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# Exercise Versus Non-exercise During Pregnancy : the Influence on Selected Maternal and Newborn Infant Parameters

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EXERCISE VERSUS NON-EXERCISE DURING PREGNANCY:

THE INFLUENCE ON SELECTED MATERNAL

AND NEWBORN INFANT PARAMETERS

by

ELLEN ANN COUGHLIN

An Abstract

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## ABSTRACT

Thirty pregnant women participated in this study to determine the effects of exercise versus non-exercise during pregnancy on the maternal parameters of body weight and systolic and diastolic blood pressure changes at 3, 6, and 9 months of pregnancy. Half the participants ($n$ = 15) were involved in a prenatal aerobic dance class which met bi-weekly throughout the pregnancy. The other half ($n$ = 15) were only involved in activities for daily living. The maternal parameters were recorded by the mothers' physician and obtained by the investigator from the women's prenatal flow charts. A MANOVA performed on maternal parameters resulted in no significant differences ($p > .05$) between exercising and non-exercising groups. The results of the analysis to detect differences at 3, 6, and 9 months indicated significant ($p < .05$) increases in the combined variables across time. The findings led to the rejection of the null hypothesis that there will be no significant difference in weight and systolic and diastolic blood pressure between women who exercise and those who do not exercise, as measured at 3-month intervals throughout the pregnancy. Each parameter was taken separately and a Tukey HSD test used to determine that there existed significant increases ($p < .05$) on all parameters across time. Weight increased significantly from the 3- to 6-month measurements and from the 6- to 9-month measurements. Systolic blood pressure only increased significantly from the 3- to 9-month measurements; there were no signficant increases between the 3- to 6-month or 6- to 9-month measurements. The newborn infants'

parameters of weight along with 1- and 5-minute Apgar scores were collected. An ANOVA on birth weight revealed no significant difference between newborn infants whose mothers exercised during pregnancy versus those newborn infants whose mothers did not exercise during pregnancy. The ANOVA of 1- and 5-minute Apgar scores showed a significant difference ($\underline{p} < .05$) between newborn infants of exercising and non-exercising mothers at both time periods. It was concluded that participation in an aerobic exercise program had a significant positive influence on the health status of the newborn infant.

Ithaca College
School of Health, Physical Education, and Recreation

CERTIFICATE OF APPROVAL

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MASTER OF SCIENCE THESIS

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This is to certify that the Master of Science Thesis of

Ellen Ann Coughlin

submitted in partial fulfillment of the requirements for the degree of Master of Science in the School of Health, Physical Education, and Recreation at Ithaca College has been approved.

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Date: May, 1985

# EXERCISE VERSUS NON-EXERCISE DURING PREGNANCY: THE INFLUENCE ON SELECTED MATERNAL AND NEWBORN INFANT PARAMETERS

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A Thesis Presented to the Faculty of
the School of Health, Physical
Education, and Recreation
Ithaca College

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In Partial Fulfillment of the
Requirements for the Degree
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May 1985

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To those women who participated in this study, a special thanks for your coöperation, for without it this study would not have been possible.

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DEDICATION

This thesis is dedicated to those people who have always been interested and happy for me to achieve my goals. They have been there with encouragement and support at all times. I want them to realize how much I love and sincerely appreciate everything. Dad, Mom, Michael, Jim, and Colleen, thanks for being there.

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Chapter 1

# INTRODUCTION

Health status is a topic which has grown in popularity in recent years. Men, women, and children are more aware of their fitness levels. The concern for improvement and maintenance of health is apparent by the growth in the number of health clubs. Men and women alike are engaged in body-toning activities such as jogging, weight training, and the newly popular activity of aerobic dance.

The general population is now aware of the benefits of exercise. Whereas it was once thought unfeminine for a woman to be physically fit and muscular, it is now thought to be beautiful. Those benefits of most interest are weight loss or maintenance, decrease or control of blood pressure, and an increase in aerobic endurance level.

Recent studies (Erkkola & Rauramo, 1976; Ihrman, 1960a, 1960b) have attempted to determine the effects of exercise on pregnant women. Is it safe for a pregnant woman to exercise? Is it safe for a pregnant woman to exert herself in other than normal daily activities? What are the effects of exercise on the fetus? To what percentage of her maximum exercise load should a pregnant woman participate?

Few studies (Erkkola & Rauramo, 1976; Ihrman, 1960a,1960b) have examined the effects of exercise during pregnancy. Some studies tend to advocate exercise during pregnancy (Clarke, 1978; Dressendorfer, 1976; Hutchinson, Cureton, & Sparling, 1981; Robbe, 1958; Wirth & Larson, 1978). Some were isolated case studies of pregnant women, and one concerned itself with 107 Olympic athletes (Clarke, 1978). These researchers were in favor of maternal exercise during pregnancy with some alterations made to adapt to the perceived level of exertion. Some adaptions made were the shortening of the exercise time, becoming involved in less strenuous activities, and becoming involved in non-weight-bearing activities such as bicycling and swimming.

The purpose of this study was to examine the effects of an aerobic prenatal dance class on the mothers' blood pressure and weight gain during pregnancy and the newborn infants' weight and Apgar scores. An Apgar score is a method for evaluation of newborn infants. It takes into account the functions of heart rate, respiratory effort, muscle tone, reflex irritability, and skin color. Newborn infants are scored 0, 1, or 2 on each of the criteria, making the maximum number of points 10. Apgar scores are calculated routinely at 1 minute and 5 minutes after birth.

## Statement of the Problem

The purpose of this study was to determine the effects of exercise during pregnancy on the changes that occur to the mother during pregnancy as well as on the apparent health of the newborn infant.

## Scope of the Problem

There were 30 pregnant women involved in this study. Participation in the study was totally voluntary, and the women were informed that they could cease involvement at any time. The women ranged in age from 21 to 30 years and were all from the Ithaca, New York area. Half of the women ($n$ = 15) regularly attended a prenatal aerobic dance class, while the other half ($n$ = 15) were not involved in regular exercise. The aerobic dance class lasted the full length of the pregnancy. The aerobic dance class was structured according to guidelines listed in Nancy Strong's aerobic dance program (1981). Each participant's weight and blood pressure was monitored throughout her pregnancy; measurements of maternal weight and blood pressure were taken at 3, 6, and 9 months of the pregnancy by the mother's physician. The data were collected from the mother's prenatal flow charts. These flow charts were obtained with the mother's permission from Tompkins Community Hospital. The birth weight and Apgar scores of the mother's newborn infant were also collected.

## Null Hypotheses

1. There will be no significant difference in weight and systolic and diastolic blood pressure between women who exercise and those who do not exercise, as measured at 3-month intervals throughout the pregnancy.

2. There will be no significant difference in pregnancy-induced systolic blood pressure between exercising and non-exercising mothers.

3. There will be no significant difference in pregnancy-induced diastolic blood pressure between exercising and non-exercising mothers.

4. There will be no significant difference in pregnancy-induced body weight gain between exercising and non-exercising mothers.

5. There will be no significant differences in newborn infants' Apgar scores from exercising and non-exercising mothers.

6. There will be no significant difference in the birthweight of those newborn infants whose mothers exercised compared to those newborn infants whose mothers did not exercise.

## Assumptions of the Study

For the purpose of this study the following assumptions were made:

1. The women participated to their fullest during exercise bouts.

2. The non-exercise group did not exercise other than activities for daily living and did not exercise on a regular basis.

3. The Apgar scores for the newborn infants were reliable.

4. Body weight and blood pressure readings were taken accurately.

## Definition of Terms

The following terms were defined for the purpose of this study:

1. Apgar Score: A method for evaluation of newborn children. It takes into account the functions of heart rate, respiratory effort, muscle tone, reflex irritability, and skin color. Newborn infants are scored 0, 1, or 2 on each of the criteria, making the maximum number of points 10. The Apgar score is calculated routinely at 1 minute and 5 minutes after birth.

2. Aerobic Dance: An exercise program which, when designed properly, consists of a warm-up, workout, and cool-down phase.

Warm-up is generally 5 to 10 minutes. A workout phase is 15 to 60 minutes. The cool-down phase lasts at least 5 to 10 minutes. The program should include floor work for improving flexibility, muscular strength, and endurance. Aerobic dance offers continuous rhythmical movement of the large muscle groups.

3. <u>Blood Pressure</u>: The rhythmic expulsion of blood from the left ventricle into the arterial system produces in the aorta and large arteries a blood pressure which rises to a maximum level, systolic pressure, during cardiac contraction or systole, and which progressively declines during relaxation and filling of the heart, diastole, to reach a minimum level, diastolic pressure, just prior to the next contraction.

4. <u>Exercise Group</u>: Pregnant women who have been involved in Nancy Strong's prenatal aerobic dance class and have participated in at least 75% of the classes held during their pregnancy.

5. <u>Non-Exercise Group</u>: Pregnant women involved in the study who did not exercise other than activities for daily living and did not exercise on a regular basis.

## Delimitations of the Study

The delimitations of the study were as follows:

1. There were 30 pregnant women participating in the study from the Ithaca, New York area.

2. Regular participation in Nancy Strong's prenatal aerobic dance class was the only criterion used to place women in the exercise group.

3. The only maternal parameters studied were weight and blood pressure at 3, 6, and 9 months of the pregnancy.

4. The only newborn infants' measurements taken were weight and Apgar scores at 1 minute and 5 minutes after birth.

## Limitations of the Study

The limitations of the study were as follows:

1. The findings may be valid for comparison only when the aerobic dance program is similar to the one used in this investigation.

2. The findings may be valid for comparison only when the non-exercising group participates in activities for daily living.

3. The findings may be valid for comparison only when blood pressure and weight measurements are taken at 3, 6, and 9 months of the pregnancy.

4. No valid conclusions may be made concerning total weight gain during pregnancy due to the fact that there are no records of pre-pregnancy weight.

5. Other exercise programs and forms of exercise may yield different results.

6. Measurements of other maternal parameters and/or newborn infants' parameters may yield different results.

## Chapter 2

## REVIEW OF LITERATURE

In recent years awareness of physical fitness and exercise has grown tremendously, encompassing many age groups and health conditions. One such area which has started to gain more emphasis is that of exercise during pregnancy. There have been old wives' tales stating that exercise during pregnancy can injure the fetus by jarring it or by overtaxing the mother's body so that the fetus is injured.

Moderate physical training during pregnancy has been advocated by Clarke (1978). He studied 107 outstanding Olympic and European pregnant athletes and observed that exercise tended to aid in decreasing discomfort and physical damage during the pregnancy. Also, there was no difference between fertility levels of those who competed and those who did not. Pfeifer (1978) reported that those women who experienced difficulty during pregnancy had a common history of lack of regular physical activity during childhood and had poorly developed abdominal musculature. In the same study the duration of labor was shown to be shorter for athletes, and there was less chance for peritoneal tears.

The review of literature for this investigation focuses on the effects of pregnancy on various body systems. These systems are (a) the circulatory system, (b) the respiratory system, (c) the digestive system, (d) the muscular system, and (e) the endocrine system. The effects of exercise during pregnancy on the offspring are also discussed. A summary of all findings is provided.

## The Circulatory System

The circulatory system must increase its efficiency in order to accommodate the increased demands of the pregnant woman. There is increased demand due to the growth of new tissue. This is compensated for by an expansion of the vascular channels, especially those travelling to the generative tract (Wilson, Beecham, & Carrington, 1971).

During pregnancy there are circulatory adjustments which, in some respects, resemble the changes which occur during physical training (Robbe, 1958). One example is the structural alterations of the right ventricle observed in the heart during pregnancy. The same change also occurs during physical training. The right ventricle thickens making it possible for the heart to pump more efficiently, and this permits the individual to adapt to a hypoxic environment more easily. There have been findings which contradict the above statement. Wilson and Gisolfi (1980) found that the thickening of the right ventricle did not enhance the ability of rats to adjust to the hypoxic environment.

With the increase in tissue demands during pregnancy there is an increase in cardiac output and an increase in the extraction of oxygen from the blood at the capillary level. Normally this increase in cardiac output is met primarily by a rise in stroke volume. It reaches its maximum at 28 weeks, increasing approximately 32%; after the 28th week there is a steady decline (Cumming & Belcastro, 1982).

Cumming and Belcastro (1982), in their review of literature, found that in early to mid-pregnancy the primary factor that accommodates the increase in circulation is cardiac output. Cardiac output is equal to heart rate times the stroke volume. The increase in cardiac output could be due to many factors such as (a) increased blood flow, (b) increased oxygen transportation, and (c) nutrient delivery to the fetus (Parizkova, 1975). Seitchik (1967) suggested that the reason for an increase in the cardiac output is the increased blood flow through the kidney and reproductive organs.

Cardiac output begins to rise at the 10th week to a level 30% to 40% above the non-pregnant level (Seitchik, 1967). The increase in cardiac output is due primarily to the increase in stroke volume (Cumming & Belcastro, 1982).

Cumming and Belcastro (1982) found that when the pregnant woman exerts herself there is an additional increase in heart rate, stroke volume, and blood pressure. Ueland, Novy, Peterson, and Metcalfe (1969) studied cardiac output during exertion in different positions. The positions studied were standing, sitting, and lying down. It was found that the least amount of exertion, as determined by heart rate and blood pressure, occurred in the two non-weight-bearing positions.

The total blood volume is increased approximately 30% during pregnancy. The red cell volume and total hemoglobin increase during pregnancy, with the expansion of plasma being greater than that of the red cell mass. Plasma volume increases during the first trimester to its peak at 40% above the normal amount.

From the 34th week until term there is a gradual decline to 25% above normal. The average increase in red cell mass is 495 ml (Wilson et al., 1971). The red cell mass continues to rise until the end of pregnancy.

The pulse pressure reaches its maximum between the 28th and 32nd week of pregnancy, at which time the maximum pulse rate has been reached (Annis, 1978). The venuous pressure in the anticubital area remains constant and normal throughout pregnancy. This is due to the area being elevated. There is an increase in the femoral pressure of 10 to 15 mm Hg. This increase is due to the pressure of the uterus on the pelvic veins. Capillary permeability is unchanged, except that there is an increase in the hydrostatic pressure in the lower extremities.

During pregnancy the blood flow to the uterus increases to approximately 500 ml/min at term, an increase from 250 ml/min. Renal blood flow increases to 30% above the average blood flow to the same area. The cutaneous blood flow also increases in order to dispense a greater amount of heat due to the increase in metabolic rate (Cumming & Belcastro, 1982).

The plasma level remains normal up to 24 weeks. Cumming and Belcastro (1982) noted that during pregnancy the plasma level in the body reaches a plateau at 32 weeks. At that time the plasma level is 50% above normal. It is controlled centrally by the heart rate and stroke volume and peripherally by arteriovenous oxygen difference and total peripheral resistance. The blood volume reaches its peak between 25 to 34 weeks. This increase is 20% to 30% above the normal (Seitchik, 1967).

Different stages of gestation reveal that there is an actual alteration in positión and an apparent increase in the size of the cardiac silhouette (Wilson et al., 1971). The heart rotates slightly anteriorly and is displaced upward and to the left. This may cause the apical impulse to be located 1 to 1.5 cm beyond the normal point of maximal impulse (Novak, Jones, & Jones, 1975).

In summary, the circulatory system adapts to pregnancy by increasing cardiac output, blood pressure, and blood flow to the entire body. Changes in the plasma level and the position and size of the cardiac silhouette have also been noted.

## The Respiratory System

In order to adapt to pregnancy, a woman increases her oxygen consumption between 10% and 20%. Throughout the pregnancy the woman alters her breathing pattern in order to accommodate herself and the fetus; this is necessary due to the fetus displacing tissue. After the diaphragm displaces the lungs, breathing becomes more costal. There is an increased tidal volume due to the carbon dioxide diffusion from the fetus (Wilson et al., 1971).

Throughout most of pregnancy there is no deficit in pulmonary ventilation, however, modifications occur. Total volume increases, and minute volume decreases. Vital capacity and maximum breathing capacity remain the same (Seitchik, 1967). Seitchik (1967) reported that pregnancy produces no alteration in the ability to ventilate and thus no effect on the woman's ability to exercise.

Along with an increase in consumption of oxygen, there is an increase in the rate of respiration caused by a lower depth of breathing (Cumming & Belcastro, 1982). Wilson and Gisolfi (1980) noted that, when adjusted for weight, there is no significant difference between pregnant and non-pregnant women in oxygen uptake.

Hutchinson, Cureton, and Sparling (1981) studied a 32-year-old pregnant woman and noted that oxygen increased linearly from the 3rd through 8th month. The average monthly increase was .05 l each minute or an increase of 14.7%. Erkkola and Rauramo (1976) found that undergoing exercise during pregnancy can increase physical working capacity, heart rate, perceived exertion, and maximum heart rate. These increases are accounted for by the adaptations that the pregnant woman must make in order to accommodate for the presence of the fetus.

Depending on the fitness level of women during pregnancy, a higher production of energy aerobically and a lower concentration and better elimination of carbon dioxide are obtained (Erkkola & Rauramo, 1976). The transfer of oxygen induces a greater reserve capacity and a reduction in the relative level of stress or overload (Blackburn & Calloway, 1976a).

Exercise modifies the oxygen acid base status of maternal blood delivered to the uterus (Cumming & Belcastro, 1982). A respiratory alkalosis occurs due to hyperventilation during exercise. Similar changes are present in fetal arterial or umbilical venous pH and $pCO_2$ (Emmanouilides, Hobel, Yashiro, & Klyman, 1972).

Several reseachers investigated the effects of weight-bearing and non-weight-bearing activities during pregnancy and noted that demands did not increase in non-weight bearing activities. However, Seitchik (1967) found that the total oxygen cost of exertion is higher from 36 weeks onward, accounting for an increase of 8%. The main alteration in oxygen demands occur in weight-bearing activities. This change is due to the increase in weight during pregnancy. In non-weight-bearing activities pregnant women are at least as efficient as non-pregnant women of the same weight and fitness level (Seitchik, 1967).

## The Digestive System

Due to the presence of the fetus it is essential that pregnant women increase their weight and caloric intake to aid in forming a healthy fetus. Normal weight gain during pregnancy is between 24 and 27 pounds; this figure is considered optimal (Naeye, Blanc, & Paul, 1974). However, in multigravidas a higher amount of weight gain is expected (Blackburn & Calloway, 1976b).

Seitchik (1967) noted that the mean expenditure rate of calories was significantly greater during quiet sitting as pregnancy progressed. The basal metabolic rate increased 13% to 37% due to the increased amount of body weight. As a result of this increased resting metabolism the pregnant woman needs to consume more calories per day. Blackburn and Calloway (1976b) estimated the ideal increase in caloric consumption to be between the 20th and 28th week of gestation. This is due to the increase in basal metabolic rate during that period.

Conflicting findings were found relative to the metabolic rate during pregnancy of exercising women. Blackburn and Calloway (1976a) state, "Women are less fit for hard work during pregnancy than post partum" (p. 24). However, both Seitchik (1967) and Robbe (1958) concluded that the work a woman can perform is unchanged during and after pregnancy.

Lederman and Rosso (1980) investigated the effects of food restriction on both pregnant and non-pregnant rats; food usage was increased for both restricted and unrestricted diets. This restriction of food was carried out by limiting both the amount and quality of food which was allowed to the rats. They found that the pregnant rats used food more efficiently.

The type of foods consumed by the mother after a period of food restriction is not important. Naeye et al. (1974) reported calorie supplements given to undernourished rats resulted in an appreciable improvement in birth weight. Those rats given a protein supplement recorded even better birth weight improvement.

## The Muscular System

The muscular system is affected by weight gain during pregnancy. The changes that occur during pregnancy resemble the changes that occur during physical training. Some examples of these are muscle hypertrophy, increased tone of musculature, and an increase in the ability to function without a build-up of lactic acid.

The concentration of lactic acid after a work test given to a pregnant woman showed a negative correlation with the level of fitness (Erkkola & Rauramo, 1976). However, a positive correlation occurred between the lactic acid in the umbilical vessel and in the mother. This implies that the fetus experiences the same build-up of lactic acid as the mother does during exercise. These findings answer a question that Seitchik (1967) posed in his paper concerning the ability of the gravid woman to shift the proper substrates to skeletal muscle while exercising. According to Erkkola and Rauramo (1976), depending on a woman's fitness level, she is able to shift substrates to skeletal muscle during exercise.

## The Offspring

The fetus sustains its life from the mother. It is for this reason that one must consider the changes which occur to the fetus as a result of the actions of the mother.

Parizkova (1975) studied the microstructure of the offspring's heart in exercised and non-exercised mother rats. The researcher found many positive effects, however, they were not longlasting. There was an increase in heart capillarization at birth which was not apparent at 65 days of age in the offspring. The latter finding coincides with that of Wilson and Gisolfi (1980), who found no significant differences in myocardial tissue of offspring from exercising and non-exercising mothers.

Fetal bradycardia and tachycardia have been observed in complicated pregnancies following maternal exercise in human subjects (Emmanouilides et al., 1972). It was concluded that moderately severe maternal exercise may be detrimental to the fetus compromising the umbilical circulation. If the activity level is continuously too strenuous it is harmful to the fetus. "Some researchers believe that a possible reduction of oxygen supply might occur in a fatigued mother" (Annis, 1978, p. 24). However, Erkkola and Rauramo (1976) concluded that in case of asphyxiated fetuses there was a lower fitness level of the mother.

During exercise a decrease in fetal oxygen level has been found as a result of a reduction in uterine flow. Decreases were also present because of changes in the oxygen affinity of maternal and fetal hemoglobin (Robbe, 1958). Both Cumming and Belcastro (1982) and Emmanouilides et al. (1972) concluded that fetal alkalosis and fetal hemoglobin affinities may play a secondary role in oxygen transfer across the placenta.

Wilson and Gisolfi's (1980) findings of no difference in myocardial tissue agreed with the findings of Robbe (1958), Cumming and Belcastro (1982), and Emmanouilides et al. (1972), but Wilson and Gisolfi (1980) also found that mothers who exercised during pregnancy did not endow their offspring with a greater aerobic capacity.

Contrary to what many people believe, the fetus is not a parasite (Lederman & Rosso, 1980). The mother is nourished before the fetus. The uterus is capable of taking blood nutrients to meet metabolic needs but can not acquire nutrients from fat stored by the mother. Fetal growth is not sustained by the mother's pre-pregnancy nutrient stores (Lederman & Rosso, 1980).

## Summary

During pregnancy changes in the systems of the body occur in order to make the body work more efficiently. Increases are apparent in all systems in order to accommodate the weight gain and meet the needs of the fetus (Naeye et al., 1974). The respiratory system is adjusted by the excursion of the diaphragm. It adjusts to this change by increasing the respiratory rate and tidal volume (Wilson et al., 1971). Many changes occur in the circulatory system. There is an increase in the plasma level, cardiac output, and peripheral and reproductive organ blood flow. The endrocrine system increases its function in order to maintain the fetus. The digestive system increases its basal metabolic rate due to the weight gain caused by the pregnancy. Also, the energy cost of exercise is increased (Blackburn & Calloway, 1976a).

The fetus is affected by what the mother does or does not do or eat. In the case of food restriction or high intensity exercise the fetus experiences hypoxia (Lederman & Rosso, 1980). If the mother has a low fitness level, labor tends to be longer and thus harder on the fetus.

## Chapter 3

## METHODS AND PROCEDURES

This chapter delineates the methods and procedures used to perform this study. Included in this chapter will be a description of (a) selection of subjects, (b) equipment, (c) procedures, and (d) treatment of the data. A summary is also included.

### Selection of Subjects

The subjects used in this study were 30 pregnant women from the Ithaca, New York area. All participants in this study were volunteers. Subjects were selected through personal contact by the investigator. The treatment group consisted of 15 women involved in Nancy Strong's prenatal aerobic dance class, which met bi-weekly for a 1-hour session each meeting. These classes were conducted throughout the entire length of the mother's pregnancy. The control group consisted of 15 women not involved in a regular exercise regimen. The women's ages ranged between 21 and 30 years.

### Equipment

The equipment needed to take the measurements used in this study were weight scales and a dynamosphygmomanometer to take the mother's weight and blood pressure. A weight scale was used in combination with Apgar scales to evaluate the health status of the newborn infant.

### Procedures

In order to collect the data of interest for this study it was necessary to obtain a signed authorization for each woman's prenatal flow chart (see Appendices A, B, and C). The authorizations were brought to Tompkins Community Hospital where the prenatal flow charts of the women were made available to the investigator. The maternal measurements were taken and recorded by the participants' physicians at 3, 6, and 9 months of pregnancy. Those participating in the exercise group followed the Nancy Strong (1981) prenatal aerobic dance protocol. The exercise program consisted of a warm-up period of approximately 10 to 15 minutes, 30 to 40 minutes of exercise, and then another 10 to 15 minutes at the end of the session dedicated to cool-down. During the warm-up different stretches were employed in order to avoid injury to the women. The aerobic portion of the workout was done in order to elevate the women's heart rates so that an aerobic benefit could be reached. The cool-down session was designed to decrease the heart rate.

## Treatment of the Data

The mother's blood pressure and weight gain were compared for each period and between the two groups. This was done using a MANOVA. A Tukey HSD was performed on the mothers' data to detect the location of any significant differences between the data collected at the different time periods. An ANOVA was also used to compare Apgar scores and birthweights of the newborn infants.

## Summary

Thirty pregnant women from the Ithaca, New York area were involved in this study. Half the pregnant women ($n$ = 15) were involved in Nancy Strong's prenatal aerobic dance class. The other group of pregnant women ($n$ = 15) were only involved in activities for daily living. Prenatal flow charts were maintained by the pregnant women's physicians. From the prenatal flow charts data concerning both the pregnant women and newborn infants were collected. A MANOVA was performed to compare the mother's blood pressure and weight gain for each measured time period and between the two groups. A Tukey HSD was performed to detect any significant increases in maternal data over time. The Apgar scores and birthweights of the newborn infants were compared using an ANOVA.

Chapter 4

# ANALYSIS OF THE DATA

This chapter deals with the analysis of the data collected on both the pregnant women and their newborn infants. The pregnant women's weight and systolic and diastolic blood pressures were measured at 3, 6, and 9 months. The data collected on the newborn infants of the exercising and non-exercising women were birth weights and Apgar scores taken at 1 minute and 5 minutes after birth. The data for all participants are listed in Appendices D and E.

In an attempt to assess if a significant difference was present between exercising and non-exercising pregnant women when considering weight and systolic and diastolic blood pressure at 3, 6, and 9 months, a group-by-trials MANOVA was performed. The analysis compared the two groups on the measured parameters of weight and systolic and diastolic blood pressure at three different times throughout the pregnancy. Univariate ANOVA tests were run to determine which variables changed significantly over time. To assess where the significant differences existed a Tukey HSD test was performed. A one-way ANOVA was performed on the newborn infants' birthweights comparing the exercising and non-exercising groups in order to assess any significant difference between the two groups. A group-by-times ANOVA was performed on the newborn infants' Apgar scores in order to assess if a significant difference was present between the two groups across two time periods.

In order to perform the MANOVA it was first necessary to see if each group followed the same pattern across time. The MANOVA revealed there was no significant multivariate interaction, $F(6, 23) = .46$, $p > .05$. The MANOVA revealed there was no significant difference between the exercising and non-exercising groups on the combination of weight and systolic and diastolic blood pressure data, $F(3, 26) = 1.28$, $p > .05$. There were significant differences over time on the combination of variables, $F(6, 23) = 70.28$, $p < .05$. Although there was no difference between groups, the finding of significant differences across time led to the rejection of the first null hypothesis that there will be no significant difference in body weight and systolic and diastolic blood pressure between women who exercise and those who do not exercise, as measured at 3-month intervals throughout the pregnancy.

In order to determine which variables contributed to the observed multivariate difference across time, univariate ANOVA tests were performed. An ANOVA performed on body weight at the three intervals across time determined that there were significant weight changes across time, $F(2, 56) = 3.26$, $p < .05$. This led to the acceptance of the null hypothesis that there will be no significant differences in pregnancy-induced weight changes between exercising and non-exercising pregnant mothers. When considering the systolic blood pressure changes across time it was determined that a significant difference occurred, $F(2, 56) = 5.11$, $p < .05$. This led to the acceptance of the null hypothesis that there will be no significant difference in pregnancy-induced systolic blood pressure between exercising and non-exercising pregnant mothers. There were also significant differences across time for diastolic blood pressure, $F(2, 56) = 13.53$, $p < .05$. This finding led to the acceptance of the null hypothesis that there will be no significant difference in pregnancy-induced diastolic blood pressure between exercising and non-exercising mothers.

In order to assess where the significant differences existed, a Tukey HSD test was performed. The Tukey test compares the mean values recorded at the three time intervals. For weight the Tukey test HSD was found to be 1.14; thus any two means that are further apart than 1.14 are considered significantly different. At all three time intervals there were significant differences recorded. The HSD for systolic blood pressure was 7.51. A significant difference was found between the 3-month and 9-month readings. However, there were no significant differences between the 3- and 6-month readings or the 6- and 9-month readings. The HSD for diastolic blood pressure was 3.97. Upon comparing the means at the three intervals there was a significant difference between the 6- and 9-month readings and the 3- and 9-month readings. There was no significant difference between the 3- and 6-month readings.

Table 1 reveals the means and standard errors of body weight and systolic and diastolic blood pressures for the exercise and non-exercisie groups separately as well as in combination with each other, as recorded at 3, 6, and 9 months of pregnancy. The mean body weights for the exercising group were consistently less than for the non-exercising group although the difference was not significant. Between the 3- and 6-month reading, the 6- and 9-month

Table 1

Body Weights and Systolic and Diastolic Blood Pressures for Exercising and Non-Exercising Pregnant Women

| Time | Parameter[a] | Exercising | Non-Exercising | Combined |
|---|---|---|---|---|
| 3 Months | | | | |
| | Weight (kg) | 59.0 ± 1.7 | 62.7 ± 2.6 | 60.9 ± 2.2 |
| | Systolic (mm/Hg) | 112 ± 3.6 | 112 ± 3.1 | 112 ± 2.3 |
| | Diastolic (mm/Hg) | 66 ± 2.2 | 65 ± 1.9 | 66 ± 1.4 |
| 6 Months | | | | |
| | Weight (kg) | 65.2 ± 1.6 | 69.3 ± 2.6 | 67.3 ± 1.6[b] |
| | Systolic (mm/Hg) | 11.8 ± 5.8 | 114 ± 3.4 | 116 ± 3.4 |
| | Diastolic (mm/Hg) | 68 ± 2.0 | 67 ± 1.6 | 6.7 ± 1.3[c] |
| 9 Months | | | | |
| | Weight (kg) | 70.5 ± 1.5 | 75.5 ± 2.3 | 73.0 ± 1.4 |
| | Systolic (mm/Hg) | 121 ± 2.3 | 123 ± 4.2 | 122 ± 2.4[d] |
| | Diastolic (mm/Hg) | 75 ± 2.3 | 73 ± 2.8 | 74 ± 1.8 |

[a]Score represents M ± SE.

[b]Weight 6-month significantly ($p < .05$) higher than 3-month, 9-month significantly higher than 3-month and 6-month readings.

[c]Diastolic blood pressure 9-month significantly ($p < .05$) higher than 3-month and 6-month measurements.

[d]Systolic blood pressure 9-month significantly ($p < .05$) higher than 3-month measurement.

reading, and the 3- and 9-month reading there were significant increases in body weight when combining the exercise and non-exercise groups.

The means and standard errors of the systolic blood pressure for both the exercise and non-exercise groups recorded at 3, 6, and 9 months did not show significant differences between the 3- and 6-month readings or between the 6- and 9-month readings. However, there was a significant difference between the 3- and 9-month readings.

The mean diastolic blood pressure was higher in the exercising women at all three time points. The diastolic blood pressure did not show a significant difference in either the exercise or non-exercise group between the 3- and 6-month readings, but did show a significant difference between the 6- and 9-month and 3- and 9-month readings.

The one-way ANOVA performed on the newborn infants' birth weights revealed that there was no significant difference between the exercise and non-exercise groups, $F(1, 28) = .09$, $p > .05$. Even though the newborn infants of mothers who did not exercise through pregnancy tended to be heavier, this was not significant This information is located on Table 2. This led to the acceptance of the null hypothesis that there will be no significant difference between the birth weight of those children whose mothers exercised compared to those children whose mothers did not exercise.

A two-way ANOVA was performed on the newborn infants' Apgar scores. The design was a group-by-times format. Initially it was necessary to determine if the groups followed the same pattern across time. It was determined that the groups did follow the same

Table 2

Newborn Infants' Birth Weights

and Apgar Scores

| | Birth Weight[a] (kg) | Apgar Scores 1-minute | Apgar Scores 5-minutes |
|---|---|---|---|
| Exercise | 3.71 ± .09 | 8.7* | 9.4* |
| Non-Exercise | 3.76 ± .12 | 8.1 | 8.8 |

[a]Score represents *M* ± *SE*.

*Significant exercise effect ($p < .05$).

pattern across time, $F(1, 28) = .11$, $p > .05$. To determine whether ther were significant differences between the 1- and 5-minute Apgar scores an ANOVA was performed. The ANOVA revealed that both groups showed significant increases from 1-minute to 5-minute Apgar scores, $F(1, 28) = 49.79$, $p < .05$. Once a significant difference was assessed over time it was then necessary to determine if a significant difference was also apparent between groups. The ANOVA revealed that the newborn infants' of women who exercised during pregnancy had higher Apgar scores than newborn infants of their non-exercising counterparts, $F(1, 28) = 7.43$, $p < .05$. This occurred at both 1 and 5 minutes postpartum. This led to the rejection of the hypothesis that there will be no significant difference in newborn infants' Apgar scores from exercising and non-exercising mothers.

## Summary

A MANOVA was performed comparing all maternal parameters measured at the three different points. There were no significant differences between the exercise and non-exercise groups on the combination of weight and systolic and diastolic blood pressure data. Across time there was also no significant multivariate interaction. An ANOVA was performed in order to determine which variables were contributing to the observed multivariate differences across time. This revealed significant differences across time for weight and systolic and diastolic blood pressure. In order to assess between which time intervals significant differences occurred, a Tukey HSD test was performed. Body weight increased significantly between the 3- and 6-month, 6- and 9-month, and 3- and 9-month readings.

The systolic blood pressure increased significantly between 3- and 9-month readings. However, there was no significant increase between the 3- and 6-month readings or the 6- and 9-month readings. The diastolic blood pressure increased significantly between the 6- and 9-month and 3- and 9-month readings. There was no significant increase between the 3- and 6-month readings. An ANOVA revealed no significant differences between the newborn infants' birth weight. A two-way ANOVA performed on the infants' Apgar scores showed a significant increase between groups and between time periods.

## Chapter 5

## DISCUSSION

The purpose of this study was to determine the effects of exercise versus non-exercise during pregnancy on maternal weight and systolic and diastolic blood pressure changes. The investigation also included the effects of maternal exercise on the apparent health of the newborn infants as assessed by Apgar scores and their birthweight. There were 30 pregnant women involved in this study from the Ithaca, New York area. Half the women ($n$ = 15) regularly attended aerobic dance class, while the other half ($n$ = 15) were not involved in regular exercise. The aerobic dance class lasted the full length of the pregnancy. The aerobic dance class was structured according to guidelines listed in Nancy Strong's aerobic dance program (Strong, 1981). Each participant's weight and blood pressure were monitored by her physician and recorded throughout her pregnancy; measurements of maternal weight and blood pressure were taken at 3, 6, and 9 months of the pregnancy. The data were collected from the mother's prenatal flow charts obtained with the mother's permission from Tompkins Community Hospital. The birth weight and Apgar scores of each mother's newborn infant were also collected.

In order to assess whether there was a significant difference between women who exercised during pregnancy and those who did not, it was first necessary to make sure that both the exercise and non-exercise groups followed the same pattern. This was done to ensure that no false conclusions would be made. Both the exercise and non-exercise groups did follow the same pattern throughout the pregnancy. Both systolic and diastolic blood pressure increased as the pregnancy progressed. However, there was little difference between groups for systolic blood pressure. The systolic blood pressure increased 8% in the exercise group compared to 9.8% increase in the non-exercise group from the 3-month to the 9-month reading. When comparing changes in diastolic blood pressure there was an increase of 13.6% in the exercise group, while the non-exercise group only increased 12.3% throughout the duration of the pregnancy. There was no significant difference throughout pregnancy for systolic and diastolic blood pressure when comparing the exercise and non-exercise groups of pregnant women. Contrary to the findings of this investigation, Annis (1978) found the venous pressure in the anticubital area to remain constant and normal throughout pregnancy. There is, however, an increase in the lower extremities due to the pressure of the uterus on the pelvic veins (Annis, 1978).

There was no significant difference between those women who exercised and those who did not on their weight gain during pregnancy. However, when looking at the combined weights for each time period there was a signifcant difference between each time period. According to Naeye, Blanc, and Paul (1974), the normal optimal weight gain during pregnancy is between 24 and 27 pounds. The exercise group's mean weight gain was approximately 24 pounds, whereas the non-exercise group's gain was 29 pounds. The initial mean weight of the exercise group was approximately 5 pounds less than the non-exercise group. The weight gain patterns followed by both the exercise and non-exercise groups were similar. The term body weight of the exercise group fell within the range of what Naeye et al. (1974) consider to be normal optimal weight gain. However, the non-exercise group tended to be above what is considered the optimal gain. Perhaps exercise during pregnancy contributed to assisting those mothers who exercised fall within the optimal weight gain.

When comparing body weight and systolic and diastolic blood pressure taken at 3, 6, and 9 months of pregnancy, there were no significant differences between groups. However, there was an observed multivariate difference across time when the two groups were combined. There are several factors that could account for the lack of difference between the groups. Lack of thorough assessment of physiological parameters makes it difficult to determine whether groups were similar at the start of the pregnancy. To better delineate and define the groups of exercise and non-exercise women, the investigator suggests it is necessary to have a better understanding of the women's physical fitness level. An extensive physical examination and stress test should be performed. This process should be repeated throughout the pregnancy on both groups, with modification to the test as necessary. A skinfold measurement taken periodically throughout the pregnancy would allow determination of how much of the weight gain during pregnancy is fat. Other measurements such as resting heart rate, cardiac output across time, vital capacity, and tidal volume would be helpful in assessing the status of the pregnant women. The exercise program followed by the women may not have been of sufficient frequency, intensity, and/or duration. This may have contributed to the lack of significant differences between the two groups when considering the measured parameters. Emmanouilides, Hobel, Yashiro, and Klyman (1972) cited that fetal bradycardia and tachycardia have been observed in complicated pregnancies following maternal exercise in human subjects. It was concluded that moderately severe maternal exercise may be detrimental to the fetus, compromising the umibilical circulation. If the activity level is continuously too strenuous it is harmful to the fetus. The exercise program was geared toward women who are pregnant. The women were instructed in self-monitored heart rate and were instructed not to exceed their optimal heart rate.

With the exercise and non-exercise groups combined, the parameters were separately observed across time. This was done in order to establish which parameters were contributing to the multivariate difference across time. All three parameters of body weight and systolic and diastolic blood pressure showed significant differences across time. The maximum readings for these parameters occurred at the 9-month reading. The increases that were found are in agreement with Annis' (1978) findings that the pulse pressure reaches its maximum between the 28th and 32nd week of pregnancy. It appears logical that the greatest increase in body weight would be the final trimester due to the fetus coming to full term.

The newborn infants' parameters measured were birth weight and Apgar scores. These parameters were compared separately between groups. There was no significant difference in body weights between newborn infants of women who exercised and those newborn infants of mothers who did not exercise during pregnancy. The newborn infants of mothers who exercised during pregnancy did have a lower birth weight, although it was not significantly less than their non-exercise counterparts.

The results of the measurements collected from the pregnant women and their newborn infants support the concept of the beneficial effects of exercise during pregnancy on the newborn infant. This is shown by the fact that the Apgar scores of the newborn infants whose mothers exercised during pregnancy were significantly higher at both the 1-minute and 5-minute readings than those of mothers who did not exercise during pregnancy. The higher Apgar scores of those newborn infants whose mothers exercised during pregnancy may indicate that, immediately postpartum, newborn infants of active mothers are in a healthier state than those from sedentary counterparts. This general statement can be made due to the areas evaluated by Apgar scores. These are heart rate, respiratory effort, muscle tone, reflex irritability, and skin color. Findings are contradictory regarding the relationship of mothers' fitness levels and the health status of newborn infants. Pomerance, Gluck, and Lynch (1974) found no correlation between physical fitness scores of the mothers and 1-minute Apgar scores. Erdelyi (1962), who examined the pregnancy outcome in 172 athletes, noted the incidence of threatened abortion, preeclampsia, and operative delivery were lower in athletes than in an undefined group of normal controls.

There is not much information on the subject of exercise during pregnancy and how it relates to maternal weight and systolic and diastolic blood pressure changes, as well as newborn infants' weight and Apgar scores. However, the information that is available tends to advocate exercise, though not strenuous exercise, for pregnant women. Moderate physical training during pregnancy has been advocated by Clarke (1978). He studied 107 outstanding Olympic European pregnant athletes and observed that exercise tended to aid in decreasing discomfort and physical damage during prengnancy. Pfeifer (1978) reported that those women who experienced difficulty during pregnancy had a common history of lack of regular physical activity during childhood and had poorly developed abdominal musculature. In the same study the duration of labor was shown to be shorter for athletes, and there was less chance for peritoneal tears.

## Summary

When comparing exercising and non-exercising pregnant women, there was no significant difference between weight gain or systolic or diastolic blood pressure. However, when combining the exercise and non-exercise groups and analyzing the data, there were significant differences across time, as measured at 3, 6, and 9 months. The lack of significant differences between the exercise and non-exercise groups may be due to the parameters measured by this study. Another factor that may account for the lack of significant differences between the two groups may be that the exercise program followed may not have been of sufficient frequency, intensity, and/or duration. When considering the health status of the newborn infants, based on the criteria evaluated by the Apgar scores, the newborn infants from exercising pregnant women appeared to be somewhat healthier after birth. There was no significant difference in birth weight between the infants of mothers who exercised during pregnancy and those mothers who did not exercise during pregnancy.

Chapter 6

# SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS FOR FURTHER STUDY

## Summary

The purpose of this study was to determine the effects of exercise versus non-exercise during pregnancy on maternal weight and systolic and diastolic blood pressure changes as well as on the apparent health of the newborn infant as assessed by Apgar scores. There were 30 women who participated in the study, and they ranged in age from 21 to 30 years old.

Participation in the study was totally voluntary, and the women were informed that they could cease involvement at any time. Half of the women ($n$ = 15) regularly attended a prenatal aerobic dance class, while the other half ($n$ = 15) were not involved in a regular exercise regimen. The aerobic dance class was structured according to guidelines listed in Nancy Strong's aerobic dance program (Strong, 1981). Each participant's weight and blood pressure were physician-monitored throughout her pregnancy. Measurements of maternal weight and blood pressure were taken at 3, 6, and 9 months of the pregnancy. The data were collected from the mother's prenatal flow charts. These flow charts were obtained with the mother's permission from Tompkins Community Hospital. The birth weight and Apgar scores of each mother's newborn infant were also collected.

The mother's blood pressure and body weight gain were compared for each period and between the two groups. This was done using a

MANOVA. There was no significant difference between exercising and non-exercising pregnant women when considering weight and systolic and diastolic blood pressure. Both groups showed significant increases in the measured parameters of body weight and systolic and diastolic blood pressure with time. A Tukey HSD was performed on the mothers' data to detect any significant increases between the data collected at the different time periods. In both the exercising and non-exercising group there was a significant increase in body weight between the 3- and 6-month readings and the 6- and 9-month readings. The systolic blood pressure showed a signficant increase between the 3-month and 9-month readings only. There was no significant increase between either the 3- and 6-month or the 6- and 9-month readings. The diastolic blood pressure showed no significant increase between the 3- and 6-month readings. However, there were significant increases between the 3- and 9-month and 6- and 9-month readings. An ANOVA was also used to compare Apgar scores of the newborn infants. In both exercising and non-exercising groups the 1-minute and 5-minute Apgar scores followed the same pattern; in both groups there was an increase in the mean Apgar score from 1-minute to the 5-minute reading. The Apgar scores of the newborn infants of exercising pregnant women were significantly higher ($\underline{p} < .05$) than those of newborn infants whose mothers did not exercise. These significantly higher scores occurred at both the 1-minute and 5-minute readings. In order to compare the newborn infants' birth weights an ANOVA was used. There was no significant difference between those women who exercised and those who did not on the newborn infants' birth weight.

## Conclusions

From the results of this investigation it can be concluded that:

1. The exercise program had no effect on the maternal parameters of body weight and systolic and diastolic blood pressure.

2. Both the exercise and non-exercise groups showed a significant increase over time for body weight and systolic and diastolic blood pressure.

3. Between those newborn infants of exercising and non-exercising mothers, there were no significant differences when considering body weight.

4. There was a beneficial exercise effect when considering the health status of newborn infants of the women who exercised during pregnancy versus those newborn infants of women who did not exercise during pregnancy.

## Recommendations for Further Study

From the results of this investigation, the following recommendations can be made:

1. The effects of forms of exercise other than aerobic dance on the parameters used in this study should be studied.

2. Studies should be conducted concerning the effects of maternal body composition (i.e., body fat) on the newborn infant's weight, body composition, and Apgar scores.

3. Further studies should be conducted to include more physiological parameters such as heart rate and percentage of body fat.

4. Further studies should be conducted concerning the

return of exercising versus non-exercising mothers to their pre-pregnancy weight following delivery.

5. Further studies should be conducted on prospective pregnant women, both exercising and non-exercising, on the parameters of body weight and blood pressure using pre-pregnancy weight and blood pressure to determine changes.

6. A stress test should be conducted in order to assess the physical fitness level of the women involved in the study.

## Appendix A

## LETTER TO PARTICIPANT

Dear Participant,

I am currently a graduate student at Ithaca College working towards my master's degree. I am studying the effects of exercise versus non-exercise during pregnancy on the changes that occur to the mother and newborn infant. In order to do this, it is necessary that I obtain your prenatal flow chart and your child's hospital records.

The information that I will be collecting is your height, weight, expected date of confinement (when the child is expected to be born), weeks pregnant as it corresponds to other measurements, and blood pressure. From your newborn infant's hospital chart. I will collect height, weight, date of birth, and Apgar scores. An Apgar score is a method for evaluation of newborn children done routinely at birth. It takes into account the functions of heart rate, respiratory effort, muscle tone, reflex irritability, and skin color. Newborn infants are scored 0, 1, or 2 on each criteria, for a maximum of 10 points.

To determine the effects of exercise during pregnancy I will be using women who are involved in a regular exercise regimen and those not involved in such a program. The data I collect will be used to show the differences, if any, that appear between exercising and non-exercising pregnant women in relation to the areas mentioned above.

In order for me to conduct this study it is necessary that you be informed of the following points:

1. All information collected concerning you and your newborn infant will remain confidential. Only I will have access to the original information.

2. I have no connection with the administration of any aspect of care during your prenantal period, nor am I involved in the planning of the aerobic dance class.

3. Even if you sign this paper indicating interest in participation you may discontinue being a subject for this study at any time.

4. I will be happy to answer any questions you might have concerning procedures or results of the tests. My home phone number is (315) 422-8957, my number at work is (315) 451-6800.

Please indicate whether or not you are interested in participating in this study below, and mail it back to me in the envelope provided.

Thank you for your time and cooperation.

Sincerely,

Ellen Ann Coughlin

_____Yes, I am interested in participation in this study.

_____No, I am not interested in participation in this study.

Please check one:

_____Exercising group

_____Non-exercising group

Name: ____________________________

Address: __________________________

__________________________

## Appendix B

## INFORMED CONSENT FORM

1. a) Purpose of the study. The purpose of this study is to determine the effects of exercise versus non-exercise during pregnancy on the changes that occur to the mother and newborn infant. Women who are enrolled in a regular exercise regimen will be compared to women not enrolled in such a program.

   b) Benefits. The benefits of this study are to see if a regular exercise regimen aids in maintaining weight and blood pressure close to those of non-pregnancy. Also to compare the weight and Apgar scores of the newborn children to see if the effects of exercise are related to these areas. Apgar scores are a method for evaluation of newborn children.

2. Method. In order to collect the necessary data information will be gathered from the participant's prenatal flow chart and the newborn infant's hospital records. After collecting the information it will be compared to see possible differences between exercising and non-exercising pregnant women. In order to participate a signed informed consent form along with another release is necessary. The other release is for prenatal flow charts and the child's hospital records.

3. Will this hurt? No.

4. Need more information? Ellen Ann Coughlin will be happy to answer any questions that might arise concerning procedures

or results of the test. Numbers to reach Ellen Ann are (315) 422-8957 (home), at work (315) 451-6800.

5. Withdrawal from the study. Participation in this study is totally voluntary and may be terminated at any time.

6. Will the data be maintained in confidence? All information concerning the mother or newborn infant will remain confidential. Only Ellen Ann Coughlin will have access to the original information.

7. I have read the above, I understand its contents, and I agree to participate in this study. I acknowledge that I am 18 years of age or older.

____________________________ ____________________________

Signature Date

## Appendix C

## AUTHORIZATION FOR MEDICAL RECORDS

Date ______________________

You are hereby authorized to give Ellen Ann Coughlin or any representative thereof, any and all information which may be requested regarding my pregnancy, and to allow them access to my prenatal records, so that Miss Coughlin may obtain data on my weight and blood pressure during the period of my pregnancy.

Signed ______________________

Witness:

______________________________

## APPENDIX D

### Exercise Group Mothers' and Newborn Infants' Data

| Maternal Parameters | | | | | | | | | Infant Parameters | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3-Month | | | 6-Month | | | 9-Month | | | Apgar Scores | | |
| Wt. (kg) | SB[a] | DB[b] | Wt. (kg) | SB[a] | DB[b] | Wt. (kg) | SB[a] | DB[b] | 1-min | 5-min | Wt.(kg) |
| 50.23 | 090 | 60 | 55.91 | 090 | 50 | 61.82 | 124 | 60 | 9 | 10 | 3.47 |
| 61.36 | 110 | 70 | 66.36 | 130 | 70 | 74.45 | 140 | 90 | 9 | 09 | 4.03 |
| 59.09 | 094 | 66 | 64.55 | 090 | 70 | 72.27 | 100 | 70 | 9 | 09 | 3.21 |
| 60.91 | 102 | 70 | 65.68 | 180 | 80 | 70.23 | 120 | 80 | 9 | 10 | 3.30 |
| 71.36 | 118 | 68 | 76.36 | 130 | 74 | 79.09 | 122 | 84 | 7 | 09 | 3.46 |
| 51.80 | 110 | 60 | 59.90 | 100 | 60 | 65.00 | 122 | 68 | 8 | 09 | 3.41 |
| 66.81 | 100 | 50 | 75.00 | 104 | 62 | 80.00 | 112 | 62 | 9 | 10 | 3.75 |
| 46.81 | 120 | 72 | 54.35 | 116 | 70 | 57.72 | 120 | 80 | 9 | 10 | 4.31 |
| 59.77 | 110 | 70 | 67.27 | 110 | 70 | 72.27 | 118 | 70 | 9 | 10 | 3.84 |
| 59.77 | 110 | 62 | 66.13 | 114 | 62 | 72.61 | 120 | 74 | 8 | 09 | 3.40 |
| 54.77 | 138 | 80 | 61.13 | 124 | 70 | 66.36 | 122 | 84 | 9 | 09 | 3.66 |
| 60.00 | 130 | 78 | 63.18 | 140 | 80 | 69.50 | 112 | 70 | 8 | 09 | 4.34 |
| 54.54 | 132 | 54 | 61.86 | 124 | 64 | 68.70 | 124 | 78 | 9 | 09 | 3.72 |
| 64.27 | 120 | 70 | 69.82 | 110 | 62 | 73.63 | 124 | 70 | 9 | 09 | 4.03 |
| 64.09 | 100 | 58 | 71.00 | 102 | 72 | 74.09 | 132 | 86 | 9 | 10 | 3.71 |

[a]Systolic Blood Pressure (mm/Hg).

[b]Diastolic Blood Pressure (mm/Hg).

## APPENDIX E

### Non-Exercise Group Mothers' and Newborn Infants' Data

| Maternal Parameters | | | | | | | | | Infant Parameters | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3-Month | | | 6-Month | | | 9-Month | | | Apgar Scores | | |
| Wt. (kg) | SB[a] | DB[b] | Wt. (kg) | SB[a] | DB[b] | Wt. (kg) | SB[a] | DB[b] | 1-min | 5-min | Wt. (kg) |
| 63.45 | 118 | 70 | 76.59 | 130 | 74 | 79.55 | 146 | 80 | 8 | 09 | 3.86 |
| 56.31 | 104 | 64 | 66.36 | 112 | 60 | 72.72 | 100 | 74 | 7 | 08 | 4.26 |
| 63.86 | 120 | 70 | 63.36 | 120 | 60 | 70.40 | 110 | 60 | 8 | 08 | 3.26 |
| 57.72 | 127 | 72 | 64.90 | 132 | 67 | 68.46 | 153 | 80 | 8 | 08 | 3.55 |
| 63.63 | 122 | 60 | 68.54 | 102 | 64 | 73.62 | 124 | 62 | 7 | 08 | 4.26 |
| 44.54 | 096 | 50 | 50.86 | 104 | 58 | 60.76 | 120 | 76 | 7 | 08 | 3.63 |
| 69.99 | 100 | 80 | 80.00 | 094 | 70 | 85.45 | 110 | 72 | 9 | 10 | 3.75 |
| 57.72 | 120 | 60 | 66.47 | 120 | 70 | 73.97 | 112 | 76 | 9 | 09 | 3.75 |
| 76.36 | 100 | 60 | 80.00 | 100 | 70 | 88.64 | 110 | 80 | 8 | 09 | 3.46 |
| 64.09 | 118 | 70 | 68.18 | 130 | 74 | 75.45 | 152 | 94 | 8 | 09 | 3.46 |
| 62.70 | 122 | 64 | 66.59 | 118 | 78 | 69.77 | 118 | 62 | 9 | 10 | 3.33 |
| 79.55 | 100 | 70 | 85.00 | 100 | 68 | 87.73 | 112 | 80 | 8 | 08 | 4.24 |
| 72.40 | 120 | 72 | 80.20 | 132 | 72 | 85.40 | 132 | 80 | 7 | 08 | 4.67 |
| 66.36 | 090 | 60 | 72.73 | 110 | 60 | 78.18 | 120 | 58 | 9 | 09 | 3.86 |
| 42.73 | 120 | 60 | 50.00 | 100 | 60 | 61.71 | 126 | 54 | 9 | 10 | 2.98 |

[a]Systolic Blood Pressure (mm/Hg).

[b]Diastolic Blood Pressure (mm/Hg).

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