EFFECTS OF MATERNAL AEROBIC EXERCISE ON SELECTED
PREGNANCY OUTCOMES IN NULLIPARAS

THESIS

Presented to the Graduate Council of the
University of North Texas in Partial
Fulfillment of the Requirements

For the Degree of

MASTER OF SCIENCE

By

Dian L. Melgar, R.N., B.A.N.
Denton, Texas
August, 1997

This study evaluated the effects of participation in aerobic exercise on pregnancy outcomes. Pregnancy outcomes included type of delivery, length of labor, gestational age, neonatal birth weight, and maternal weight gain. The 137 nulliparas were categorized as active (N=44) or sedentary (N=93) based on self-reported aerobic exercise. Findings from this study suggest that pregnant women who were active during pregnancy were more likely to have vaginal deliveries than sedentary women. No significant differences between active and sedentary women were found in neonatal birth weight, maternal weight gain, length of labor, or gestational age.
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I would like to express my deepest gratitude to my husband for his love, support, and encouragement. “You can do it” and “It will be OK” were common words of strength from him that sustained me in the depths of stress.

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May God bless you all.
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CHAPTER 1

INTRODUCTION

With the advent of the fitness movement of the 1980s, pregnant women have become more physically active in strenuous exercise and sports (Baddeley & Green, 1992; Wallace, Boyer, Dan, & Holm, 1986). Consequently, consumers and health professionals are seeking information regarding benefits and risks of aerobic exercise during pregnancy and on pregnancy outcomes. Historically, medical advice to pregnant women was to rest throughout pregnancy (Wolfe, Brenner, & Mottola, 1994). Such advice results in denial of a usually recommended healthful behavior and could conceivably lead to a sedentary lifestyle after the birth of the baby.

Exercise during pregnancy benefits most individuals with a healthy pregnancy who were previously active before conception (Revelli, Durando, & Massobrio, 1992). Pregnancy is often associated with multiple discomforts; however, women who exercise during pregnancy may lessen the frequency of physical discomforts (Wallace et al., 1986), and be better prepared for the “marathon of labor” (Tupler, 1996). Physical activity and exercise are important during pregnancy because they contribute to a sense of well-being, self-confidence, and greater physical resilience (Artal Mittelmark, Wiswell, & Drinkwater, 1991).

Exercise has also proven beneficial to women in terms of type of
obstetrical delivery. The two major types of obstetrical deliveries are vaginal and cesarean section. Risks to the mother for a cesarean delivery include infection, increased blood loss, decreased bowel function, respiratory complications, reactions to anesthesia, and a longer hospital stay and recovery time (Johnson, 1994). In addition, cesarean deliveries pose risks to the baby, such as premature birth, respiratory problems, low Apgar scores (ratings of fetal well-being), and fetal injury (Johnson, 1994). Cesarean deliveries may also delay mother-infant bonding and breastfeeding (Bobak, Jensen, & Zalar, 1989). Therefore, vaginal deliveries, when possible, are preferable to cesarean deliveries.

Three studies have reported a higher incidence of vaginal deliveries among exercising women (Clapp, 1990; Hall & Kaufmann, 1987; Zeanah & Schlosser, 1993). In a prospective study, Hall and Kaufmann (1987) found that 93.3% of the women in the high exercise group had vaginal deliveries compared to only 71.9% in the control group. Chi-square analysis of variance used by Zeanah and Schlosser (1993) reported a higher incidence of vaginal deliveries in members of the low and moderate intensity groups (<149 beats per minute) and also among women who exercised for 40 minutes or more per session. Clapp's prospective study (1990) also found that maternal aerobic exercise facilitated vaginal deliveries by comparing nonexercisers and women who regularly exercised (running, aerobics). Kulpa, White, and Visscher (1987) found no difference in mode of delivery in their study.

Another possible benefit of maternal aerobic exercise is a shortened labor. In a review article, four studies from 1951 to 1976 found noticeably shorter labors in female
athletes than sedentary women (Rivelli et al., 1992). These results were confirmed by Kulpa et al. (1987) who found a shortened labor when comparing an exercise group to a control group. Other researchers have not found significant differences in times of labor (Hall & Kaufmann, 1987; Horns, Ratcliffe, Legett, & Swanson, 1996; Lokey, Tran, Wells, Myers, & Tran, 1991).

Problem of Study

Private health clubs, YMCAs, community recreation centers, and hospitals commonly offer prenatal exercise classes. Many women have discovered that a physically active lifestyle is essential for optimal health (Wells & Shoenhair, 1996) and want to continue exercising throughout pregnancy. Therefore, the purpose of this study is to describe the effects of maternal aerobic exercise on selected pregnancy outcomes.

Justification of the Study

Regular physical exercise has become an integral part of many women's lives. As women become pregnant, many will seek information regarding the efficacy of continuing exercise programs during pregnancy. The research to date has yielded conflicting results and is insufficient to answer many pregnant women's questions about the impact of exercise on pregnancy. Virtually all of the studies to date have included women with one (primiparas) or more pregnancies (multiparas). This study will compare exercise backgrounds in homogenous subjects (exclusively nulliparas). Nulliparas are women who have not completed a pregnancy past 22-23 weeks gestation. This study will seek to add data on the effects of exercise during pregnancy in this select population since the relevant literature indicated a need for further information.
Hypotheses

The following hypotheses will be investigated:

1. Women who exercise regularly will have a higher rate of vaginal deliveries and a lower rate of cesarean deliveries than nonexercisers.

2. Other selected pregnancy outcomes (neonatal birth weight, maternal weight gain, gestational age of newborn, and length of labor) will be more positive for those who were regular exercisers than nonexercisers.

Definition of Terms

The following terms are defined relative to this study:

1. Maternal aerobic exercise: within the framework of available research, as well as the recommendations of the American College of Sports Medicine (ACSM), aerobic exercise should be performed at least 3 days a week for at least 20 minutes. The activity should include large muscle groups at an intensity of 60-90% of maximum heart rate (ACSM, 1995).

For purposes of this study, maternal aerobic exercise will be assessed by subjects who are at least 32 weeks but less than 42 weeks pregnant. Women will be asked to identify the activities they regularly performed (e.g., swimming, brisk walking, running) and the average number of times per week each activity was performed. Instructions will specify that an activity must be performed for a total of at least 20 minutes per day to be counted. Active women will meet the above specifications by exercising at least three or more times per week during the first and second trimesters. All other women were classified as sedentary.
2. **Pregnancy outcomes:** to be defined in terms of neonatal birth weight, maternal weight gain, length of labor, occurrence of cesarean delivery, and gestational age of newborn at delivery. This information was collected via telephone within 2 weeks of delivery.

3. **Gestational age:** to be calculated in weeks as the difference between the date of delivery and date of the last menstrual period.

4. **Onset of labor:** The onset of regular uterine contractions followed by a progressive cervical change or the membranes ruptured (“water broken”).

5. **Length of labor:** computed as time of delivery minus onset of regular contractions/water broken. An average labor is complete within 24 hours.

6. **Term infant:** an infant who is born between 38 and 42 weeks of gestation. The normal birth weight range for term infants is 2500-4000g (5.5-9.0 lbs).

7. **Maternal weight gain:** self-reported weight at last prenatal visit minus prepregnancy weight. The acceptable weight gain for most healthy women is between 22-32 lbs.

8. **Nullipara:** a woman who has not completed a pregnancy with a fetus that reached viability (22-23 weeks gestation).

9. **Parity:** number of pregnancies that have reached viability.

**Limitations**

For the purpose of this study, the following limitations were identified:

1. Use of a convenience sample limits the generalizability of the results of this study to populations that have similar demographic compositions.

2. Use of a retrospective, self-reported questionnaire limits results, as recall bias may affect the accuracy of responses.
3. No attempt was made to control the hospital where deliveries took place. Variations in hospitals, especially cesarean section rates, could affect results.

Summary

The heightened awareness of exercise as a health promotion behavior has led many women to want to continue aerobic exercise during pregnancy. Conflicting results are presented in the literature, therefore more research is needed to investigate this topic. To meet this need, pregnancy outcomes will be studied in relationship to maternal aerobic exercise. Two hypotheses were listed, terms were defined, and limitations were presented in this chapter.
CHAPTER 2

LITERATURE REVIEW

This chapter includes a review of the literature related to the physiological adaptations to pregnancy and effects of exercise, potential risks of exercise during pregnancy, benefits of aerobic exercise for pregnant women, and recommendations for and contraindications to exercise in pregnancy.

Physiological Adaptations To Pregnancy and Effects of Exercise

Pregnancy is accompanied by profound and ever-changing alterations in virtually every system in the woman's body. Thus, the response to exercise is deeply modified in comparison to non pregnant women. The major systems affected are the cardiovascular, respiratory, metabolic, thermoregulatory, and musculoskeletal systems.

Cardiovascular Changes

Maternal changes are induced by peptide and steroid signals from the conceptus that evoke a series of responses (Clapp, Rokey, Treadway, Carpenter, Artal, & Warnnes, 1992). Such changes include an increase in blood volume, cardiac output, and resting pulse and a decrease in systemic vascular resistance (Wolfe, Hall, Webb, Goodman, Monga, & McGrath, 1989a).

Blood flow is redistributed during exercise to provide working skeletal muscle with adequate oxygen and nutrients (McCardle, Katch, & Katch, 1996). This may cause
a shunting of maternal cardiac output from the visceral organs, including the uterus and placenta, to the active muscles (McMurray, Mottola, Wolfe, Artal, Millar, & Pivarnik; 1993). The fetus may be exposed to transient periods of hypoxia if this shift in maternal blood flow compromises uterine blood flow. Developmental abnormalities and neurologic damage could result from repeated exposure to hypoxia during maternal exercise (Wells & Shoenhair, 1996).

Animal models involving pregnant sheep that examined the effects of uterine blood flow have been inconclusive (Sady & Carpenter, 1989; Wallace & Wiswell, 1991). In humans, the fetal heart rate is monitored to detect fetal hypoxia (Lotgering, Gilbert, & Longo, 1985). While prolonged bradycardia is of concern, “no mortality or morbidity has ever been linked to exercise induced bradycardias in women with normal pregnancies” (McMurray et al., 1993, p. 1309).

The effect of exercise on cardiac output in pregnancy is not entirely clear, since different authors have reported conflicting results (Clapp et al., 1992; Revelli et al., 1992; Sady & Carpenter, 1989). Cardiac output in the third trimester of pregnancy is maximal with the subject in the left or right lateral recumbent position (Clark, Cotton, Pivarnik, Lee, Hankins, Benedetti, & Phelan, 1991). In contrast, after the third trimester, the supine position results in relative obstruction of venous return by the enlarging uterus and a significant decrease in cardiac output (ACOG, 1994; Morton, 1991).

Maternal blood volume increases approximately 30 to 50% during pregnancy (Lotgering et al., 1985). The plasma volume increases more than the blood cell volume and a certain degree of hemodilution occurs (Revelli et al., 1992). A recent study
revealed that blood volumes were significantly greater in the physically active compared to sedentary subjects (Pivarnik, Mauer, Ayre, Kirshon, Dildy, & Cotton, 1994).

**Respiratory Changes**

Respiratory changes in pregnancy result in a 50% increase in minute ventilation, primarily as a result of increased tidal volume (Artal, Wiswell, Romem, & Dorey, 1986). The increased ventilation has been attributed to a direct effect of progesterone and increased sensitivity to CO2 (Pivarnik, Lee, & Miller, 1991; Wolfe, Ohtake, Mottola, & McGrath, 1989b). There is greater use of the accessory muscles of respiration, but the expected increases in the oxygen cost of breathing may be partly offset by increased airway conductance (Wolfe et al., 1989a). These adaptations minimize the likelihood of fetal ischemia or metabolic acidosis (Wolfe et al., 1989a).

**Metabolic and Thermoregulatory Changes**

The metabolic needs of pregnancy require approximately 300 extra kilocalories per day (Artal, Masaki, Khodiguian, Romem, Rutherford, & Wiswell, 1989). This caloric requirement is increased further in pregnant women who exercise regularly. Such concerns do not appear to be significant for most exercising pregnant women (ACOG, 1994).

There is concern that exercise can result in elevated body core temperature to a degree that would cause pathological changes (teratogenic effects) in a developing fetus. McMurray et al. (1993) cited three animal studies that suggested body core temperature elevations above 39°C increases the risk of neural tube defects. The 40% increase in maternal blood volume that occurs during pregnancy appears to help transfer heat from
the fetus (Jarski & Trippett, 1990). Several investigators (Hauth, Gilstrap, & Widmer, 1982; McMurray & Katz, 1990) have concluded that maternal temperature does not increase above 39°C under normal exercise conditions. Furthermore, “there has been no demonstrated increase in neural tube or other birth defects among pregnancies of women who continue to perform even vigorous exercise during early pregnancy” (ACOG, 1994, p. 2).

**Musculoskeletal Changes**

The weight gain of 22 to 32 pounds during an average normal pregnancy causes shifts and strains in the pregnant woman’s musculoskeletal system (Freyer, 1989). A shift in the center of gravity, lordosis, and generalized ligamentous relaxation can result in instability of balance, low back pain, and an increased chance of sprains (Karzel & Friedman, 1991).

**Benefits of Aerobic Exercise For Pregnant Women**

Numerous studies have suggested women with a healthy pregnancy may safely engage in aerobic exercise during pregnancy without compromising fetal growth and development or complicating the process of pregnancy, labor, or delivery (Hall & Kaufmann, 1987; Jackson, Gott, Lye, Knox Ritchie, & Clapp, 1995; Rice & Fort, 1991; Sternfeld, Quesenberry, Eskenazi, & Newman, 1995; Wallace et al., 1986). In fact, exercise may reduce the symptoms of pregnancy.

**Comfort and Image**

Wallace et al. (1986) found that 31 pregnant women who participated in aerobic exercise had significantly fewer physical discomforts during pregnancy than the control
group. The exercisers demonstrated significantly lower scores for shortness of breath, backache, headache, fatigue, and hot flashes.

A longitudinal design utilizing the Physical Discomforts Checklist was also used by Sternfeld et al. (1995). Beginning at 16.5 weeks gestation, 388 women were followed through delivery. In-person interviews were used to determine the frequency, duration, and mode of aerobic exercise prior to conception and during the first trimester. Exercise patterns during the second and third trimesters were assessed by telephone interviews. For each time period, women were categorized into four levels of activity ranging from Level I (3x / week for 20 minutes) to Level IV (<1x / week). The data revealed that women who exercised more in the 3 months before pregnancy reported significantly fewer symptoms during the first and third trimesters than women exercising at Levels III and IV. Also, the comparison of women who continued a high level of exercise with those who did not indicated that the decrease in activity preceded differences in reporting symptoms. Therefore, women were not exercising because they felt better, but rather, feeling better because they were exercising.

Fourteen common discomforts of pregnancy were also studied by Horns et al. (1996). Forty-eight pregnant women were categorized as active by exercising at least 15-30 minutes three or more times per week in a listed cardiovascular activity. The 53 sedentary women were similar in terms of ethnicity, marital status, and age. Twenty-five percent of the active group reported five or fewer discomforts during pregnancy while 94% of the sedentary group had greater than 5 discomforts (p<.01).

Exercise can also help pregnant women release tension, improve body image, and
decrease depression (Hall & Kaufmann, 1987; Artal & Artal Mittelmark, 1991). Hall and Kaufmann (1987) prescribed exercise programs for 845 subjects. When the women were surveyed 6 weeks postpartum, all of the exercisers reported that the conditioning program gave them an improved self-image, decreased the discomforts of pregnancy, and relieved tension.

**Labor Length and Exertion**

The normal labor consists of three stages. The first stage of labor begins with the onset of regular uterine contractions and culminates when the cervix has reached full dilation. The first stage can be further divided into a latent phase and an active phase. For nulliparas, the first stage may take up to 24 hours. The second stage of labor, expulsion of the baby, lasts from full dilation of the cervix to delivery of the fetus. Labor of up to 2 hours is considered within the normal range for the second stage. The third stage of labor lasts from delivery of the fetus to delivery of the placenta. The length of this stage can vary from less than five minutes to up to an hour depending on the physician or midwife (Bobak et al., 1989).

Maternal aerobic exercise can benefit women in terms of labor as well. Kulpa et al. (1987) conducted a 2.5 year prospective study on aerobic exercise during pregnancy. The exercise group had a shortened active phase and second stage of labor (7.5 hours) compared to the control group (10.5 hours). The aerobic exercise consisted of swimming laps, aerobic exercise, jogging, brisk walking, cross-country skiing, stationary biking, and playing racquetball.

Wong and McKenzie (1987) also reported a shortened labor in all three stages for
“fit” women. The 20 subjects were classified as “fit” or “unfit” based on heart rate response to a submaximal cycle ergometry test. The trained women had a mean duration of just over 11 hours for the first stage of labor compared to almost 14 hours in the untrained group. The second stage of labor in the trained group was less than 80% of the untrained group ($T = 70.0\, \text{min.}, \, UT = 90.5\, \text{min.}$). The authors concluded that increased cardiorespiratory fitness aided the birthing process by postponing the onset of fatigue.

Erdelyi (1962) even found shortened second stages of labor over 30 years ago. His study based on 172 Hungarian female athletes found that 87.2% of the athletes delivered their baby faster than the established average. His theory emphasized the favorable effect of the strengthened abdominal muscles proving beneficial during the second stage of labor.

Exercise has also helped women in terms of labor exertion (Rice & Fort, 1991). Using Borg’s Perceived Exertion Scale, active women were interviewed 2-5 days following delivery. Subjects rated their perceived exertion during labor on a scale of 6-20 with 6 being extremely light and 20 being extremely difficult. The mean score for the active women was 12.9 whereas the sedentary group rated labor more difficult at 14.1.

Type of Delivery

The increased incidence of vaginal deliveries versus cesarean deliveries is another benefit of maternal aerobic exercise. Hall and Kaufmann (1987) included 845 pregnant women who were given the option of participating in a prenatal exercise program. The program consisted of strengthening exercises plus an aerobic workout on exercise bicycles. Subjects were categorized into four groups based on the total number of
exercise sessions completed during pregnancy: control (minimal exercise), low exercise, medium exercise, and high exercise. The rate of vaginal delivery was 93.3% in the high-exercise group and 81.0% in the medium-exercise group, compared with only 71.9% in the control group (p<.0001).

Clapp (1990) prospectively followed 67 recreational runners and 64 aerobic dancers over a 6.5 year period. All women exercised regularly for at least 6 months prior to conception. The 87 women who continued to exercise at or above 50% of their preconceptual performance level throughout pregnancy were compared to the 46 women who spontaneously stopped their exercise regimen by the end of the first trimester. The women who continued to exercise had a vaginal delivery rate of 88% compared to only 70% in the discontinued group (p<.01). In addition, 81% of the nonexercisers required an episiotomy while only 46% of the exercisers did (p<.01).

Zeanah and Schlosser (1993) surveyed women attending two national physical fitness conferences. One hundred seventy-three women who exercised during pregnancy were divided into six groups. The groups were based on self-reported heart rates and duration of exercise during the third trimester of pregnancy. The high intensity group included women who exercised at heart rates of 150 beats per minute (bpm) or greater. The moderate and low intensity groups consisted of women who exercised at heart rates of 130 to 149 bpm and at or below 129 bpm, respectively. The long duration group included women who participated in the vigorous aerobic portion of a workout for 40 minutes or more. The moderate duration group exercised from 20-39 minutes, and the short duration group exercised for 19 minutes or less. Because groups were not mutually
exclusive, a woman could be included in both intensity and duration groups. Members of
the moderate intensity groups and long duration had significantly fewer cesarean
deliveries.

Birth Weight

Some research has demonstrated either a reduced birth weight in neonates whose
mothers exercised during pregnancy (Clapp & Dickstein, 1984; Bell, Palma, & Lumley,
1995) or no significant difference in birth weight (Lokey et al., 1991; Sternfeld et al.,

Two cohort studies of over 1600 total pregnant women have reported higher birth
weights among women who exercised during pregnancy (Hatch, Shu, McLean, Levin,
women by telephone at 13 weeks of gestation and utilized questionnaires at 28 and 36
weeks gestation. The reported activities were assigned an intensity code in kilocalories
per minute based on the Minnesota Leisure-Time Physical Activity Questionnaire.
Exercise was trichotomized as “no exercise,” “low-moderate exercise” (≤1,000
kcal/week), and “heavy exercise” (>1,000 kcal/week). Overall, in each trimester, women
who exercised had higher birth weights than nonexercisers. Heavy exercise throughout
pregnancy was associated with a gestational age-adjusted mean birth weight that was 276
g higher than nonexercisers.

The mean birth weight of exercising mothers was 65 to 151 g higher than the
control group in Hall and Kaufmann’s study (1987). The greatest difference was
between the control and high-exercise group.
Maternal Weight Gain

One study has documented a significant difference in maternal weight gain during pregnancy (Kulpa et al., 1987). The control group gained a mean total of 33.9 pounds whereas the exercising women only gained 27.5 pounds ($p<0.03$). The active women gained a mean of 35.9 pounds in the study by Horns et al. (1996) compared to 38.2 pounds in the sedentary group. The results were not statistically significant however. Other studies have reported no difference in maternal weight gain between exercisers and nonexercisers (Rice & Fort, 1991; Wong & McKenzie, 1987; Lokey et al., 1991).

Placental Composition

Jackson et al. (1995) compared the volume and surface areas of placentas between exercisers and a control group. Several vascular dimensions were measured in 60 placentas. The surface areas of arteries, veins, and capillaries were significantly greater in the placenta from women who continued exercising than the control group. Likewise many of the vessel diameters and volumes were significantly larger in the exercisers. These changes all suggest increased placental perfusion and improved transport capability serving to protect the fetus during decreases in uterine blood flow.

Potential Risks of Exercise During Pregnancy

As observed in animal models and discussed previously, certain types of exercise may endanger the fetus and lead to detrimental outcomes (Lotgering et al., 1985). One criteria for judging detrimental effects of exercise on pregnancy is to compare birth weights of newborns of exercising women with those of controls of a similar socioeconomic level (Bell et al., 1995; Goodlin & Buckley, 1984).
In 1984, Clapp and Dickstein followed 228 women who continued endurance exercise until at least the 28th week of pregnancy. Endurance exercise was limited to aerobic dance, running, and cross country skiing. Women who continued to exercise into the third trimester were matched for socioeconomic status, parity, age, and preconceptual weight with women who were sedentary or who stopped exercising prior to the 28th week of pregnancy. Women who continued endurance exercise during pregnancy had babies whose mean birth weight was 500 g lower than the mean birth weight of babies born to sedentary women and those who stopped exercising prior to the 28th week. A reduction in mean birth weight of 500 g is a clinically significant reduction being at least 2 times the impact on birth weight of smoking a pack of cigarettes per day (Brooke, Anderson, Bland, Peacock, & Stewart, 1989).

Another prospective study found that women doing more than four sessions of vigorous exercise weekly had lower birth weight infants (Bell et al., 1995). A dose-dependent reduction in birth weight was observed as the amount of exercise increased. Clapp and Capeless (1990) have theorized that this slightly decreased birth weight may reflect lower infant body fat mass. Furthermore, the ACOG (1994) stated that, “intrauterine growth retardation and other deleterious short-or long-term effects of decreased fetal weight have not been documented” (p. 3).

Another potential risk of exercise during pregnancy is the precipitation of preterm labor. Norepinephrine, which increases during exercise, can act as a stimulant to the uterus and induce premature labor (Artal Mittelmark, 1991). Simpson (1993) reported that no randomized trials have been done and that baseline uterine activity is not
increased with physical activity. The most recent studies have not indicated any relationship between exercise and a shortened gestation (Sternfeld et al., 1995; Pivarnik et al., 1994; Zeanah & Schlosser, 1993; Lokey et al., 1991).

Recommendations for and Contraindications to Exercise in Pregnancy

Prior to 1985, guidelines for exercise during pregnancy were nonexistent (Wells & Shoehnair, 1996). The ACOG issued its first guidelines for exercise during pregnancy in 1985. The document stated that maternal heart rate should not exceed 140 beats per minute and strenuous activities should not exceed 15 minutes in duration (ACOG, 1985). Recent studies tested these specific guidelines and found no adverse maternal or fetal outcomes (Zeanah & Schlosser, 1993; Clapp, 1990; Wong & McKenzie, 1987). For women who do not have any additional risk factors, the ACOG (1994) offered the following recommendations:

1. Mild to moderate regular (at least three times a week) exercise routines are preferable to intermittent activity.

2. Exercise in the supine position should be avoided after the first trimester because this position can cause decreased cardiac output. Prolonged periods of motionless standing should be avoided.

3. The intensity of exercise should be modified according to maternal symptoms.

   Exercise activity should not continue to fatigue or exhaustion.

4. Caution should be taken for exercises requiring a lot of balance, especially in the last trimester. Exercise involving the potential for even mild abdominal trauma should be
avoided.

5. Because pregnancy requires an additional 300 kcals per day, women who exercise should be particularly careful to consume an adequate diet.

6. During the first trimester, heat dissipation should be augmented by ensuring adequate hydration, appropriate clothing, and optimal environmental surroundings during exercise.

7. Because physical changes persist 4 to 6 weeks postpartum, prepregnancy exercise routines should be resumed gradually.

The ACOG (1994) emphasized that “none of the recommendations has a firm basis in prospective, randomized, clinical trials” (p. 3). The following six medical or obstetric conditions should be considered contraindications to exercise during pregnancy (ACOG, 1994):

1. Pregnancy-induced hypertension.
2. Preterm rupture of membranes.
3. Preterm labor during the prior or current pregnancy or both.
4. Incompetent cervix/cerclage.
5. Persistent second- or third-trimester bleeding.
6. Intrauterine growth retardation.

Summary

The substantial physiological adaptations to pregnancy appear to protect both the mother and fetus during exercise. Although some risks have been identified, it appears that physically active women can continue an exercise program throughout pregnancy.
In addition, continuing a regular exercise program may have a beneficial effect on multiple aspects of the course and outcome of pregnancy and labor.

In the absence of obstetric or medical complications, pregnant women can continue to exercise and derive related benefits. Depending on the individual's needs and the physiologic changes associated with pregnancy, women may have to modify their specific exercise regimens during pregnancy.
CHAPTER 3

METHODOLOGY

A retrospective, cohort study design was used to investigate the relationship between maternal aerobic exercise and selected pregnancy outcomes. A description of the sample and setting, protection of human subjects, instrument, data collection, and data analysis are included in this chapter.

Sample and Setting

The target population for this study consisted of pregnant women voluntarily attending childbirth education classes and pregnant women voluntarily attending private fitness centers and hospital-based prenatal aerobics classes. The childbirth education classes were offered through three private, for-profit hospitals. The hospitals and fitness centers were located in suburbs of a large metropolitan area in the southwestern United States.

Convenience sampling technique was used to obtain the sample from the population. Questionnaires were distributed to 168 nulliparas. Because of inclusion criteria, sample selection was made after reviewing each questionnaire which allowed for more privacy and confidentiality. Subjects were excluded if they did not meet the following criteria:

1. Participants must be nulliparas.
2. Participants must be ages 18-34 years. Subjects between the ages of 35-40 were included if they did not report any pregnancy-related complications.

3. Participants must be nonsmokers.

4. Participants must be free of medical complications and have a healthy, singleton pregnancy.

Protection of Human Subjects

Approval to conduct this study was obtained from the University of North Texas Institutional Review Board (Appendix A). No risks were identified for participants in this study. At the beginning of each class, the researcher asked for volunteers without intimidation or prejudice to participate in the study. Each woman who completed a questionnaire and informed consent was assured that the information collected would be kept strictly confidential. Subjects’ names were numerically coded in sequential order for data base entry. Preliminary findings were reported in group format without name identification. Follow-up data were collected via telephone communication. Questionnaires remained in a locked file under the control of the investigator and destroyed at the project’s completion.

Instrument

The instrument used in this study was a written questionnaire (Appendix B). Preliminary data collection was completed by participants who were between the gestational ages of 32 and 42 weeks. The survey included items which assessed the following variables: age, ethnic background, education, marital status, parity, significant past medical history, smoking habits, caffeine and alcohol usage during pregnancy,
exercise habits during each trimester, and whether subjects engaged in exercise prior to becoming pregnant. When subjects completed the questionnaire they were given a reminder card with information to record for the follow-up phase. The follow-up phase consisted of a telephone survey approximately two weeks after the anticipated due date. At that time participants were asked the infant delivery date, infant birth weight, length of labor, maternal weight gain, gestational age at delivery, type of delivery (vaginal or cesarean section), forceps/vacuum extractor use, medication received, and episiotomy incidence.

A pilot test was performed to detect unclear instructions, ambiguously worded questions, and potential problems in administering the questionnaire. Seven questionnaires were completed by women who had recently delivered infants. Data from these questionnaires were excluded from the sample study. Minor changes were made in the questionnaire as a result of the pilot testing.

Data Collection

Approval was obtained from authorities at the participating sites prior to data collection (Appendix C). Childbirth education classes were offered on a weekly basis and were sustained for six weeks in the hospital setting. A separate and unique group met each night; therefore, the researcher went each night in a final session to request volunteer participation. That session typically occurred one to four weeks prior to delivery. Additionally, the researcher attended day-long classes which met on weekends. Additionally, structured prenatal aerobics classes were attended on weeknights and weekends. Those who agreed to participate were instructed to complete the
questionnaire as accurately as possible. An explanatory letter, inviting participation and briefly stating the study’s purpose, accompanied each questionnaire (Appendix B).

At the health club setting, a flyer was inserted in a monthly newsletter. Prospective subjects were instructed to phone the researcher if they wished to participate in the study. The study was briefly explained and women were asked to voluntarily participate. After telephone contact, the investigator met with prospective subjects to administer the questionnaire.

Data Analysis

Data was analyzed using the Statistical Package of the Social Sciences (SPSS). Frequency distributions were used to describe age, ethnic background, marital status, education level, forceps or vacuum extractor use, episiotomy rates, and incidence of vaginal births across the active and sedentary groups. The selected pregnancy outcomes and other means of continuous variables were analyzed for statistical differences between exercising and sedentary subjects by independent t-tests. Chi-square analysis was used to determine statistical differences in categorical data between the two groups. The level of statistical significance was \( p \leq 0.05 \) for all tests.

Summary

A retrospective, cohort study design was used to investigate the relationship between maternal aerobic exercise and selected pregnancy outcomes. The sample of nulliparas was obtained from for-profit hospital childbirth education and prenatal aerobics classes, as well as private fitness centers. The data to be analyzed included demographic information, exercise levels, and labor outcomes. Independent t-tests and
Chi-square analysis were used to test the hypotheses, with the level of significance at $p \leq 0.05$. 
CHAPTER 4

RESULTS

The purpose of this retrospective, cohort study was to examine the relationship between maternal aerobic exercise and selected pregnancy outcomes. A description of the sample and the findings are presented.

Description of the Sample

Participants were recruited for this study from the population of women attending childbirth education classes and structured prenatal aerobics classes. Of the 164 women who volunteered, final data analysis was completed on 137 questionnaires. The remainder were excluded for the following reasons: medical conditions, such as diabetes (N=10), smoking (N=6), previous pregnancy which passed 22-23 weeks gestation (N=4), and inability to contact at follow-up (N=7). Of all the classes attended, only four women declined to participate in the study.

Five aerobics classes and 25 childbirth education classes were utilized for the sample of convenience. Data was collected over a 3 month period during the spring of 1997.

The ethnicity of this group of nulliparas was predominantly white (N=112; 81.8%). Of the 137 subjects, 10 (7.3%) were Hispanic, 9 (6.6%) were Asian, 4 (2.9%) marked other, and 2 (1.5%) were African-American. Differences in ethnicity between
Table 1

Initial Maternal Characteristics of 137 Nulliparas
In the Active and Sedentary Groups

<table>
<thead>
<tr>
<th>Variable</th>
<th>Active (Mean ± SD)</th>
<th>Sedentary (Mean ± SD)</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>29.6 ± 3.3</td>
<td>28.4 ± 4.6</td>
<td>1.75</td>
<td>.08</td>
</tr>
<tr>
<td>Education (yrs)</td>
<td>15.9 ± 1.5</td>
<td>15.1 ± 1.7</td>
<td>2.79</td>
<td>.006</td>
</tr>
<tr>
<td>Prepregnant weight (lbs)</td>
<td>130.4 ± 21.5</td>
<td>138.9 ± 26.3</td>
<td>-2.00</td>
<td>.05</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>165.9 ± 6.2</td>
<td>165.4 ± 6.4</td>
<td>.39</td>
<td>.70</td>
</tr>
</tbody>
</table>

The initial maternal characteristics of age, height, weight prior to pregnancy, and education were analyzed using independent t-tests (Table 1). The mean age of the sample was 28.8 years. The mean age of the active group was 29.6 years. The sedentary group had a mean age of 28.4 years. The difference in age was not significant (p = .08).

The nulliparas in the active group weighed significantly less prior to becoming pregnant (p < .05). The mean weight for the active women was 130.4 pounds while the sedentary women had a mean of 138.9 pounds.

The level of education attained was significant (p = .006) between the active and sedentary groups. The active women had a mean of 15.9 years of education whereas the sedentary group had a mean of 15.1 years.

Marital status also was significant between the two groups (p = .04). All of the
active women were married while 8 (8.6%) of the sedentary women were not married.

Caffeine, nutrition, and alcohol intake were similar in the two groups. Active women consumed a mean of 7.2 ounces of caffeinated drinks per day and sedentary women 6.7 ounces. Women were asked to report the number of days in a week that a well-balanced diet was maintained. On most days, the women ate a variety of foods. The mean was 5.9 days for the active women and 5.6 days for the sedentary group. Almost all of the women (96.4%) reported no consumption of alcohol during pregnancy.

The type of delivery of the majority (N=104; 76%) of the nullipara subjects was vaginal. The remaining 33 (24%) subjects had cesarean deliveries. In the active group, 37 (84.1%) delivered vaginally and only 7 (15.9%) had cesarean sections. Twenty-six (28%) of the sedentary women required cesarean deliveries and 67 (72%) delivered vaginally. The Fisher's Exact Chi-Square revealed a p-value of 0.09.

Reasons varied for performing the 33 cesarean section deliveries (Table 2). The primary reasons included failure to progress, breech, and cephalopelvic disproportion (a disparity between the size of the maternal pelvis and the fetal head). The plurality (N=12; 36.4%) of the subjects had failure to progress as the reason for a cesarean section delivery. Other reasons included fetal distress, prolapsed cord, and inability to push.

The active and sedentary women did not demonstrate statistical differences in the use of forceps, vacuum extractor, or episiotomies (Table 3). The forceps or vacuum extractor was used in 34 (24.8%) of the 104 vaginal deliveries. Ten (27%) of the active women while 24 (35.8%) of the sedentary women required the assistance of forceps or vacuum extractor. Of the 104 vaginal deliveries, 83 (79.8%) women had episiotomies.
Table 2

Frequency and Percentage of Reasons for Cesarean Section Deliveries of 33 Nulliparas

<table>
<thead>
<tr>
<th>Reason for Cesarean Section Delivery</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failure to Progress</td>
<td>12</td>
<td>36.4</td>
</tr>
<tr>
<td>Breech</td>
<td>8</td>
<td>24.2</td>
</tr>
<tr>
<td>Cephalopelvic Disproportion</td>
<td>5</td>
<td>15.2</td>
</tr>
<tr>
<td>Other</td>
<td>8</td>
<td>24.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>33</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

The number of active women that received an episiotomy was 31 (83.8%). Fifty-two (77.6%) of the sedentary women had episiotomies.

The active and sedentary groups had a high rate of epidural anesthetic (88.3%). The number of active subjects who had an epidural was 39 (88.6%). In the sedentary group, 82 (88.2%) also had epidurals.

All subjects were asked to report exercise in the six months prior to pregnancy. Although no prior exercise was reported by 65 (47.4%) of the 137 subjects, 72 (52.6%) did report prepregnancy exercise at least three times a week. The majority of the subjects who were active during pregnancy (N=35; 79.5%) were also active prior to pregnancy. In the sedentary group, 37 (39.8%) exercised at least three times a week prior to pregnancy, but did not exercise during pregnancy. The differences in prior exercise were statistically different between the active and sedentary subjects (p < .0001).
Table 3

Labor Management and Outcomes Between Active and Sedentary Nulliparas

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Active n(%)</th>
<th>Sedentary n(%)</th>
<th>Chi-Square</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epidural</td>
<td>39 (88.6)</td>
<td>82 (88.2)</td>
<td>.006</td>
<td>.59</td>
</tr>
<tr>
<td>Other Medication</td>
<td>25 (56.8)</td>
<td>50 (53.8)</td>
<td>.550</td>
<td>.76</td>
</tr>
<tr>
<td>Episiotomy</td>
<td>31 (83.8)</td>
<td>52 (77.6)</td>
<td>.840</td>
<td>.26</td>
</tr>
<tr>
<td>Forceps/Vacuum</td>
<td>10 (27.0)</td>
<td>24 (35.8)</td>
<td>.378</td>
<td>.35</td>
</tr>
<tr>
<td>Vaginal Delivery</td>
<td>37 (84.1)</td>
<td>67 (72.0)</td>
<td>2.371</td>
<td>.09</td>
</tr>
</tbody>
</table>

The 44 nulliparas who were active during pregnancy participated in various types of exercise (Table 4). These exercises primarily included vigorous walking (N=33; 75%) and aerobics/exercise class (N=15; 34.1%). Other types of activities included Stairmaster, stationary bike, jogging, and other sports.

Information was also collected on the pregnancy outcomes of the 137 nulliparas (Table 5). These outcomes included neonatal birth weight, maternal weight gain, length of labor, and gestational age.

Fetal birth weight varied from 2497 grams to 5675 grams, with a mean of 3433 grams (SD = 460.13), and a median of 3434 grams. When the fetal birth weight was compared between active and sedentary subjects by using a t-test for independent samples, no significant difference between groups was found (t = .91, df = 110, p = .366). When the data were analyzed by type of delivery, the mean fetal birth weight in the nulliparas who delivered vaginally was 3416 grams (SD = 397) and the mean fetal birth
weight of the nulliparas who delivered by cesarean section was 3485 grams (SD = 624).

No significant difference between groups was found (t = .595, p = .555).

Table 4

Frequency and Percentage of Type of Exercise During Pregnancy of 44 Active Nulliparas

<table>
<thead>
<tr>
<th>Type of Exercise</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vigorous Walking</td>
<td>33</td>
<td>75.0</td>
</tr>
<tr>
<td>Aerobics/Exercise Class</td>
<td>15</td>
<td>34.1</td>
</tr>
<tr>
<td>Stairmaster</td>
<td>9</td>
<td>20.5</td>
</tr>
<tr>
<td>Stationary Bicycle</td>
<td>9</td>
<td>20.5</td>
</tr>
<tr>
<td>Jogging/Running</td>
<td>6</td>
<td>13.6</td>
</tr>
<tr>
<td>Weights</td>
<td>4</td>
<td>9.1</td>
</tr>
<tr>
<td>Swimming</td>
<td>2</td>
<td>4.5</td>
</tr>
<tr>
<td>Rollerblading</td>
<td>2</td>
<td>4.5</td>
</tr>
<tr>
<td>Tennis</td>
<td>1</td>
<td>2.3</td>
</tr>
</tbody>
</table>

The maternal weight gain was similar in both the active and sedentary groups. Active women gained a mean of 33.8 pounds (SD = 8.5) while sedentary women gained a mean of 35.6 pounds (SD = 12.4). The differences were not significant when an independent t-test was used to compare the subjects (t = .96, p = .341).

The active and sedentary women had similar lengths of labor. The active women were in labor for a mean of 10.3 hours (SD = 3.6). Subjects who were sedentary had a mean labor duration of 10.9 hours (SD = 6.1). This difference was not statistically significant (p = .55).
The length of gestation also did not differ significantly between the active and sedentary subjects ($p = .69$). Active women delivered at a mean of 39.5 weeks and sedentary women at 39.4 weeks.

Table 5
Comparison of Pregnancy Outcomes Between Active and Sedentary Nulliparas

<table>
<thead>
<tr>
<th>Pregnancy Outcome</th>
<th>Active (Mean ± SD)</th>
<th>Sedentary (Mean ± SD)</th>
<th>t-test</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth weight (g)</td>
<td>3386 ± 369</td>
<td>3455 ± 498</td>
<td>.909</td>
<td>.366</td>
</tr>
<tr>
<td>Weight gain (lb)</td>
<td>33.8 ± 8.5</td>
<td>35.6 ± 12.4</td>
<td>.956</td>
<td>.341</td>
</tr>
<tr>
<td>Length of labor (h)</td>
<td>10.3 ± 3.6</td>
<td>10.9 ± 6.1</td>
<td>.686</td>
<td>.553</td>
</tr>
<tr>
<td>Gestational age (wk)</td>
<td>39.5 ± 1.2</td>
<td>39.4 ± 1.1</td>
<td>.395</td>
<td>.694</td>
</tr>
</tbody>
</table>

Findings

One hypothesis formulated in this study was that women who exercised would have a higher rate of vaginal deliveries. The alpha was set at $p = .05$. While a trend was apparent that active women were more likely to have a vaginal delivery, a statistically significant association was not found.

The second hypothesis of this study stated that the other selected pregnancy outcomes would be more positive for those who were regular exercisers than nonexercisers. The outcomes of neonatal birth weight, maternal weight gain, gestational age of newborn, and length of labor were analyzed by independent t-tests. No significant differences on any of the variables were found.

Summary
Most of the 137 nulliparas who participated in this study were white (81.8%), had vaginal deliveries (75.9%), and epidural anesthesia (88.3%). Mean fetal birth weight of infants born to subjects was 3433 grams. The gestational ages were very similar with a mean of 39.5 weeks. Length of labor and maternal weight gain did not differ significantly between the active and sedentary groups.

A trend was identified in the type of obstetrical delivery. Women who were active during pregnancy were more likely to have vaginal deliveries although statistical significance was not attained.
CHAPTER 5

DISCUSSION AND CONCLUSIONS

This retrospective, cohort study was conducted to examine the relationship between maternal aerobic exercise and selected pregnancy outcomes. A summary, discussion of findings, conclusions, implications, and recommendations further research are presented.

Summary

The independent variable for statistical comparison of pregnancy outcome was the maternal aerobic exercise performed during the first and second trimesters of pregnancy. The dependent variables of pregnancy outcome were defined in 5 ways: neonatal birth weight, maternal weight gain, length of labor, occurrence of cesarean delivery, and gestational age of newborn at delivery.

Demographic data indicated that 81.8% of the 137 nulliparas were white. The majority (76%) of the subjects had vaginal deliveries with epidural anesthetic (88.3%) and a mean fetal birth weight of 3,433 grams.

Two hypothesis were investigated in this study. The first hypothesis stated that women who exercised regularly would have a higher rate of vaginal deliveries and a lower rate of cesarean deliveries than nonexercisers. Results indicated that 84.1% of the active women did have vaginal deliveries, whereas 72% of the nonexercisers delivered
vaginally. The second hypothesis predicted that the other selected pregnancy outcomes would be more positive in the active group. Neonatal birth weight, maternal weight gain, length of labor, and gestational age did not differ significantly between the active and sedentary subjects.

Discussion of Findings

There was a trend toward benefits in nulliparas who remained active during pregnancy. The results of this study regarding type of obstetrical delivery demonstrated that active women had a higher incidence of vaginal deliveries. Furthermore, maternal aerobic exercise during pregnancy did not adversely impact any of the other selected pregnancy outcomes.

Previous studies have also demonstrated a higher incidence of vaginal deliveries among physically active women. Clapp (1990) reported a vaginal delivery rate of 88% while Hall and Kaufmann found 93.3% of the “high-exercisers” had vaginal deliveries. Zeanah and Schlosser (1993) also found significantly more vaginal deliveries but did not report specific data. One benefit of vaginal deliveries is reduced cost. Excess costs of cesarean delivery have been reported at $3,160 per procedure (“Rates of”, 1994). Over $104,000 was spent on the 33 cesarean section births in this study.

The results of this study regarding neonatal birth weight, maternal weight gain, length of labor, and gestational age all demonstrated that active and sedentary women had similar outcomes.

Other researchers have reported no significant difference in birth weight between exercisers and nonexercisers (Lokey et al., 1991; Sternfeld et al., 1995; Horns et al.,
Clapp and Dickstein (1984) reported results which were contrary to the present findings. Women in their study who continued exercising to term had infants whose mean birth weight was 500 grams less. Exercise in their study was limited to endurance activities: running, aerobic dance, and cross-country skiing. The slightly decreased birth weight may reflect lower infant body fat mass which is accumulated primarily during the last 8-10 weeks of gestation (Clapp & Capeless, 1990).

Earlier research documented a significant difference in maternal weight gain between exercisers and nonexercisers (Kulpa et al., 1987). This study found similar weight gains during pregnancy; however, the active women were significantly lighter prior to pregnancy. The majority of these women were active prior to pregnancy which could account for the lower weight. Kulpa et al. (1987) used an experimental design and randomly assigned subjects to control or exercise groups which was not possible in this retrospective study.

Maternal aerobic exercise was not significantly beneficial in terms of reducing labor length. This disagrees with some findings reported in the literature (Kulpa et al., 1987; Wong & McKenzie, 1987; Erdelyi, 1962). However, other researchers have not found significant differences in times of labor (Lokey et al., 1991; Hall & Kaufmann, 1987; Horns et al., 1996). The first stage of labor is involuntary and would not be affected by the subject's aerobic fitness level (Wong & McKenzie, 1987). This study did not discriminate between the stages of labor. The use of analgesic medication could also alter the findings.
The active and sedentary women had almost identical lengths of gestation. Clapp and Dickstein (1984) observed significantly shortened gestation in women who continued to exercise beyond week 28 of pregnancy. A reason for the differences in present findings and those of Clapp and Dickstein (1984) might be that those in the active group were defined as those active during the first and second trimester. Perhaps only those who exercise beyond week 28 of pregnancy will exhibit shorter lengths of gestation. However, an increased incidence of premature delivery has not been a common finding in other investigations of exercise in pregnant women (Wolfe et al., 1989b).

In this study, physical activity was assessed by self-report. It is possible that the absence of significant associations between exercise and the selected pregnancy outcomes could be attributed to misclassification bias. However, quantitative activity histories have been found to be reasonably predictive of fitness level as measured by treadmill tests (Montoye & Taylor, 1984).

The episiotomy rate in the active group was very high in this study (83.8%) compared to previous research. Clapp (1990) reported only 46% of the women in the exercise group had episiotomies. The subjects’ exercise level in this study did not give any objective measurement of the condition of the muscles of the pelvic floor or ligamentous structures which are factors associated with episiotomies. It is possible that physician training may differ in different parts of the country and Texas physicians just do more episiotomies.

Conclusions and Implications

From the findings of this study, the following conclusions were drawn.
1. This research demonstrated a trend between participation in maternal aerobic exercise and incidence of vaginal delivery.

2. The present study found participation in maternal aerobic exercise to be unrelated to other pregnancy outcomes, including neonatal birth weight, maternal weight gain, length of labor, and gestational age.

3. Women who are pregnant may be very health conscious as evidenced by the high rates of health promoting behaviors. This included proper nutrition, minimal alcohol intake, not smoking, and exercise. Women recognize that adopting these behaviors may increase their chance of positive outcomes of pregnancy.

4. Present results suggest that epidural anesthesia may have an indirect influence on delivery outcomes. It is possible that this anesthesia negatively impacts the laboring female by making delivery more difficult.

   The implications of this study call upon health professionals to take an active role in impacting pregnant women. Health professionals are in position to influence pregnant women's activity patterns through education and encouragement. It is essential that pregnant women know they may exercise and doing so could reduce their risk of cesarean section. Proper instruction in exercises to contract and relax the muscles of the pelvic floor should be taught because an exercised muscle can stretch and contract readily at the time of birth (Bobak et al., 1989). This could reduce the need for an episiotomy.

   The issue of exercise during pregnancy has been inconclusive and insufficient. However, recent studies show that the benefits of regular exercise for the healthy, pregnant woman appear to outweigh the risks. This is an important point to emphasize
when interacting with pregnant women. Physicians can also be reminded that exercise is not harmful to the pregnant female or the baby. Physicians should be kept current regarding the guidelines set forth by the American College of Obstetricians and Gynecologists

**Recommendations for Further Research**

The challenge is open for health professionals to meet the ethical, legal, and scientific aspects of investigating exercise during human pregnancy. Therefore, recommendations for further research include the following:

1. Reproduce the study in both similar and different settings, with a larger pool of subjects to assess variation in geographic location and demographic variables.
2. Study the changes of exercise practices during pregnancy, addressing the reasons that women either initiate or stop exercising once pregnant.
3. Investigate the relationship between epidural anesthesia and the progression of labor as a contributing factor to type of delivery utilizing retrospective studies of nulliparas.
4. Follow a cohort of women to determine the effect of exercise in pregnancy on maternal recovery: weight loss, return to fitness, postpartum depression, and adjustment to being a mother.
5. A longitudinal design could be utilized to accurately determine the influence of differences in intensity, duration, or mode of exercise. Random assignment of subjects to control or exercise groups could be used.
6. Episiotomy rates should be studied to determine whether natural tearing or episiotomy is better at minimizing trauma.
7. Study the mood changes and self-esteem associated with pregnancy.
APPENDIX A

HUMAN SUBJECTS APPROVAL
Ms. Dian Melgar
396 E. Southwest Pkwy #1523
Lewisville, TX 75067

Re: Human Subjects Application No. 97-030

Dear Ms. Melgar:

As permitted by federal law and regulations governing the use of human subjects in research projects (45 CFR 46), I have conducted an expedited review of your proposed project titled “Effects of Maternal Aerobic Exercise on Selected Pregnancy Outcomes in Nulliparas.” The risks inherent in this research are minimal, and the potential benefits to the subjects outweigh those risks. The submitted protocol and informed consent form are hereby approved for the use of human subjects on this project.

The UNTIRB must re-review this project prior to any modifications you make in the approved project. Please contact me if you wish to make such changes or need additional information.

If you have questions, please contact me.

Sincerely,

Mark Elder
Chairman
Institutional Review Board

cc. IRB Members
APPENDIX B

QUESTIONNAIRE
Dear Study Participant:

I am a Master's Degree student at the University of North Texas and am conducting a study designed to investigate the effects of exercise on pregnancy outcome. Although this study may not benefit you directly, it may prove helpful to future pregnant women and you will be part of exciting research. There are no identified health risks to you or your baby for your participation in this study. Of course, participation is voluntary and you may refuse to participate or withdraw from this study at any time without intimidation or prejudice. Please discuss any questions that you may have with myself or my faculty advisor. I may be contacted at (972)420-8652. My advisor, Dr. Tim Bungum, may be reached at (817)565-2546.

Participation in this study involves the completion of a written questionnaire, which should take approximately 5 minutes and a follow-up phone call after the birth of your baby which should take approximately 1-2 minutes. All data gathered through this study will be treated confidentially. Your name will not be identified in any way with this research. Confidentiality will be maintained by keeping your names in a locked file cabinet that only my advisor and I will have access to.

Your signature below indicates that you have read the information, have been given the necessary information, and have been given the opportunity to ask questions which have been answered to your satisfaction. Information about the results of this study will be provided to those who request it.

THANK YOU!
Dian Melgar, R.N.
Graduate Student
University of North Texas

Signature ___________________________  Printed Name ___________________________

Due Date of Baby ______________________

Telephone # _________________________

THIS STUDY HAS BEEN REVIEWED BY THE UNIVERSITY OF NORTH TEXAS COMMITTEE FOR THE PROTECTION OF HUMAN SUBJECTS (Phone: (817)565-3940).
PREGNANCY QUESTIONNAIRE

Please answer each question by writing in, circling, or placing a check mark by the statement that best describes you.

1. Age _____  
2. Height _____

3. Ethnic Background: White _____ African-American _____ Hispanic _____  
   Asian _____ Other ________

4. In the six months prior to this pregnancy, did you exercise regularly at least 3 times a week?  
   Yes _____ No _____

5. Did you exercise regularly during this pregnancy?  
   Yes _____ No _____ (If no, skip to question 7)

6. This question is designed to assess the type and frequency of exercise which you performed during each trimester. **An activity must be performed for a total of at least 20 minutes per day to be counted.** Please indicate the average number of **times per week** you performed the activity.

<table>
<thead>
<tr>
<th>EXERCISE</th>
<th>1st TRIMESTER (0-12 weeks)</th>
<th>2nd TRIMESTER (13-27 weeks)</th>
<th>3rd TRIMESTER (28-40 weeks)</th>
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</thead>
<tbody>
<tr>
<td>Vigorous Walking</td>
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<tr>
<td>Jogging / Running</td>
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<tr>
<td>Aerobic / exercise class</td>
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<tr>
<td>Swimming</td>
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<td>Stationary</td>
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<tr>
<td>Bicycling</td>
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<td>Stairmaster</td>
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<tr>
<td>Handball / Racquetball</td>
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<tr>
<td>Rollerblading</td>
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<tr>
<td>(In-line skating)</td>
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<tr>
<td>Tennis</td>
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<tr>
<td>Other</td>
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<tr>
<td>(please specify)</td>
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</tbody>
</table>
7. Are you presently married?  
   Yes ____  No ____  

8. How many pregnancies (including this one) have you had where you reached at least 22-23 weeks gestation? ____  

9. Have you ever had a cesarean section delivery?  
   Yes ____  No ____  

10. How much did you weigh before you were pregnant?  

11. When was the first day of your last menstrual period?  

12. Did you experience any of the following problems during your pregnancy?  
   a. Diabetes (high blood sugar)  
   b. High blood pressure  
   c. Twins or triplets  
   d. Preeclampsia (toxemia)  
   e. Abnormal bleeding  
   f. Other (please specify) ____  

13. Did you smoke any during this pregnancy?  
   Yes ____  No ____  

14. What average number of alcoholic beverages did you consume during this pregnancy?  
   a. None  
   b. 2-5 drinks a month  
   c. 6-8 drinks a month  
   d. 3 drinks a week  
   e. 1 or more daily  
   f. Other (please specify) ____  

15. In a typical day, how many ounces of caffeinated tea, cola, coffee, or cocoa did you drink during your pregnancy? (1 cup = 8 oz.; 1 can of cola = 12 oz.)  
   Number of ounces: ____  

16. During your pregnancy, how many days in a typical week did your dietary intake consist of a variety of foods, including whole-grain cereals and breads, vegetables and fruits, protein-rich foods, and dairy products?  
   1  2  3  4  5  6  7  

17. What is the highest level of education you have completed?  
   1  2  3  4  5  6  7  8  9  10  11  12  13  14  15  16  17+
Telephone Follow-up

Hello, this is Dian Melgar, the graduate student from the University of North Texas. Is this a good time to talk? This should take approximately 2 minutes. Have you had your baby?

Participant_________________________        Code # __________

1. On what date was your baby born? __________

2. What was your infant’s birth weight? __________

3. How much did you weigh at your last check-up prior to birth? __________  
   (Do you know how much weight you gained during your pregnancy?)

4. How many weeks pregnant were you when your baby was born? __________

5. I would like to know what time you went into labor. This can be signalled by several symptoms. Which of the following was the first to take place:
   1) The onset of contractions that occurred regularly (every 5-8 mins. for an hour), that increased in strength (lasted 60 seconds) and led to your cervix dilating.
   2) Your membranes ruptured — also known as your “water broken”
   3) Pink mucus or “bloody show” (scant, pink, & sticky discharge)
   Time Started __________

6. What time was your baby born? __________

7. Was Labor Induced?  Yes  No  
   (Did they give you an IV and medication to stimulate labor?)

8. Did you have a vaginal birth or a c-section?
   Do you know why you required a cesarean delivery?  Why?

9. Did you have an episiotomy?  Yes  No

10. Were forceps or a vacuum extractor used to deliver your baby?  Yes  No

11. Did you receive any medication during your labor or delivery?  Yes  No

12. Did you have an epidural?  Yes  No

Thank you very much for your participation!
APPENDIX C

AGENCY APPROVALS
Dear Dian:

I have talked with you and discussed your study, Effects of Maternal Aerobic Exercise on Selected Pregnancy Outcomes in Nulliparas." I have agreed to allow you to conduct your research and welcome you into our facility to gather your data. It is understood that participation is voluntary and the participants are free to drop out of the study without prejudice.

I would be interested in hearing from you after your research is complete to review your results.

Sincerely,

Peggy Benedict RN
Director of Women's and Children's Services
December 27, 1996

Dian L. Melgar
396 Southwest Parkway
#1523
Lewisville, Texas 75067

Dear Dian:

I talked with you on December 3rd and discussed your study, "Effects of Maternal Aerobic Exercise on Selected Pregnancy Outcomes in Nulliparas." I have agreed to allow you to conduct your research and welcome you into our facility to gather your research data. It is understood that participation is voluntary and that participants are free to drop out of the study without prejudice.

Sincerely,

Cheryl Gaudet, RNC
Director, Women's and Children's Services
1/20/97

Dear Diane:

I have talked with you and discussed your study, "Effect of Natural Aerobic Exercise on Selected Frugine Outcomes in Nulliparas." I have agreed to allow you to conduct your research and welcome you into our facility to gather your research data. It is understood that participation is voluntary and that participants are free to drop out of the study without prejudice.

Sincerely,

[Signature]
January 23, 1997

Dian L. Melgar
396 Southwest Parkway #1523
Lewisville, Texas 75067

Dear Dian:

I have talked with you and discussed your study, "Effects of Maternal Aerobic Exercise on Selected Pregnancy Outcomes in Nulliparas." I have agreed to allow you to conduct your research and welcome you into our facility to gather your research data. It is understood that participation is voluntary and that participants are free to drop out of the study without prejudice.

Sincerely,

Lynn Emas
Director-Maternal Child Health
REFERENCES


and Gynecology, 142, 545-547.


