaire was completed.

Results: There were no significant differences between exercise groups for birthweight and gestational age at birth.

Conclusions: There was no evidence that the intensity duration and frequency of vigorous exercise were associated with significant reductions in mean birth outcomes for the infants of women who participated in the study. Replication in a large, more diverse sample is recommended.

Key words: birth outcomes, birthweight, exercise, gestational age, pregnancy.

Introduction

It has been estimated that approximately 10% of Australian women of child-bearing age (15–44 years) regularly participate in vigorous exercise. Therefore, the issue of whether vigorous exercise is associated with reduced birth outcomes is an important one. In a review of the field, Clapp suggests that ‘the underlying concern is that exercise induced increases in maternal body temperature, circulating stress hormones, calorific expenditure, and biomechanical stress coupled with decreased visceral blood flow could have adverse effects on multiple outcomes of the course and outcome of pregnancy’. Although no study has found any negative effect of moderate intensity aerobic exercise on pregnancy outcome in a normal, healthy pregnancy, the safe limits for exercise during pregnancy have not been determined. The goal of this study was to address this issue.

Two definitions of vigorous exercise during pregnancy were of particular interest. First, Bell et al. reported a reduction in mean infant birthweight as the weekly number of vigorous sustained exercise sessions increased. In that study, vigorous sustained exercise was defined as at least 30 min or more of running, swimming and aerobics at greater than 50% of maximum heart rate (220 minus age in years) at least three times a week. The researchers found that women who participated in five or more weekly sessions at that standard at 25 weeks pregnancy delivered lower birthweight infants than did non-exercisers and women reporting three to four such sessions; the women reporting three to four such sessions per week delivered infants with higher birthweights than non-exercisers.

The second definition of vigorous exercise was drawn from the American College of Obstetricians and Gynecologists (ACOG) 1985 guidelines for exercise during pregnancy, which recommended that women exercise at a heart rate not greater than 140 beats per minute (b.p.m.), for a maximum of 15 min, at least three times a week. Although the most recent ACOG guidelines placed no specific limits on vigorous exercise during pregnancy, they cautioned exercising women to maintain close medical supervision.

Since the 1985 ACOG pregnancy guidelines, a meta-analysis by Lokey et al. examined 18 studies that measured birth outcomes for women who exercised within the guidelines versus those who exceeded them. Although all exercisers complied with the recommendation of at least three weekly

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sessions, many women exceeded the session time and heart rate limits. These authors concluded that pregnant women could exercise up to three times a week, for 43 min per session, at a heart rate of 144 b.p.m. without harming themselves or their unborn infants.

To date, insufficient research exists regarding vigorous exercise. Moreover, a lack of agreed standards of what constitutes vigorous exercise makes conclusions difficult to draw. Clearly, further prospective research that investigates standards for exercise vigour during pregnancy is needed.

Therefore, this prospective study, which followed recreational exercisers across pregnancy, had two main aims. The study examined: (i) whether, using the definition of Bell et al., frequent sustained exercise was associated with reduced birth outcomes (birthweight, and total weeks gestation at birth) and (ii) whether participants who exceeded ACOG 1985 recommendations (vs. those who complied) for exercise duration, frequency and intensity during the most vigorous parts of exercise had reduced birth outcomes. Another goal of this study was to describe the average duration, frequency and intensity of vigorous exercise reported and to compare our findings with those of Bell et al. and Lokey et al.

**Method**

**Participants**

A total of 148 women participated in the study (women carrying twins were excluded) with a mean age of 31.7 years (range, 21–42 years). On average, the women were 18.6 weeks pregnant (range, 16–23 weeks) at time 1 (T1), 26.6 weeks (24–31 weeks) at time 2 (T2), and 34.5 weeks (32–38 weeks) at time 3 (T3). The women were primiparous (45.1%), or had one child (35.8%), or two children (9.3%) or more than three children (2.5%). Of the participants, 70.9% reported annual household incomes of more than $A70 000; 10.1% reported incomes of between $A50 000 to $A69 000; 14.9% reported incomes of between $A30 000 to $A49 000; and 2% reported incomes of less than $A30 000. Most women were married (87.8%), with others in de facto relationships (11.5%) or single (0.7%). In total, 81.8% were tertiary educated, 16.9% had secondary education and 1.4% had primary education and most were in paid employment (73.5%), with 40.1% full-time and 34% part-time workers. Most participants were born in Australia (87.2%), with others representing all continents.

In all, 97.3% of participants reported exercising before pregnancy. Participants’ average body mass index (BMI; weight (kg)/height (m)\(^2\)) was 23.8 at prepregnancy, 25.3 at T1, 26.8 at T2 and 28.3 at T3. Across pregnancy, 6.2% reported smoking at T1, 5.4% at T2 and 3.4% at T3; 31.1% consumed alcohol at T1, 43.3% at T2 and 41.2% at T3; and 1.4% smoked cannabis at T1, 1.4% at T2 and 2.1% at T3.

**Procedure and measures**

After obtaining university ethics approval, participants were recruited through advertisements in sports organisations’ newsletters and websites; suburban and daily newspapers; information placed with prenatal exercise providers; a fitness centre; and in waiting rooms of obstetricians and gynaecologists. Active consent was obtained.

At 7- to 8-week intervals at 16–23 weeks (T1), 24–31 weeks (T2) and 32–38 weeks (T3) gestation, participants were mailed questionnaires, a Polar ‘Beat’ heart rate monitor with instructions for use, and a reply paid envelope for return. Prepregnancy information was obtained retrospectively at T1. At T1, participants reported demographic information, including weight, height, parity and number of weeks of pregnancy. At T1, T2 and T3, for seven consecutive days, participants maintained an exercise diary in which they recorded each time that they exercised, the exercise types, duration of exercise, heart rate during exercise, the highest heart rate during exercise, duration of the most vigorous part of exercise and levels of puffing. At each pregnancy time point (and at T1 for prepregnancy), women detailed the amount and frequency of tobacco, cannabis, alcohol and medication. Between 7 and 14 days post-partum, participants provided details of birthweight and date of birth from the child health record.

Two definitions of vigorous exercise during pregnancy were examined. For definition 1, based on Bell et al., frequent sustained exercise was defined as ≥30 min of swimming, cycling, aerobic classes, running and walking, including reports of puffing and a heart rate >50% of age-adjusted heart rate (220 minus age in years × 0.5) ≥3 times a week. Definition 2, drawn from ACOG 1985 guidelines, defined vigorous exercise as ≥3 weekly sessions of aerobic classes, swimming, cycling, running, walking, circuit training, weight training, martial arts or dance maintained for ≥15 continuous minutes at heart rates above 140 b.p.m.

**Results**

**Description of birth outcomes and exercise levels**

The mean birthweight for the sample (N = 148) was 3497.3 g (SD = 495.7), and mean weeks gestation at birth was 39.6 (SD = 1.6). Bivariate correlations indicated that maternal age and parity were not associated with birth outcomes (P > 0.05).

Regarding the criteria used by Bell et al., in this study, 102 women (86.4% of exercisers) participated in vigorous sustained exercise (definition 1). Of these, 26.5% participated in five or more weekly sessions (mean = 6.1 sessions) with 11.5% doing high puff and 6.6% low puff exercise; while 23.5% participated in three to four weekly sessions (mean = 3.4 sessions) with 8.8% doing high puff and 7.4% low puff exercise. Twenty-one women (14.2%) did five or more vigorous sessions at T1, T2 and T3 compared with six women (4.1%) who did five or more sessions at T1 and/or T2 (but not at T3). On average, 94.1% of sessions of sustained exercise lasted for a mean of 60 min or less.

In relation to ACOG criteria, in the present study, 60.3% of 120 exercising women exceeded a heart rate of 140 b.p.m.; 28.9% exceeded 140 b.p.m. and did more than 15 min of
exercise; 23% exceeded 140 b.p.m. and did more than 15 min of exercise at least three times a week (definition 2).

**Relationships between exercise levels (definition 1) and birth outcomes**

Between groups, ANOVA was used to explore the effect of frequent sustained exercise (FSE; definition 1) on birth outcomes across pregnancy (group 1a: 5+ sessions FSE; group 1b: 3–4 sessions; group 1c: 1–2 sessions; group 1d: did not meet criteria; group 1e: no aerobic exercise; group 0: no exercise). No significant difference was found for birthweight ($F(5, 142) = 0.89, P = 0.49$); and weeks gestation ($F(5, 142) = 0.93, P = 0.46$, see Table 1).

**ACOG recommendations (definition 2) and birth outcomes**

Between groups, ANOVA was used to explore the impact of mean heart rate, exercise duration and frequency on birth outcomes (group 2a: exceeded ACOG guidelines of 140 b.p.m. and 15 min and three or more sessions; group 2b: did not exceed all criteria; group 2c: did other types of exercise (e.g. yoga, pilates; group 0: no exercise)). No significant differences were found for birthweight ($F(3, 144) = 0.27, P = 0.84$); and weeks gestation ($F(3, 144) = 0.99, P = 0.40$, see Table 1).

**Analysis of power**

Post-hoc analyses of power explored the sample size required to reach statistical significance ($< 0.05$). For both birthweight and gestational age, definition 1 (Bell et al.) analyses and definition 2 (ACOG guidelines) indicated 103 and 88 participants per group, respectively, would be needed to reach significance.

**Low birthweight and preterm infants**

Four low birthweight (LBW) infants (< 2500 g) were born to participants. All LBW infants were born preterm (< 37 weeks). Three were delivered by emergency Caesarean section at 32, 34 and 34.6 weeks, and one following spontaneous vaginal labour at 35.6 weeks. Three of the four women who delivered LBW infants exercised at T1 and/or T2 but not at T3. One did five walks and three pregnancy classes of exercise in the reported week at T1 (mean session length = 44 min, mean minutes > 140 b.p.m. = 20), and six walks and two pregnancy classes at T2 (mean session length = 42 min, mean minutes > 140 b.p.m. = 20). Another participant did four walks and two pregnancy classes at T1 (mean session length = 60 min, mean > 140 b.p.m. = 5) with no exercise at T2. The third participant (one pregnancy class in the week at T1 only) did not meet the criteria for frequent sustained exercise and reported 3 min of exercise > 140 b.p.m. A fourth participant did no exercise.

Women who delivered LBW infants reported drinking between two and 10 standard glasses of alcohol weekly before pregnancy, and one smoked 20 cigarettes daily and five cannabis cigarettes monthly before pregnancy. None reported drinking alcohol or smoking cigarettes or cannabis during pregnancy. No pre-existing illness was reported. However, one woman developed pre-eclampsia during pregnancy, one had a prior miscarriage, and one took *in vitro* fertilisation medication daily before pregnancy.

**Discussion**

This prospective study examined two definitions of vigorous exercise in relationship to birthweight and gestational age in a sample of recreational exercisers. No evidence of more adverse results for fetal growth was found for infants of women who exceeded criteria set by Bell et al.3 or by ACOG when compared with those exercising within the criteria or non-exercising controls. As will be discussed below, however, further research is needed prior to confidently changing the 1985 ACOG guidelines and for determining safe upper limits for exercise.

In the present study, 26.5% of exercisers participated in five or more vigorous weekly sustained exercise sessions, and
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23.5% in three or four vigorous weekly sessions across pregnancy compared with 26.2 and 39.8%, respectively, in the study by Bell et al. In all, 94.1% sessions of sustained exercise lasted for 60 mean minutes or less compared to 82% of sessions in the study by Bell et al. Women in the 5+ sessions group of the present study participated in an average of 46 min exercise sessions six times a week, and those in the three to four sessions group in 52 min sessions three and a half times a week across pregnancy.

In contrast to the study by Bell et al., the present study found no significant reduction in mean birthweight for exercisers who did five or more weekly sessions of sustained exercise during pregnancy when compared to non-exercising controls and other exercise groups. It was possible that differences in the types of exercise that women participated in may have affected results. Women participated in running, swimming and aerobic classes in the study by Bell et al., whereas those in the present study participated in those activities, including walking and cycling. Moreover, while some continued to run throughout pregnancy in the study by Bell et al., in the present study only two women ran at 13–23 weeks pregnancy, and by 24 weeks pregnancy, all running had ceased. Additionally, whereas all participants in Bell et al.’s five or more session’s group reported puffing, only 70% of women in our high exercise group reported equivalent levels of puffing. Thus, because aerobic capacity was not measured in either study, we cannot be certain that participants in the studies were exercising at equivalent intensities, with equivalent caloric expenditure. Thus, future research should consider more vigorous exercise, such as running, and could also consider variables not examined here such as weight-bearing versus non-weight-bearing exercise and impact versus non-impact exercise on birth outcomes.

In agreement with Lokey et al., we found no significant differences in mean birth outcomes for the infants of women who exceeded ACOG recommendations when compared with those exercising within the guidelines. On average, those exceeding all ACOG recommendations in this study participated in 4.7 (range, 3–9) weekly sessions of vigorous continuous exercise of 22.7 min (range, 16–40), at heart rates of 154 b.p.m. (range, 141–168). In comparison, Lokey et al. found that pregnant women participating in 43 min sessions at heart rates of 144 b.p.m. up to three times a week (some what lower levels than in the current study) also did not have harmful outcomes.

In looking for other reasons to explain the differences between the studies, most importantly the present study employed a prospective design. Moreover, the present study (and Bell et al.) instructed participants to complete a daily exercise diary to determine the influence of exercise intensity, duration and frequency for a number of exercise types across pregnancy. In contrast, 31% of studies in Lokey et al. used a retrospective design that relied on participant recall of their exercise. Women in the present study, in the study by Bell et al. and in some studies in Lokey et al. provided self-report of exercise, thus, increasing the chance of inaccurate reporting. However, the opportunity for error was limited in the present study as participants completed a structured daily exercise diary over a maintainable time period; and they also had a heart monitor that displayed their heart rate during exercise.

Two of four women who delivered preterm LBW infants in the present study exceeded ACOG guidelines for heart rate, duration and number of sessions at T1 and/or T2. Therefore, it would be premature to do away with ACOG guidelines. However, no LBW infants were delivered to women who continued vigorous sustained exercise or exceeded ACOG guidelines across pregnancy. There are many factors (including genetics, social economic status, maternal age, diet, smoking, pregnancy complications and premature delivery) that contribute to LBW. The two participants who exceeded ACOG guidelines for heart rate and number of sessions at T1 and/or T2 and delivered preterm LBW infants in the present study reported pregnancy complications (i.e. pre-eclampsia or previous miscarriage) that would have excluded them from analyses in past studies. Allowance must also be made for infants born preterm as they have less time to develop than those delivered at term. More research examining a large sample of women with LBW and/or preterm infants is needed.

It should be noted that the present study examined the 1985 ACOG guidelines and also compared the present findings to a previous Australian study of frequent sustained exercise, both definitions of which used a set heart rate (140 for ACOG, age adjusted for Bell et al.). However, resting heart rate varies across women (and gradually increases with advancing gestation until reaching approximately 15 b.p.m. above prepregnancy values in the third trimester), and thus 140 b.p.m. would represent different levels of vigour for different women. Future research should therefore control for participants’ resting heart rates.

A demographic limitation of this study was that the majority of participants were either married or in a de facto relationship and were tertiary educated. Furthermore, the women in our sample was somewhat thinner prepregnancy (BMI mean = 23.8) than the norm (the 1995 national mean BMI for women aged 25–44 was 25.3). Replication in a more diverse sample is required, also considering variables, such as socio-economic status and education levels to determine the effect of environmental factors that have not been considered here. However, given the sample demographics, we can be reasonably assured that factors known to affect birthweight, such as poverty and inadequate nutrition, were not important factors. Whether exercise becomes problematic when other risk factors are present remains to be examined in future studies.

We note that the number of vigorous exercisers in the present study (and the study by Bell et al.) was small. However, analyses of power indicated it was unlikely that sample size led to type II errors (i.e. failing to detect a real difference between the groups).

In summary, we found that the intensity duration and frequency of vigorous exercise were not associated with significant reductions in mean birth outcome or lower gestational age for the infants of women in this sample. However, replication in a large, more diverse sample is recommended before conclusions can be drawn. The present findings contribute to the limited research on vigorous exercise during pregnancy.

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References