PRIMIGRAVID WOMEN AND THE EFFECTS OF EXERCISE ON PSYCHOLOGICAL WELL-BEING, PREGNANCY AND BIRTH OUTCOME

by

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DECLARATION

I declare that this thesis was composed by myself and that all data were collected and analysed by myself.

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ABSTRACT

The effects of undertaking a regular exercise programme during and following pregnancy were investigated with healthy primigravid women within Ayrshire Central Hospital, Irvine. A randomised control trial was used with subjects being randomly assigned to either a control group who continued with the existing antenatal education programme or an exercise group who had the addition of participating in an aerobic exercise programme. Subjects were recruited to the study at the first antenatal appointment in early pregnancy and continued until 16 weeks postpartum. Of the subjects (n=157) recruited, 98 (62%) completed the study of whom 48 (64%) were in the control group and 50 (61%) were in the exercise group.

The aim of the study was to investigate any differences between the two groups in relation to psychological indicators including perceptions of coping assets (positive psychological well-being), coping deficits (negative psychological well-being), physical well-being, body image, somatic symptoms, and attitudes to marital relationships, sex, pregnancy and baby. Pregnancy and birth outcomes were also investigated which included length of gestation†, duration of labour†, mode of delivery, Apgar† scores and birthweight†. Outcome measures for psychological variables included Psychological well-being scale, Maternal Attitude and Adaptation to Pregnancy questionnaire and Edinburgh Postnatal† Depression Scale. Measurements were obtained in early pregnancy (12-16 weeks), late pregnancy (36-40 weeks) and post pregnancy (12-16 weeks). A record of physical activity was obtained at each of the time points of interest.

The change in the responses of each of the psychological variables at each time point was of interest. Statistical analysis was undertaken using Repeated Measures ANOVAs. Follow up Multiple Comparisons Procedure with simultaneous 95% confidence intervals were undertaken once significance was indicated. Pearson product moment coefficient of correlations were undertaken to determine if there was a relationship between the frequency of total activity and the responses on psychological indicators in post pregnancy. Significance level used was $p<0.05$. Two sample t-tests and Chi-square tests were used to compare demographic details, pregnancy, birth outcomes, physical activity levels and drop out rate of subjects.

In early pregnancy, no significant differences were found between the groups in relation to activity levels or mean scores of psychological variables with the exception of the control group having significantly more positive scores for perceptions of body image. During and following pregnancy, the exercise group maintained their scores on all psychological variables i.e. perceptions of coping assets (positive psychological well-being), coping deficits (negative psychological well-being), physical well-being, body image, somatic symptoms experienced, attitudes to marital relationships, sex and pregnancy. In contrast, the control group tended to have significant reductions in perceptions of the ability to cope (positive psychological well-being), physical well-being, body image, somatic symptoms experienced, attitudes to marital relationships, pregnancy and sex during pregnancy in addition to an increase in perceived coping deficits (negative psychological well-being).

There was no indication of any risk to the pregnancy or baby and no significant difference was found between the groups in relation to any of the pregnancy and birth outcomes investigated for both those women who completed and those women who dropped out of the study.

The exercise group participated in a significantly higher number of episodes of physical activity sessions than the control group. No significant relationship was noted between frequency of physical activity and responses to psychological indicators in post pregnancy.

In conclusion, women who participated in regular physical activity tended to have a protection against a reduction of psychological well-being as measured by a variety of psychological constructs. The maintenance in psychological well-being was experienced both during and following pregnancy and there was no indication of any risk to the pregnancy or the baby. This was in contrast to the significant reduction in psychological well-being experienced by the women in the control group during the same period.

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GLOSSARY OF TERMS

Words included within the Glossary of Terms are highlighted in the text†

Abortion This is the term used to denote an interruption of pregnancy before the 24th week of gestation

Aerobic Capacity (VO_2) refers to the rate at which oxygen can be utilised by the cells. It can be described as absolute or functional aerobic capacity. The evaluation of ***functional*** aerobic capacity describes the individual's capacity to meet and sustain daily weight-bearing activities while ***absolute*** aerobic capacity is a measure of the individual's maximal cardiopulmonary capacity and maximal energy output by aerobic processes

Anoxia refers to the lack of oxygen which, if persists, will result in death of the fetus

Apgar score is a numerical assessment of the newborn in terms of general condition immediately following birth. This involves consideration of the degree to which the following five signs are present or absent i.e. heart rate, respiratory effort, muscle tone, reflex and colour

Birthweight is the first weight of the newborn obtained preferably within one hour of birth before significant postnatal weight loss has occurred

Bradycardia is fetal heart rate below 120 beats per minute

Cardiotocography is the use of Doppler ultrasound to make an immediate assessment of fetoplacental well-being

Congenital abnormalities refers to any abnormalities present at birth

Contracted Pelvis refers to a pelvis with all diameters reduced by one centimetre

Duration of labour averages between 10-12 hours for a primigravida and 6 hours for a multigravida

Dystocia is the term used to encompass all the factors which cause labour to be prolonged. The term dystocia originates from the Greek words ***Dys*** meaning 'bad or abnormal' and ***Tokos*** meaning 'labour'

Episiotomy refers to the surgical incision of the perineum and vagina which enlarges the introitus to facilitate delivery of the baby

Fetus is the term used to describe the human being from the 10th week of gestation until birth

Fetal refers to the fetus

Fetal Bradycardia refers to the fetal heart rate of less than 120 beats per minute (bpm)

Fetal Tachycardia refers to the fetal heart rate greater than 160 beats per minute (bpm)

Gestation of pregnancy is the period of gestation calculated from the date of the last menstrual period and normally is of 40 weeks duration. ***Gestational age*** of the pregnancy or fetus refers to this period

Hypertension refers to blood pressure of >140/90 mm Hg or a rise of 15-20 systolic and 10-15 diastolic

Hypoxia refers to a lack of oxygen which can result in distress of the fetus in utero

Gravid is the term used for pregnant e.g. gravid uterus

Labour refers to the process by which the fetus, placenta and membranes are expelled through the birth canal

Late deceleration refers to a drop in fetal heart rate which shows the lowest level of deceleration lagging behind the highest peak of the uterine contraction

Low birthweight is a birthweight of less than 2500 grammes. This includes premature infants and growth retarded infants of maturity more than 37 weeks

Maximal oxygen consumption (VO_2max) is defined as the maximal rate at which oxygen can be utilised by the cells in the body. It is a non invasive measurement of physical fitness which is a measure of cardiovascular endurance. This includes a circulatory component to oxygen uptake (*oxygen delivery*) and an extraction component (*oxygen utilisation*)

Multigravida is the term used for a woman who is pregnant for the second or subsequent time

Neonatal is the term used for the newborn infant (neonate) in the first 28 days of life

Neonatal period describes the first 28 days of life

Normal labour is a labour in which the fetus presents by the vertex, the occiput rotates anteriorly and the result is the birth of a living, mature fetus with no complications, the duration of labour ranging from 4-24 hours

Obstructed labour is the term to describe labour when there is no descent of the presenting part in the presence of good contractions. Usually there is extensive caput and moulding, a malposition or malpresentation. The fetus is often large and the pelvis small or abnormal in shape

Occiput is the term used to describe the back of the fetal head behind the posterior fontanelle

Operative delivery is usually by Lower Uterine Segment Caesarean Section (LUSCS) which is the surgical removal of the fetus by abdominal route after fetal viability (24^{th} week)

Partum is the term used to refer to period of childbirth. ***Antepartum*** refers to the period before labour and delivery; ***intrapartum*** refers to the period during labour and delivery and ***postpartum*** refers to the six week period following delivery

Placenta is the organ of communication i.e. nutrition and products of metabolism, between the fetus and the mother

Postnatal period refers to the first 28 days following delivery of the baby

Precipitous labour describes labour that is very rapid labour with intense frequent contractions which result in the delivery of the baby within one hour

Preterm baby refers to a baby born before the 37^{th} completed week of pregnancy

Preterm delivery refers to labour and delivery occurring before the 37^{th} completed week of pregnancy

Primigravida is the term used to describe a woman who is pregnant for the first time

Ratings of Perceived Exertion Scale (RPE) is a scale reported to equate subjective feelings of effort with numerical values derived from a standardised scale

Spontaneous Vertex Delivery is a normal delivery with the vertex of the fetal skull presenting

Stages of labour: First stage of labour commences from the onset of regular, rhythmic uterine contractions until full dilatation of the cervix (i.e. 0-10 centimetres). Second stage of labour refers to the time from full dilatation of the cervix until expulsion of the fetus. Third stage occurs from delivery of the baby until expulsion of the placenta and membranes

Tachycardia is a fetal heart rate above 160 beats per minute and a **maternal** heart rate above 100 beats per minute. This indicates a degree of distress

Term describes the gestation of pregnancy between 37 and 42 completed weeks

Trimester of pregnancy refers to each of the three trimesters, each lasting 3 months

Ultrasound is the use of high frequency short wavelength sound wave reflections to diagnose pregnancy, assess gestational age, diagnose multiple pregnancy, malpresentation etc.

Variability is the term to describe the variation within the fetal heart beat. Lack of fetal heart beat variation may be due to severe or chronic hypoxia when the fetal autonomic nervous system is unable to respond to stress

Vertex is the term which applies to area at the top of the fetal skull between the anterior and posterior fontanelles and the parietal eminences

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CHAPTER 1

INTRODUCTION

Over recent decades there has been a dramatic increase in the number of women who engage in regular physical activity (Artal Mittlemark & Gardin 1991). This current trend is reflected in the number of pregnant women now adopting a more active lifestyle (Mottola & Wolfe 1994).

Exercise is universally advocated as a means to maintain and enhance good physical and mental health (Raglin 1990). There is general agreement that regular exercise by healthy individuals has both physical and psychological benefits including improved physical fitness and enhanced quality of life (Griffiths 1996). These benefits have recently been acknowledged within national strategies in the promotion of regular physical activity to the general population, with women of all ages identified as one of the target groups (Scottish Office Home & Health Department 1992; Royal College of Physicians 1993).

Women today are more autonomous and feel empowered to be in control of their health, mind and body. Exercise is now accepted as an integral part of normal life for many women (Halksworth 1993). Anecdotal information has consistently suggested that exercise may be particularly beneficial for women (Harris 1981; Berger 1984). Recently, several reviews have suggested that exercise can be beneficial in helping women cope with issues faced in reproductive life (Gannon 1988; Choi & Mutrie 1996).

Many women may participate in physical activity for recreation, health benefits or as part of a fitness or training programme. More often, women regularly participate in exercise as part of an exercise related career or to enhance sports performance. The majority of exercising women wish to remain physically active during pregnancy so that they can continue to enjoy the physical and psychological benefits (Halksworth 1993). In particular, there has been a growing demand for exercise specifically for pregnant women who are not accustomed to exercise but who wish to exercise in order to take better care of themselves and their babies during pregnancy (Gaskill 1993; Mottola & Wolfe 1994).

Pregnancy is a very special time in a woman's life and some women may be reluctant to start or continue to exercise during pregnancy for fear of harming their unborn baby (Halksworth 1993). Women want to learn all they can about remaining active during pregnancy, what potential benefits and risks exist to pregnancy, how much exercise is safe for the baby, and how pregnancy will affect their sports performance (Artal Mittlemark, Wiswell & Drinkwater 1991a). Therefore, an increasing number of women may approach health professionals for sound advice which will enable them to continue to exercise safely during pregnancy (Gaskill 1994).

There are also important fundamental questions of interest to exercise scientists and health professionals. These include the ways in which pregnancy alters the woman's ability to exercise, to what extent the response to exercise during pregnancy differs from that in the non pregnant state and in what way physical activity influences the course of pregnancy and the development of the fetus† (Artal Mittlemark *et al* 1991a; Mottola & Wolfe 1994). Lack of knowledge in the area of exercise during pregnancy may lead to a lost opportunity to promote a healthy lifestyle (Halksworth 1993).

The impact of pregnancy and childbirth presents physical and psychological challenges to women. The process of childbirth itself, has been depicted as a normal developmental positive experience (Zajiceck 1981; McGoldrick & Carter 1982). Others have described pregnancy as a developmental or maturational crisis involving one of the greatest transitions in a woman's life (Bibring 1959; Erikson 1965; Grossman, Eitchler & Winickoff 1980). Therefore, any physical or psychological benefits gained through exercise would be an advantage to pregnant women during this important life event.

Pregnancy is probably one of the most important times in a woman's life when it is desirable that exercise is carried out safely and correctly. However, the unique physical and physiological conditions that exist during pregnancy and the postpartum† period create special risks that do not affect non pregnant women (Kramer 1996).

Careful consideration should be given to the additional impact that exercise may have on the progressive anatomical, physiological and psychological changes which normally occur during pregnancy (Wells 1991; Artal Mittlemark *et al* 1991a).

In general, there appears to be no contraindication to exercise during pregnancy in the healthy woman (Wells 1991). In fact, there is belief in the value of safe exercise during pregnancy, provided that any advice given is appropriate to the needs of the individual woman (Huch & Erkkola 1990; Lokey, Tran, Wells *et al* 1991; Kramer 1996). Without doubt, improved stamina, resilience, well being and self reliance would benefit women in their preparation for the physical and emotional challenges inherent in pregnancy, childbirth and transition to parenthood (Artal & Artal Mittlemark 1991).

It is important that up to date scientific research is available to support existing findings on the effects of exercise during pregnancy. Information, based on sound research findings, should be widely disseminated and readily available to health professionals concerned with pregnant women. This would allow the health professionals to provide up to date accurate and appropriate advice and guidance to pregnant women. Possible benefits and available opportunities to gain these benefits should be incorporated into antenatal education programmes to enable women to make informed choices and be supported if they wish to exercise during and following pregnancy.

1.1 Aims of Investigation and Plan of Thesis

The overall aim of this study was to investigate the effect of a structured exercise programme on 'low risk' pregnant women by a two group randomised controlled trial during and following their first pregnancy. The women in the 'control group' continued with the existing antenatal education programme available in Ayrshire which was designed to prepare women for pregnancy, labour[†] and the transition to parenthood. Women in the 'exercise group' participated in a structured exercise programme in addition to the existing antenatal education programme. Women were studied from twelve weeks of pregnancy until four months after delivery of the baby.

The outcome measures, used within the study, focused on the psychological aspects of pregnancy. These included how the women felt about themselves and their bodies, how well they felt they could cope, their attitudes to marital relationships, sex, pregnancy and the baby. Pregnancy and birth outcomes were also investigated as well as the amount of physical activity undertaken throughout the study.

Chapter **1** provides an introduction to the current situation of an increasing number of women of childbearing years who participate in regular exercise during pregnancy. The interest and concerns of women, health professionals and exercise scientists in relation to the effects of exercise during pregnancy are identified. The overall aims of the study are presented.

Chapter **2** presents a review of the physiological and psychological changes of pregnancy, in particular those progressive anatomical and physiological changes of pregnancy which need to be considered in the context of exercise having a further impact on pregnancy. There is an overview of the physiological, psychological and potential short and long term health benefits of exercise to the non pregnant population. This is followed by an historical overview of exercise in obstetrics. Thereafter, there is a detailed review of the current literature in relation to scientific evidence of the physiological and psychological effects of exercise on pregnancy, birth outcomes and the postpartum† period. The review highlights gaps in the existing literature and research methodologies, the basis for the present study and issues for future research. The present study is discussed in terms of the need for research in this area and the aims and objectives of the research.

Chapter **3** defines the methodology and theoretical approach. The methods are discussed in detail and justification for the design is presented.

Chapter **4** reports the findings of the study and contains detailed analyses of the data obtained.

Chapter **5** contains a detailed synthesis of the findings from the study and the relevance of these findings to current knowledge is discussed.

Chapter **6** presents the conclusions, recommendations for practice based on the findings from the study and recommendations for further research in this area of interest. **Appendices** provide additional detailed information in relation to issues presented and discussed within the thesis.

CHAPTER 2

LITERATURE REVIEW

2.1 Physiological Changes during Pregnancy

Pregnancy is distinguished by a multitude of profound physiological and endocrine adjustments which are necessary to provide an optimal environment for the developing fetus†. Every organ system in the woman is intimately involved in this complex process from the moment of conception until after the birth of the baby. These normal physiological changes which occur during pregnancy need to be acknowledged and given careful consideration to ensure that a safe environment is maintained for mother and fetus† during pregnancy.

2.1.1 Cardiovascular System

Cardiovascular changes during pregnancy include a substantial increase in blood volume, compensated in part by increased venous capacity, cardiac dilatation and reduced peripheral vascular resistance (Wolfe, Ohtake, Mottola *et al* 1989a).

There is a physiological increase in blood volume of between 18 and 40% above the non pregnant volume (de Swiet 1991a; Gorski 1985). This increase is mainly due to a 50% increase in plasma volume and a 20% increase in red blood cell volume. This leads to an overall dilution of these cells and subsequently, there are fewer red blood cells in a single area to transport oxygen than in a nonpregnant woman. The ability of the blood to carry oxygen is called the oxygen carrying capacity and this results in the *'physiological anaemia of pregnancy'* (de Swiet 1991a).

Cardiac output during rest increases gradually in the first trimester† of pregnancy, reaching between 30 and 50% above the non pregnant value by the beginning of the third trimester† (Sharp 1993). There is uncertainty about the exact timing and pattern of the component changes and the underlying factors responsible for these changes (de Swiet 1991a; Duvekot, Cheriex, Pieters *et al* 1995).

The increase in cardiac output, which begins in early pregnancy, is due to an increase in blood volume and a progressive increase in both stroke volume and heart rate (Capeless

& Clapp 1989; Robson, Hunter & Boys 1989; Duvekot, Cheriex & Pieters *et al* 1993). The increase in circulating blood volume is not uniformly distributed throughout the body. The hepatic and cerebral bloodflow remain unchanged whereas uterine bloodflow increases to meet the requirements of the developing fetus and growing uterus (Gorski 1985).

After the fourth month of pregnancy, the enlarging uterus is capable of interfering with venous return by compression of the inferior vena cava. This can cause supine hypertension syndrome, affecting cardiac output, and interfering with uterine circulation (Ueland, Novy, Peterson *et al* 1969; Sweet & Tiran 1997).

The systemic vascular resistance is also markedly reduced due to both a reduction in vascular tone because of high levels of progesterone and a several-fold increase of blood flow to the placenta and pregnant uterus (Schrier & Briner 1991). In early pregnancy, the relaxing effects of the hormone progesterone leads to a decrease in blood pressure (Magness & Rosenfeld 1989; Omar, Ramirez & Gibson 1995). Systolic blood pressure remains relatively stable throughout pregnancy although diastolic blood pressure falls, being lowest at mid pregnancy and recovering as pregnancy develops (Gorski 1985; Duvekot *et al* 1993).

2.1.2 Respiratory System

The changes in the respiratory system are extensive and include anatomic and functional alterations. These changes occur very early due to hormonal influence, mainly progesterone, even before the growing uterus mechanically impairs ventilation. In the third trimester†, the bulky uterus forces up the diaphragm by as much as four centimetres and distorts the chest shape and size, resulting in a reduction in respiratory reserve. Movement of the diaphragm increases and the rib cage also expands to compensate ventilation (Gorski 1985).

The respiratory centre has increased sensitivity to carbon dioxide and increased ventilation is achieved by breathing more deeply and not more frequently (Romen, Masaki & Mittlemark 1991; de Swiet 1991b). Ventilatory capacity remains essentially normal throughout pregnancy despite the expiratory reserve volume and functional residual

capacity progressively decreasing in the second half of pregnancy. Minute ventilation increases by 50% resulting from an increase in tidal volume since respiratory frequency remains unchanged (Pernoll, Metcalfe, Schlenker *et al* 1975; de Swiet 1991b).

2.1.3 Musculo-Skeletal System

Gestationally induced changes in plasma hormone levels of oestrogen and relaxin increase relaxation and joint mobility especially in the third trimester† of pregnancy. The effect of relaxin on the ligaments causes softening, making them more elastic and potentially unstable. This affects mainly the sacro-iliac joints and symphysis pubis joint in the pelvis to accommodate the growing fetus† and facilitate delivery (Romen *et al* 1991). However, hormones affect all joints, putting them at risk of over-stretching especially in weight-bearing areas.

By 12 weeks of pregnancy, the enlarging uterus moves from the pelvic cavity to become an abdominal organ (McNitt-Gray 1991). As pregnancy progresses, the woman's centre of gravity shifts upwards and forwards and the pelvis tilts forwards and down to keep the trunk upright (Sharp 1993). The anterior orientation of the uterus expands into the abdominal cavity and this, along with changes in the breasts, puts extra work on the muscles to keep the body *'in balance'*. It can make the body more unstable, either at rest or for any kind of movement, resulting in the woman *'relearning'* how to stand or to move (McNitt-Gray 1991).

Spinal changes may be characterised by further development of lumbar lordosis to help bear the weight of the growing fetus† towards term†. The abdominal muscles may become weaker as pregnancy progresses as they have to stretch around the fetus†. As a result, they become less efficient in their vital role of supporting the lower back and maintaining posture. This may cause additional strain on the back and can often create balance and co-ordination problems (McNitt-Gray 1991).

Low back pain is a common recurrent complaint during pregnancy (Sweet & Tiran 1997). Factors hypothesised to contribute to its aetiology include exaggeration of lumbar lordosis and mechanical loading of the lumbar spine. This accommodates for the gravid†

uterus, loss of strength and tone of the abdominal musculature and increased laxity of the pelvic and sacro-iliac joints (Romen *et al* 1991).

Other problems of particular concern at this time include nerve compression syndromes and more rarely separation of the symphysis pubis. Fluid retention, mainly in the ground substance of connective tissue, causes these changes. This results in marked, visible ankle oedema and paraesthesia in the hands, muscular weakness and the carpal and tarsal tunnel syndrome (Tobin 1967).

2.1.4 Endocrine Factors

The endocrine systems undergo profound changes during pregnancy. Changes are modulated by the ovaries, maternal endocrine glands and the placenta† which plays an important role as a multifunctional endocrine gland (Romen *et al* 1991).

Pregnancy is a diabetogenic event especially through the action of hormones cortisol, progesterone and human chorionic sommatomammotrophin. These hormones start to rise between 45 and 65 days and peak between 25 and 32 weeks which predisposes to carbohydrate intolerance by insulin resistance (Sharp 1993). During pregnancy, fasting blood sugar and glucose levels tend to be lower than in the non pregnant state. Since the pregnant woman utilises carbohydrates at a greater rate during pregnancy, hypoglycaemia may occur under conditions of prolonged or strenuous exercise (Gorski 1985).

2.1.5 Oxygen Consumption

The progressive increases in cardiac output and pulmonary ventilation are proportionally greater than those occurring in maternal and fetal† consumption during pregnancy (de Swiet 1991b). The resting oxygen intake rises significantly from around 18 weeks to between 15 and 20% above normal during pregnancy (Gorski 1985; de Swiet 1991b). The initial increase is primarily due to increased cardiac and renal energy costs. The major increase in resting oxygen consumption occurs during the second half of pregnancy and is due to the rapidly growing fetus†, the enlarging placenta† and uterus (de Swiet 1991b).

2.1.6 Nutritional and Energy Requirements

The estimated additional energy requirement of a typical pregnancy is approximately 85,000 kilocalories or 300 kilocalories/day above that needed in the non pregnant state (Butterfield & King 1991). These extra kilocalories are required to meet the metabolic needs of pregnancy and the developing fetus†. The energy demand is unevenly distributed with most energy being required in the middle 20 weeks of pregnancy mainly due to fat storage during this period. Thus the demands are less at the beginning and end of pregnancy when fat storage does not occur. This energy cost of pregnancy can either be met by increasing calorie intake or by reducing energy expenditure (King, Butte, Bronstein *et al* 1994).

A healthy average woman during the course of her pregnancy can gain between 11 and 13 Kg in weight depending on maternal diet, activity levels and other factors pertaining to gestation† such as *'morning sickness'* and multiple pregnancy. Factors which contribute to this overall weight gain include; the growing fetus†, placenta†, amniotic fluid and increased body fluids, breast and other body tissues, and body fat (Sweet & Tiran 1997).

2.2 Psychological Factors

Pregnancy is generally regarded as a critical event in a woman's life. During pregnancy and early motherhood, psychological change is rapid compared with other periods in adult life (Leifer 1977; Raphael-Leff 1991). Some of these changes may only be temporary due to biological events while other changes may be more long term and affect psychological well-being (Leifer 1977).

The psychological effects of pregnancy have been of interest for many years (Raphael-Leff 1991). A variety of theoretical views have been put forward concerning the psychological and emotional aspects of pregnancy. Deutsch (1947) described pregnancy as a calm, dreamlike period that fulfils a woman's deepest yearnings. Conversely, Bibring (1959) viewed pregnancy as inherently a period of emotional, psychological and social stress with the level of anxiety increasing as pregnancy progresses (Bibring, Dwyer, Huntington *et al* 1961). Page (1997) has suggested that the time, particularly around the

time of birth, was critical and sensitive and may have a profound affect on the physical, spiritual and emotional health of the woman.

2.2.1 Emotional Aspects

Many factors influence a woman's reactions to pregnancy and her ability to cope with her feelings. Every woman is different and unique but common emotional and cognitive reactions include anxiety, hostility, fatigue, introversion, mood swings, denial, impatience (Chalmers 1982) and often negative changes in body image (Strang & Sullivan 1985).

The woman's perception of pregnancy may be strongly influenced by social, cultural and peer norms (Price 1993a; Choi & Mutrie 1996). To a large extent, the way a woman copes with the changes of pregnancy will be influenced by her personality, lifestyle, relationship with her partner and family, feelings about herself, having a baby and level of physical fitness (Wells 1991).

Findings from numerous empirical studies, have indicated that women feel both happy and anxious in early pregnancy (Green 1990a) and that anxiety, depression and irritability increased during pregnancy when compared with the non pregnant state (Condon 1987). Green (1990b) reported that some women tend to be preoccupied with worry about various aspects of pregnancy from early pregnancy onwards. Negative feelings, particularly related to the birth, were found to peak around third trimester† of pregnancy (Elliot, Rugg, Watson *et al* 1983). Some women may never experience these negative emotions and have reported increased rather than decreased psychological well-being (Elliot *et al* 1983; Condon 1987).

A woman's habitual coping style may determine whether she has a sense of success and adequate self esteem as she progresses through pregnancy. An increase in the symptoms of pregnancy experienced has been associated with negative attitudes towards pregnancy, particularly in the later stages (Raphael-Leff 1991). The results of empirical research indicate that pregnancy was not entirely pleasurable for most women. Wolkind & Zajicek (1981) found that crying, worry, misery, and nervousness were common psychological factors in the second and early third trimesters† of pregnancy. Women who were highly distressed, anxious or depressed during pregnancy were more likely to

experience depression in the postnatal period† (Watson, Elliot, Rugg *et al* 1984; Elliot *et al* 1983; Sharp 1989). These high levels of stress and distress can adversely effect the fetus† and the mother's relationship with her partner, friends and family (Raphael-Leff 1991; Niven 1992). Green (1990a) has also suggested that antenatal mood is an important predictor of postnatal† mood.

Anxiety during pregnancy has been related to the trimester† of pregnancy (Friederich 1977; Pitt 1977). Glazer (1980) recommended that maternal anxiety should be reduced to improve the gravid† woman's emotional and physical well-being as well as to protect the fetus. The emotional state of the mother during pregnancy may affect the labour and delivery process (Sweet & Tiran 1997). In particular, a high anxiety level in the mother may be associated with a variety of obstetric complications including prolonged labour† and difficult birth (Zax, Sameroff & Farnum 1975). Such findings have encouraged the development of programmes for mothers that can potentially improve their attitude towards childbirth and enhance their emotional state (Sweet & Tiran 1997).

It is a widely held opinion that psychosocial support has a positive influence upon the mental health throughout the lifespan of individuals (Oakley 1992; Wheatley 1998). During pregnancy, this psychosocial support is a key component of psychological care and includes good interpersonal and support skills within a facilitative environment (Hirst, Hewison, Dowswell *et al* 1998). The right kind of social support has been shown to significantly enhance emotional well-being (Oakley 1992; Wheatley 1998) and has also helped pregnant women become more confident and self reliant rather than be dependent on others (Hirst *et al* 1998).

2.2.2 Body Image, Sexuality and Marital Relationships

Pregnancy and childbirth represent a normal body image adjustment which may pose a significant challenge to the woman's perception of her body more than any other natural life process (Price 1993a; 1993b; 1996). Pregnancy radically alters the physical dimensions and function of the body, and a woman's sense of completeness and sexual identity (Raphael-Leff 1991; Price 1996).

Throughout the lifespan, opinion and feelings about the body are formulated through visual assessment of appearance and the visual sensations that the body provides (Ussher 1993). The body image associated with pregnancy, childbirth and breastfeeding involves a significant distortion of the woman's normal body contours, her weight and body sensations (Raphael-Leff 1991; Price 1993a). The woman's perception of 'body reality' is set against a 'body ideal' that will be different for each woman. This perception of 'body reality' will incorporate either the woman's acceptance that the pregnant woman 'blooms' or may cause the woman to lament the loss of a smaller, thinner appearance (Price 1993a).

Pregnancy and birth are recognised as being far more than a physical experience (Raphael-Leff 1991). The transition to new roles and responsibilities require a social and emotional adaptation which are suggested to be the most crucial adaptations of human life (Clement 1998).

Outward acceptance or even enthusiasm for the pregnancy may conceal inner anxiety and fear. Even when the woman has viewed her pregnancy as being highly desirable, there are unavoidable tensions between her needs and desires and the growing fetus† (Raphael-Leff 1991). These may include perceptions of the pregnancy as an invasion of privacy, an intrusion in personal relationships, an alteration to lifestyle, a loss of career opportunities or independence. It has been suggested that the changing roles experienced by women may be in conflict and may be associated with a loss of control (Price 1993b; Ball 1994). The pregnant woman may feel that she is perceived as a 'pregnancy' only and that her own identity becomes submerged (Raphael-Leff 1991; Alder 1994).

Changing body image during pregnancy can have a powerful effect on a woman and her partner (Sweet & Tiran 1997). These changes may be either positive or negative and can extend to affect sexual and postpartum† relationships (Price 1993b). The mother's adjustment to pregnancy might be dominated by her developing relationship with her baby, with her relationship to the baby's father taking second place. There is evidence to associate the quality of marital relationships and the psychological well-being of the mother during pregnancy. Scott-Heyes (1984) suggests that women are more likely to suffer from depression if they have poor marital relationships during pregnancy.

Pregnancy and new parenting occur within a compact time-frame that includes a variety of interpersonal, cultural and physical challenges. These need to be incorporated within the individual's sexual identity and shared relationship (Raphael-Leff 1991). There is agreement in the literature that a woman's level of sexual interest changes during pregnancy and remains altered for weeks or months after the birth (Fischman, Rankin, Soeken *et al* 1986). There are also discrepancies about the nature, pattern, magnitude and duration of these changes (Barclay, McDonald & 0'Loughlan 1994). However, the interaction between pregnancy, childbirth, sexual and marital relationships remains poorly understood.

2.3 Exercise and the Healthy Individual

Exercise represents an important instrument in health promotion, as it seeks to change behaviour and encourage the general community to develop life skills. Individuals perceive exercise very differently but, in general, most forms of exercise are associated with physical fitness which signifies a sense of 'well-being' (Lamb 1987).

Physical activity has been defined as 'any bodily movement produced by skeletal muscles that results in energy expenditure' (Caspersen, Powell & Christenson 1985). Physical activity is closely related to, but distinct from, exercise and physical fitness. Exercise is a subset of physical activity and has been defined as 'planned, structured and repetitive bodily movements done to improve or maintain one or more components of physical fitness'. Physical fitness is 'a set of attributes that people have or achieve that relates to the ability to perform physical activity' (Caspersen *et al* 1985).

Exercise physiology is concerned with the functional changes within an organism brought about by participation of acute or chronic exposure to physical exercise often with improving the exercise response. Acute exercise is a physiological stressor and this requires a major haemostatic adjustment in all major organs. The common differences in responses to chronic exercise among any group of individuals are dependent on several factors. These include species, age, body weight and composition, the muscles involved, physical condition, nutritional status, motivation, body position, exercise regime and the environment where the activity is undertaken (Astrand & Rodahl 1987; Wells 1991).

Aerobic exercise requires metabolic processes that utilise oxygen from inspired air which is delivered to exercising muscles by the cardiovascular system. It involves large muscle groups working in a steady rhythm such as walking, running and cycling. Anaerobic exercise utilises processes that do not primarily utilise oxygen from inspired air and are explosive type exercises of short duration such as weight lifting (Lamb 1987).

Observations have suggested that a complex interaction of many variables will determine individual attitudes and behaviour towards exercise. Consideration should be given to underlying motives for exercising besides the common and fully conscious reason to 'feel better' (Allied Dunbar National Fitness Survey 1992).

2.3.1 Physical and Health Benefits of Exercise

Regular physical activity has long been regarded as an important component of a healthy lifestyle (Pate, Pratt, Steven *et al* 1995). There is general agreement that exercise performed by healthy individuals of all ages has both physical and psychological benefits, including improved physical performance and enhanced quality of life (Bouchard, Shephard & Stephens 1994). Some of the most important benefits supported by a wealth of scientific evidence include increased stamina and reserve to cope with extra physical demands; maintenance of muscle strength, tone and joint flexibility; and management of body weight (ADNFS 1992).

There is belief that regular physical activity, resulting in physical fitness, has benefits for healthy individuals as well as implications for medical care of individuals with certain conditions and diseases (Bouchard *et al* 1994). These implications include a reduced risk of coronary heart disease; better control of blood pressure in cases of mild hypertension; prevention of osteoporosis; management of non-insulin dependent diabetes; reduced risk of obesity due to improved weight control; and alleviation of disabilities (ADNFS 1992; Bouchard *et al* 1994).

There have been suggestions that exercise may affect longevity or that a reversal of ageing may occur. A number of epidemiological studies have attempted to examine the long term effects of exercise on longevity. There is well documented evidence of the benefit of exercise training in relation to the normal age-related decline in peak

performance and maximal aerobic capacity, loss of muscle, bone mass, increase in body fat and modification or retardation of the ageing process (Astrand & Rodahl 1987).

Anecdotal evidence suggests that physical activity is particularly beneficial to women (Harris, 1981; Berger 1984). A recent review of available empirical evidence support the indications that exercise promotes improved physical and mental health in women (Choi & Mutrie 1996). In particular, recent reviews have suggested that physical activity may enhance bone density which could help protect women against osteoporosis (Gannon 1988; Marcus, Drinkwater, Dalsky *et al* 1992). Osteoporosis is the medical term for a condition in which there is a decrease in bone density rendering the skeleton susceptible to fractures. Women are more at risk of this condition than men due to the acceleration of bone loss as a result of cessation of ovarian function during and following the menopause. Findings from clinical trials suggest that appropriate weight-bearing activity may enhance bone density by 4% which is similar to the improvements noted from drug therapies (Simkin, Ayalon & Leichter 1987; Smith, Smith & Gilligan 1990).

The beneficial effects of exercise are likely to be multifactorial. Exercise is associated with lower body weight, a lower percentage of body fat, lower incidence of cigarette smoking, lower blood pressure and lower total cholesterol levels (Gibbons, Blair, Cooper *et al* 1983). Exercise affects the incidence of coronary heart disease by reducing the risk factors for the development of the disease although the mechanism for this affect remains unclear (Morris, Pollard, Everitt *et al* 1980; Berlin & Colditz 1990; Morris 1995).

Chronic adaptations in physiological function developed as a result of physical training, are generally believed to have benefits to the individual to the extent of influencing mortality and morbidity (Gibbons *et al* 1983; Blair, Kohl, Paffenbarger *et al* 1989). Despite well documented evidence of the benefits of exercise, there are detrimental effects such as cardiovascular accidents (CVA) and sudden death when exercise is undertaken by an unsuitable participant or carried out in an inappropriate environment.

Health promotion and disease prevention are of prime importance in reducing mortality and morbidity rates. The focus of health enhancement through physical activity is now widely proposed and achieving health through exercise and fitness has been central

to many contemporary health promotion programmes (Fahlberg & Fahlberg 1996). An increasingly active society is likely to have a major impact in reducing the economic and social costs caused by chronic ill-health or premature death and could improve the quality of life for millions of people (ADNFS 1992).

2.3.2 Psychological Benefits of Exercise

Exercise contributes to achieving optimal psychological health (ADNFS 1992) although the physiological basis for these effects remains unclear. Numerous affective benefits are associated with both acute and chronic physical activity (Brown & Harrison 1986; Roth & Holmes 1987).

Over the last two decades, research has demonstrated the positive effects and associations between physical activity and psychological well-being in both normal and clinical populations. These include positive mood, decreased levels of anxiety and depression (McCann & Holmes 1984), enhanced self esteem (Hughes 1984) and increased ability to cope with stress (Brown & Harrison 1986; Crews & Landers 1987; Stephens 1988; ADNFS 1992). A meta analysis of studies in this areas suggests that exercise either acts as a coping strategy or serves as an *'inoculator'* to enable individuals to more effectively respond to psychosocial stress and thus provides an efficient coping system for stress (Crews & Landers 1987).

Physical activity has been found to be positively associated with general well-being, lower levels of anxiety and depression and more positive mood (Stephens 1988; Crammer, Nieman & Lee 1991). Women have reported an improvement in coping abilities and reduced tension / anxiety levels after following a moderate exercise programme (Morgan 1979 & 1985; Steptoe, Moses & Mathews 1989; Moses, Steptoe, Mathews *et al* 1989). Other reported benefits of exercise programmes include: enhancement of mood (Roth & Holmes 1987), improved self-confidence, feelings of self satisfaction, achievement, self-sufficiency in the normal population (Brown & Harrison 1986).

Physical activity may help people to cope more effectively and reduce emotional reaction to stressful life events (Steptoe 1992). Steptoe, Edwards, Moses *et al* (1989) conducted a comparison of the psychological effects of a moderate aerobic training (n=24)

and an attention placebo strength and flexibility training programme in inactive anxious adults from the general population. They concluded that moderate exercise led to significant improvements in aerobic fitness and was associated with significantly greater reductions in tension -anxiety and depression than the attention - placebo condition together with increases in the perceived ability to cope with stress. They concluded that aerobic training had a favourable effect on psychological well-being, using the main psychological indicators of well-being of coping abilities, coping deficits and physical well-being. Loughlan (1995) used similar psychological indicators of well-being in his study where he compared the effectiveness of fitness assessment with exercise consultation in increasing physical activity in sedentary adults in a workplace setting. He demonstrated that giving appropriate information to carefully targeted sedentary employees who work in a supportive environment can help increase physical activity levels which can significantly improve coping deficits and contribute to improving coping abilities.

Self concept is the picture a person has of his / her self and physical self perception is the picture formed by the perceptions that a person has of his / her physical domain including perceptions of physical capacities as well as awareness of body image and attractiveness (Schilder 1950; Fox 1988; Fox & Corbin 1989). Self esteem is a personal judgement of one's own worth and physical self perception contributes to self esteem as a whole (Fox 1988).

In general, subjects who exercise report more positive subjective parameters than non exercising counterparts. Body image and perception of physical ability are highly correlated with measures of global self esteem (Sonstroem 1984). Reviews of findings from research studies indicate that exercise is associated with improvements in mental health. Many factors may be involved in this association but one causal link has not yet been established (Raglin 1990; Thirlaway & Benton 1996).

It can be concluded that women who exercise regularly are likely to be more comfortable with day to day physical exertion and have reduced anxiety and improved body image. It is generally thought that physical activity leads to improved quality of life (ADNFS 1992) despite subjective parameters being difficult to measure. Individuals who

are regularly active may be more likely to adopt other 'health lifestyle' behaviours (Jamieson & Flood 1993).

2.3.3 Psychological Benefits of Exercise During Pregnancy

Possible psychological benefits of exercise during pregnancy are important as women have to cope with anatomic and physiologic changes, physical discomforts lifestyle changes and other social factors (Rubin 1967; Raphael-Leff 1991; Clement 1998).

Many reports have investigated the proposed 'mental health' benefits of exercise with normal and clinical populations. Research has usually investigated the emotional and cognitive consequences resulting from involvement in an exercise regime, such as reductions in depression (McCann & Holmes 1984), anxiety (Steptoe *et al* 1989; Moses *et al* 1989; Roth & Holmes 1987; Morgan 1985) or elevations in self esteem and feelings of well-being. (Hughes 1984; Plummer & Koh 1987; Brown & Harrison 1986). However, there are only a few reported studies investigating the psychological effects of exercise during pregnancy.

Wallace, Boyer, Dan *et al* (1986) compared subjective responses to exercise in women participating in aerobic exercise during pregnancy (n=37) with a group of non exercising women (n=22). Women in the exercise group had participated in exercise for at least four weeks prior to data collection at 27 weeks of pregnancy. The groups did not differ significantly with respect to age, gestational age†, parity or weight gain during pregnancy. A physical discomfort checklist was specifically designed to measure the individual's perception of the frequency and intensity of minor symptoms occurring during pregnancy. Exercising subjects had scores which indicated higher self esteem than the control group. The exercising group had a significantly lower incidence of overall physical symptoms and of backache, shortness of breath, fatigue, headache and hot flushes. A significant inverse relationship was also observed between the overall incidence of physical symptoms and the total duration of exercise performed during the third trimester† of pregnancy. The researchers recognised that self selection of the subjects may have influenced the results.

Similar findings were reported by Hall & Kaufmann (1987) who carried out a large retrospective study to evaluate the effects of a combined programme of aerobic and strength conditioning exercises on self image, reductions in physical complaints and relief of tension in women after childbirth. Subjects were divided into either a control group (n=393), or high (n=82), medium (n=309) and low (n=61) intensity exercise groups based on attendance at supervised classes. Comfort was assessed from subjective reports by the subjects and included tension level, general physical discomfort, and sense of well-being. All exercise subjects reported improved self image, reduced tension and a decrease in physical discomforts during the time of participation. Multigravid† women reported a more rapid postpartum† recovery than previous pregnancies. Horns, Ratcliffe, Leggett *et al* (1996) conclude from their study, that women who engaged in active exercise during the third trimester† of pregnancy, experienced fewer of the common disorders of pregnancy.

Slavin, Lutter, Cushman *et al* (1988) conducted a retrospective (n=195) and prospective study (n=182) to investigate subjective responses to exercise during pregnancy. From their findings, they conclude that women perceived regular exercise during pregnancy enabled them to have control over their bodies at a time of profound bodily changes. The authors suggest that exercise continued during pregnancy is an aid to maintaining a positive self image for women and giving them the chance to relax.

More recently, Koniak-Griffin (1994) studied the effects of participation in an aerobic exercise programme over a six week period for adolescent pregnant females between 14 and 20 years of age. Subjects in the exercise group were observed to have a decrease in depressive symptoms over time and an increase in total self esteem. Significant differences were found between the exercise group when compared to a comparison group who also reported an increase in physical discomforts associated with pregnancy. The researchers suggest that exercise during pregnancy promotes psychological well-being.

Koltyn & Schultes (1997) studied a self selected group of women (n=20) who had delivered a baby within the past year. Mood changes in the postpartum† period were studied following exercise and quiet rest periods. Results indicated that 'state anxiety' and depression decreased significantly following exercise and quiet rest. Exercise was

associated with significant decreases in total mood disturbances as well as significant increases in vigour in the exercise women.

In summary, there is general agreement within the literature that exercise during pregnancy has a beneficial effect on psychological well-being of women. Benefits reported include improved feelings of 'well-being', reduced anxiety and tension, improved mood, increased self image and coping abilities. Literature in this area is limited and further research is needed to confirm these current findings.

2.3.4 Mechanisms proposed for Psychological Benefits

The majority of authorities currently agree that exercise reduces tension and improves mental health. However, a specific 'cause-and-effect' has not yet been identified and there remains uncertainty as to the mechanisms which can be attributed to the psychological benefits experienced by people who exercise.

The 'endorphin hypothesis' was first proposed in the 1970's and remains a popular hypothesis to explain affective benefits associated with exercise. This hypothesis focuses on the knowledge that various endorphins are produced by the brain, pituitary gland and other tissues and their action could be 'morphine like' in the sense that they have the ability to reduce the sense of pain and produce a state of euphoria or the much publicised 'exercise high' (Morgan 1985). However, it is unlikely that this hypothesis alone could provide the answer to all the complex neurobiological factors involved in mood alterations associated with exercise.

La Forge (1995) undertook a comprehensive review of the literature related to the most popular hypothetical neurobiologic mechanisms which underpin exercise-related mood alterations. He recognised that nearly all the hypotheses overlapped or shared some common neuroanatomic pathway. He concluded that the most likely explanation for exercise-induced affective changes evolved from an integration of brain neurotransmission processes involving principle neuroactive substances such as norepinephrine (NA), serotonin (5HT), endorphin, dopamine and enkephalin. He suggested that the likely mechanism responsible for mood changes, was the extraordinary influences of biological transactions, including genetic, environmental, and acute and adaptive neurobiologic

processes. He concluded that the final answers would emerge in the future due the combined action of researchers and theorists from exercise science, cognitive science and neurobiology.

2.4 Historical Overview of Exercise in Obstetrics

Since biblical times, it has been recognised that there is a possible relationship between maternal physical activity, pregnancy and birth outcome. Hebrew women whose lives were filled with active hard work tended to have easier and shorter labours than Egyptian women who lived a sedentary lifestyle (Exodus I, 19).

2.4.1 Fifteenth - Eighteenth Centuries

Obstetricians during the Tudor and Stuart times in England made similar observations with women from different social backgrounds. Childbirth was thought to be painful and dangerous for rich and respectable women but it was believed that the same pain and danger did not attend childbirth among women from lower orders (Eccles 1982).

One may speculate from these observations that those hard working women who had experienced easier and shorter labours had either delivered relatively small infants or had been predisposed to premature or precipitous labours†. Conversely those women living sedentary lifestyles may have delivered larger infants with the possibility of associated dystocia†.

The belief that rich, tender and beautiful women living a sedentary life had more difficult labours, compared to those of poor hard worked women, acquired a social cachet (Eccles 1982). This belief was desirable for the medical practitioners as it was essential that women of quality required assiduous attendance during their confinement. This was beneficial to the practitioners as they, no doubt, found it useful *'to increase their own importance, and hence their fees*' (Eccles 1982 p. 90).

The philosophy during the seventeenth and eighteenth centuries was to encourage women to exercise during pregnancy although this was within the lifestyle and social limitations of this period (Eccles 1982; Harvey 1950; Gelis 1991). English writers acknowledged advice in relation to physical activity to ensure good health during pregnancy and prevent miscarriage. Pregnant women were advised to take a sedan or a

litter as opposed to riding horseback or in a coach, and to avoid dressing their own hair to prevent straining the ligaments of the womb upwards. The best sort of exercise to undertake was walking in low heeled shoes and they could continue to exercise the arms by spinning or carding (Eccles 1982).

Barrett (1699) claimed that the correct ordering of the classical non-naturals, air, food, drink, exercise and rest, sleep and waking, fullness and emptiness and passion of the mind, would keep pregnant women in good frame for childbirth unlike the fine ladies who pampered themselves (cited in Eccles 1982 p. 61). Strangulation of the infant with the umbilical cord was a universal fear. It was advised that pregnant women should avoid any activity that involved circular movements such as unwinding skeins of wool or grinding coffee (Gelis 1991).

During the seventeenth century, many midwives and obstetricians advised women to increase the amount of exercise near the time of delivery although others disagreed. Mauriceau (1683) was strongly opposed to this increase in exercise as he thought it could predispose to the child turning sideways or into some other malposition and be a cause of hard labour[†] (cited in Eccles 1982 p.62). This was also the view taken by Louise Bourgeois, a renowned French midwife, who was one of the first women to write in obstetrics. She held the belief that exercise in the late stages of pregnancy would dilate the belly, drag down the womb and bruise the child's head against the mother's pelvis (Harvey 1950 p. 215).

Eighteenth century doctors were interested in the regulation in lifestyle of pregnant women and were free with advice and criticism (Gelis 1991). Alexander Hamilton, Professor of Midwifery of the University of Edinburgh, in the first edition of his *'Treatise of Midwifery'* published 1781 gave *'Rules and Caution for the Conduct of Pregnant Women'* which included the following recommendations,

" Women when pregnant should lead a regular and temperate life carefully avoiding whatever is observed to disagree with the stomach;.....their exercise should be moderate, and adapted to their particular situation; they should, especially in the early months when the connection between ovum and womb is feeble, avoid crowds, confinement, every situation which renders them under any disagreeable restriction; agitation of body from violent or improper exercise, as jolting in a carriage, riding on horseback, dancing and whatever disturbs either body or mind"(Munro Kerr, Johnstone & Phillips 1954 p.145).

James Lucas, Surgeon at Leeds General Infirmary, advocated *'an increase in exercise'* in a paper he read to the Medical Society of London in 1788. He proposed that exercise would reduce the size of the child and help overcome difficulty in labour† in the event of a woman having a contracted pelvis† (Munro Kerr *et al* 1954 p.145).

In France, it was customary for women to remain inactive during early pregnancy when the fetus's† hold on life was fragile. However, doctors were opposed to this inactivity continuing throughout pregnancy as they held the belief that exercise was necessary to nourish good health of the pregnant woman. They advised that walking was by far the best exercise for pregnant women while it was necessary *' to refrain from extremes either too much or too little'* in relation to dancing (Gelis 1991 p. 78).

2.4.2 Nineteenth Century

A relationship between physical activity, social class and the birthweight† of infants was recognised and acknowledged during the nineteenth century. Published scientific studies demonstrated that women from lower social classes gave birth to lighter babies than their counterparts from higher social classes (Pinard 1985). Letourner (1986) concluded that strong 'robust' women engaged in strenuous physical work delivered lower birthweight† babies than lighter women involved in less demanding work (cited in Artal Mittlemark & Gardin 1991 p.2).

The nineteenth century was also a period of paradox in terms of women and their bodies. Social etiquette during the Victorian age was deemed to be of prime importance for middle and upper class women. Women, of this status, strove for the ideal status symbol of *'true womanhood'* which was represented in the passive, weak, frail and delicate female. This indolent, inactive lifestyle was in contrast to that of the lower class

women who relied on their body for survival and who viewed physical strength and endurance as a valued commodity for survival (Lutter 1994).

This era was also dominated by patronising attitudes towards pregnancy which were initiated and perpetuated by a patriarchal society. These attitudes towards the physical capabilities of women had a long-lasting impact upon the lifestyle and outlook of middle class women. The pregnant well bred lady of this era had to be reticent and was advised to rest and undertake the minimal physical activity possible. They avoided social company during pregnancy because of the adverse effect they might create (Blankfield 1967).

Many obstetricians continued to realise the importance of exercise in the antenatal period. Thomas Bull (1837), in one of the first books solely devoted to antenatal care, advised that physical activity and the need for outdoor air were prerequisites for a healthy pregnancy. Ballantyne (1903) also advocated that antenatal exercises and training in relaxation techniques would benefit pregnant women during their labour† (cited in Munro Kerr *et al* 1954 p.146). The concept that women of lower social classes had far easier labours compared with their rich counterparts was attributed to differences in levels of physical activity (Munro Kerr *et al* 1954). This idea was developed to such an extent that uterine inertia was subsequently attributed to lack of exercise (Haultain & Fahmy 1929).

On these grounds, pregnant women were recommended to walk outdoors in moderation and partake in gentle forms of exercises which included croquet, bathing, swimming, golf and ballroom dancing. They were also advised to avoid horse riding, and violent and sudden forms of activity which were deemed particularly harmful to pregnancy (Munro Kerr *et al* 1954).

2.4.3 Twentieth Century (1900-1960))

During the first few decades of the twentieth century, Fairbairn (1926) advocated that *'natural childbirth'* could be achieved through antenatal / relaxation exercises. He was the first to propose that some form of physical preparation could benefit women during pregnancy to prepare for childbirth. Specialised exercise programmes to prepare women for childbirth were first introduced during the late 1920's and early 1930's. This

'preventative outlook' for childbirth was one of the most progressive features of obstetrics during this era (Munro Kerr *et al* 1954).

It was now generally believed that women could be physically prepared to undertake the muscular feat of labour which may possibly be the greatest feat that many woman would ever undertake. Dick-Read (1933), Randell (1939) and Morris (1936) were English pioneers in the field of antenatal education who were influenced by this concept and advocated antenatal preparation for childbirth. The importance of the psychological benefits gained by exercise was subsequently recognised within contemporary programmes (Munro Kerr *et al* 1954).

During the 1930's, Dick-Read developed and introduced specific breathing and exercises to physically prepare women antenatally for labour†. He felt that labour† was not necessarily an inherently painful process but that the pain experienced during labour arose from socially induced expectations about pain. The physically based programme aimed to improve health, muscle tone, a *'sense of well-being'* as well as decreasing the pain of childbirth (Dick-Read 1933). Initially, Read's teachings were practised and more widely accepted abroad, particularly in the United States of America, than in Britain (Munro Kerr *et al* 1954 p.156).

Morris (1936) and Randell (1939) were largely responsible for the development of antenatal and postnatal† exercise programmes. Morris (1936) in collaboration with Randell devised an exercise programme to enhance therapeutic benefits of exercise during and following pregnancy.

Randell (1939) recommended squatting and lunging exercises during pregnancy to widen the pubic arch and shorten the anterior wall of the birth canal to aid the delivery process. Vaughan (1942) held the view that flexible joints were an essential factor for an easy labour†. She believed that women should adopt a squatting position during labour† to encourage the pelvic joints to open out and allow an easier passage for delivery of the baby through the birth canal. Women were encouraged to adopt tailor-sitting positions and also perform pelvic floor exercises to increase elasticity and tonicity of the perineum and

prevent perineal trauma. These practices continued despite being subsequently proven not to enlarge the pelvis and also to be a potential source of injury to women (Young 1940).

Vaughan (1951) suggested that women who exercised regularly were likely to have an easier confinement than sedentary woman. She associated a sedentary lifestyle with difficulty in childbirth due to stunted growth and development of the pelvis. She also advocated that all women should undertake specialised exercise programmes in a group situation as part of their physical preparation for labour† and delivery (cited in Munro Kerr *et al* 1954).

Another pioneer of modern childbirth preparation was Lamaze who introduced the psycho-prophylactic method of painless childbirth to the western world during the 1950's. This *'Lamaze Method'* did not place any direct emphasis on exercise to prepare women psychologically but did include exercises within the programme to physically prepare women for childbirth (Lamaze 1958).

Heardman (1959) advocated that physical training for childbirth promoted good health, poise, good posture and good body mechanics during and following pregnancy. She had previously recommended the use of pelvic tilting and rocking during pregnancy and labour† as these were considered to be invaluable exercises in the relief of low back strain (Heardman 1951).

The importance of antenatal education and exercise in relation to the psychological and physical preparation of women for labour and childbirth was now widely accepted by obstetricians. This acceptance resulted in the initiation of antenatal classes which were established on a large scale. The content of the classes mainly included relaxation and breathing exercises with some gentle physical exercise to tone limbs and strengthen abdominal muscles (Munro Kerr *et al* 1954). Advice pertaining to exercise was a common feature offered during antenatal care (Stern & Burnett 1958 p.48). Physical and psychological preparation of women for pregnancy and childbirth remains an important component in modern day midwifery practice.

2.5 Scientific Investigations of Exercise during Pregnancy

The response to exercise is determined by a number of psychological and physiological factors. Regular physical activity has become an integral part of life for many women and the fundamental concern is to what extent responses to exercise during pregnancy differ from those in the non pregnant state.

Over the last three decades, a wealth of research evidence has emerged in terms of the physiological response to exercise during pregnancy. Scientific advances in technology have allowed sophisticated assessment of maternal and fetal responses to exercise conditions. However, to date, the most reliable physiological data are derived from animal studies which continue to be of great value in understanding the physiology and regulation of pregnancy, and the fundamental biology of the interaction between pregnancy and exercise.

The strengths and limitations of the various animal models for studying different aspects of the interaction must be recognised if information with potential human relevance is to be obtained. The strengths of animal models lie in the experimental design which allows control over multiple confounding factors as well as the ability to directly control and measure the independent and dependent variables associated with an intervention. Animal studies allow a more invasive approach from which correlations in structure and function can be readily obtained. However, important differences in animal physiology and behaviour suggest that results of such studies may be of limited applicability to humans. Physiological findings from animal studies need to be considered as the performance of such exercise studies in humans present both ethical and legal problems.

A detailed review of scientific investigations over the last thirty years is presented in this section of the literature review. Anecdotal information and research evidence from both human and animal studies relevant to the physiological and psychological effects of exercise during pregnancy is discussed. Gaps in the existing literature are highlighted and an overview of the aims of the current study are presented.

2.5.1 Maternal Physiological Considerations

Pregnancy is known to have a major impact on the circulatory system. The blood volume is increased, blood pressure may either increase or decrease, and there are significant changes in both resting and exercise heart rate (Gorski 1985, de Swiet 1991a). There is concern that significant cardiovascular changes induced by exercise may have potential adverse effects on the fetus† due to the selective redistribution of blood flow to the working muscles away from the splanchnic organs. In the normal healthy pregnant woman, such occurrences should be only rarely encountered during mild and moderate exercise, but they are more likely to occur during strenuous and prolonged exercise (Artal Mittlemark *et al* 1991a).

In one of the earliest studies in this area, Ueland *et al* (1969) recorded cardiovascular responses during pregnancy at rest, during and following light and moderate exercise performed on a bicycle ergometer. Cardiac output, heart rate, stroke volume and arterial blood pressure were measured by insertion of a catheter into the brachial artery and antecubital vein. Cardiac output increased to peak values between 20 and 24 weeks gestation and remained elevated until term†. Heart rate increased throughout pregnancy with stroke volume decreasing progressively from 20 weeks gestation†. The increase in cardiac output with light work was comparable with the increase found in non pregnant women. However, the increase in cardiac output during moderate work became progressively smaller with advancing pregnancy. The investigators concluded that the increase in cardiac output with exercise was well within normal limits for non pregnant women.

Similar findings were reported by Guzman & Caplan (1970) who studied the cardiovascular response of pregnant women to monthly bicycle tests from early pregnancy until 3 months after delivery. The increase in cardiovascular response to exercise per unit of aerobic capacity† ($V0_2$) at all stages of pregnancy was found to be similar to the post pregnancy levels.

More recently, Pivarnik, Ayres, Mauer *et al* (1993) found that physically fit women (n=10) who continued to exercise during pregnancy had an enhanced and maintained cardiopulmonary response to exercise compared to sedentary women. Pivarnik *et al*

(1994) concluded from a small study that physically active women (n=9) had significantly greater vascular volumes than their sedentary counterparts (n=6). These increased volumes were maintained throughout pregnancy with continued exercise.

The individual's capacity for exercise is limited by the combined ability of the cardiovascular and respiratory systems to meet the increased demands of the muscles. During pregnancy, oxygen consumption measured at rest increases with advancing gestation† to a maximum level of between 15 and 20% above the normal level at term† (Lotgering, Gilbert & Longo 1985; Lotgering 1988). The major increase in resting oxygen consumption occurs during the second half of pregnancy and is due to the rapidly growing fetus†, enlarging placenta† and uterus (Hytten & Chamberlain 1991).

Many women, especially those who are involved in competitive or endurance activities, are keen to continue exercising throughout pregnancy (Hale & Artal Mittlemark 1991). There is now growing concern that the pressures to exercise and the competitive spirit that challenges some women may result in some placing performance goals above safety by striving to improve or maintain training levels (Hale & Artal Mittlemark 1991). Therefore, scientific research has focused on what extent, if any, exercise undertaken during pregnancy can improve physical fitness and elicit a training effect.

One of the best measures of physical fitness is the non invasive measurement of maximal oxygen consumption† (VO_{2max}) which is a measure of cardiovascular endurance. This includes a circulatory component to oxygen uptake (oxygen delivery) and an extraction component (oxygen utilisation). Maximal oxygen consumption† (VO_{2max}) is defined as the maximal rate at which oxygen can be utilised by the cells in the body (Lamb 1987). In many instances, it is not advisable for subjects to perform at maximal exercise and therefore submaximal exercise tests give some indication of exercise tolerance.

Varying reports in the literature suggest that aerobic capacity† or oxygen consumption is either not affected by exercise during pregnancy (Guzman & Caplan 1970), or increased during pregnancy (Collings, Curet & Mullin 1983). Other authors suggest that aerobic capacity† or oxygen consumption is increased during pregnancy but does not remain elevated following delivery (Knuttgen & Emerson 1974; Pernoll *et al* 1975) or continues

to remain elevated in the postpartum† period (Pivarnik *et al* 1991; Clapp & Capeless 1991b). These reported studies are based on varying methodologies.

Guzman & Caplan (1970) reported that oxygen uptake (VO_2) was unchanged in women (n=8) who performed monthly bicycle tests at three different workloads from the first trimester† of pregnancy until 3 months following delivery.

Knuttgen and Emerson (1974) investigated women (n=13) who participated in graded moderate - strenuous exercise performed on treadmill and bicycle ergometer during the second and third trimesters† of pregnancy and up to six weeks postpartum†. Testing was carried out at four weekly intervals and compared with a control group of non pregnant subjects (n=3). No variation was found in the oxygen consumption of subjects in the control group. The exercise group had an increased oxygen consumption in pregnancy during treadmill exercise but was not increased during ergometer cycling. The increase in VO_2 (13%) compared closely to the increase (15%) in body weight. Little difference was noted in VO_2 levels when the same subjects were tested in the postpartum† period. A limitation to this study was recognised to be the analysis of an average of oxygen values during pregnancy as opposed to serial oxygen values.

Another study, of light bicycle work at monthly intervals during and following pregnancy, produced slightly different results (Pernoll *et al* 1975). They reported that oxygen consumption was significantly higher during late pregnancy than following pregnancy at the same relative workloads.

The evaluation of 'functional aerobic capacity†' best describes the individual's capacity to meet and sustain daily weight-bearing activities while 'absolute aerobic capacity†' is a measure of the individual's maximal cardiopulmonary capacity and maximal energy output by aerobic processes.

Pivarnik *et al* (1991) found that oxygen consumption was higher from the beginning of the third trimester of pregnancy and remained elevated following delivery in previously sedentary women (n=16) who exercised during pregnancy from 13 weeks gestation† onwards. Women exercised on the bicycle ergometer and treadmill and testing was carried out at four weekly intervals until three months postpartum†. Functional aerobic capacity†

(V_{O_2} ml /kg/ min) during treadmill exercise was unchanged throughout pregnancy and the postpartum† period. Absolute aerobic capacity† (V_{O_2} ml/min) was found to increase from 25 weeks gestation† onwards when exercise was carried out on the bicycle ergometer. These findings suggest that the bicycle ergometer is not a true non weight-bearing exercise. Postural problems may have been implicated while cycling and leg oedema may have possibly increased weight of lower limbs or interfered with mechanical efficiency. Heart rate and Rated Perceived Exertion† (RPE), as measured with the Borg scale, remained constant during gestation† and reduced in the postpartum† period.

In a study by Collings *et al* (1983), women (n=20) assigned to an aerobic exercise programme (n=8) and a non exercising control group (n=12), were studied during the second and third trimesters† of pregnancy. Baseline recordings of aerobic capacity† were obtained and individual exercise programmes designed. Tests of aerobic capacity† were carried out in the second and third trimesters† of pregnancy. Aerobic capacity† was evaluated in both absolute† (l /min) and functional† (ml/kg of body weight/min) terms to determine the effect of pregnancy weight gain. An improvement of 18% in absolute aerobic capacity† was found in the exercising group with a corresponding decrease of 4% in the control group. Despite increasing body weight, an 8% increase in functional aerobic capacity† was found in exercising subjects compared with a 10 % decrease in functional aerobic capacity† in non exercising women.

South-Paul, Rajagopal & Tenholder (1988) reported a similar increase in physical fitness although findings were statistically non significant. They studied measurements of aerobic capacity ($V0_{2max}$) in healthy pregnant women at 20 and 30 weeks gestation† using a bicycle ergometer. Women, randomly assigned to either a non exercising group (n=10) or an exercise group (n=7), trained for one hour / four times per week under supervision. The exercise group demonstrated greater improvement in aerobic capacity† than did the control group.

Clapp & Capeless (1991b) investigated whether women (n=40) could elicit a training effect during pregnancy. Healthy well conditioned women (n=20) participating in recreational exercise were studied for aerobic capacity† before conception. Non pregnant

women (n=20) acted as control subjects. After conception, women continued with their moderate-high exercise regime and were tested again during and following pregnancy. Non pregnant subjects remained unchanged in aerobic capacity† while pregnant subjects significantly increased aerobic capacity† during pregnancy. Following delivery, aerobic capacity† remained elevated between 12 and 20 weeks and was maintained at 38 weeks postpartum†. Researchers concluded that a significant training effect may be possible when healthy recreational exercisers maintained a moderate-high exercise regime during pregnancy.

Kramer (1996) carried out a systematic review of research studies in this area. He concluded that regular aerobic exercise during pregnancy appeared to improve or maintain physical fitness. This was consistent with data from studies of the training effect in men and non pregnant women which showed improvements of between 15% and 25% in functional aerobic capacity† (Astrand & Rodahl 1987). These findings suggest that pregnant women may be as trainable as their non pregnant counterparts.

Ohtake & Wolfe (1998) compared the ventilatory effects of healthy women (n=27) who exercised on a bicycle ergometer with a control group of healthy women (n=20) during the second and third trimesters† of pregnancy. Their findings supported the hypothesis that, in late gestation†, physical conditioning reduces both ventilatory demand and respiratory perception of effort.

The endocrine effects of pregnancy cause striking changes in maternal metabolism, cardiovascular regulation, acid-base balance, and thermoregulation at rest and standard submaximal exercise. The apparent purpose of these changes is to accommodate fetal† needs in addition to those of the exercising woman. When the stress of strenuous physical activity is superimposed upon that of pregnancy, the metabolic demands of the gravid† uterus may come in conflict with those of the exercising muscles. This may result in reduced exercise performance of the woman or adverse effects on the fetus†.

Artal, Platt, Sperling *et al* (1981) studied maternal responses in healthy pregnant women (n=23) before, during and after 15 minutes of walking exercise on a treadmill in the third trimester† of pregnancy. Subjects had never undertaken any athletic training. A

transient but reversible increase in both catecholamines and glucagon levels following mild exercise was recorded. In contrast, the insulin concentration did not change significantly. Since blood samples were not collected during exercise, it was not known whether this response was quantitatively different from that in non pregnant women.

Similar findings in the levels of glucagon and insulin were reported in a study undertaken by Javonic, Kessler & Peterson (1988). They reported increased levels of catecholamines following mild exercise, with norepinephrine being four times greater than that of epinephrine. Clapp & Capeless (1991a) obtained serial data from exercising women (n=75) before, during and following pregnancy. Findings supported the hypothesis that pregnancy reversed the non pregnant hyperglycaemic response to sustained exercise. Mild irregular contractions reported by four pregnant subjects during the exercise subsided within the initial recovery period.

The most serious argument against the intensity of activity during pregnancy remains the concern in relation to the increase in body temperature which is recognised as a normal response to physical activity (Astrand & Rodahl 1987). Maternal hyperthermia and redistribution of blood to the working muscles and skin for thermoregulation may have an adverse effect on the development of the fetus† (Huch & Erkkola 1990).

There is currently limited knowledge concerning fetal† adaptability to thermal stress and to increased maternal heat production during exercise. It has been assumed that the woman's capacity for heat elimination during pregnancy is lowered due to considerable vasodilatation in the skin (de Swiet 1991a). One possible explanation offered is that relatively lower work intensity of work performance achieved by pregnant women is not sufficient to induce significant increases in body temperature. In addition, it is postulated that changes in efficiency of heat dissipation related to alterations in regional blood flow during pregnancy enhances maternal cooling ability (Clapp, Wesley & Sleamaker 1987).

Clapp (1991) studied recreational women (n=18) who exercised before, during and following pregnancy to test the hypothesis that the thermal response to endurance exercise was altered by the thermal adaptation to pregnancy. From the findings, he suggests that

maternal physiological adaptation to pregnancy results in a marked reduction in the 'exercise - associated' thermal stress for the embryo and fetus†.

McMurray, Katz, Meyer-Goodwin *et al* (1993) studied women (n=7) at 25 weeks gestation† for twenty minutes on a bicycle ergometer at 70% maximum heart rate and then in water (30^0c) to compare thermoregulation response. Their findings conclude that land exercise causes greater heat storage and sweat loss in pregnant women.

In contrast, Jones, Botti, Anderson *et al* (1985) investigated the effects of increased temperatures resulting from an exercise study of women (n=33) who ran three or more miles four times per week. Core, vaginal and skin temperature were recorded before, during and after a twenty minute treadmill run at 12, 24 and 32 weeks gestation† and 10 weeks postpartum†. The mean resting skin temperature increased throughout pregnancy but the maternal core and vaginal temperature remained unchanged. All subjects gave birth to healthy full term† infants with normal neonatal† physical examination including the neurological examination.

The increase in maternal blood volume (40 %) occurring during pregnancy appears to help transfer heat away from the fetus†. Therefore, decreased uterine bloodflow or placental† bloodflow coupled with elevated internal maternal temperature might result in fetal† hyperthermia. However, studies have shown that normal healthy pregnant women are able to maintain thermal balance and heat stress should not be a concern for pregnant women undertaking moderate exercise.

Current guidelines for exercise during pregnancy recommend 38^0c for brief temperature elevation during exercise (American College of Obstetricians & Gynecologist 1994) whereas 38.5^0c has been considered to be a more realistic temperature (Clapp 1991). There are no reported exercise-induced adverse effects on the fetus† found within the literature.

In summary, numerous studies have investigated maternal adaptations to exercise during pregnancy. Studies suggest that exercise undertaken during pregnancy may improve or maintain physical fitness. Hyperthermia experienced by women during pregnancy is a particular area of concern as this may have an adverse effect on fetal

development and growth. However, studies suggest that thermoregulation is maintained by women undertaking moderate exercise. Further research is needed in this area to investigate maternal physiological effects during high intensity levels of exercise and prolonged episodes of moderate exercise.

2.5.2 Fetal Considerations

The fetus† requires a continuous and adequate supply of oxygen and nutrients for its metabolism and growth. Severe, acute interference with fetal supply is likely to cause hypoxic† damage, while milder more chronic reductions may result in suboptimal growth. Fetal† heart rate (FHR) and oxygen consumption are physiological variables which may only represent temporary adjustments. Therefore, these factors provide limited information as to whether fetal† tolerance is exceeded and as to when irreversible damage may have occurred.

Uterine blood flow may be compromised during exercise and this remains a controversial issue when comparing animal and human studies. Several lines of evidence, based on animal studies, suggest that the fetus† may experience transient hypoxia† during maternal aerobic exercise as a result of redistribution of blood from the viscera to the working muscles. Clapp (1980) reported no appreciable changes in uterine blood flow in pregnant ewes not exercised to exhaustion on a treadmill in contrast to a decrease (28%) in uterine blood flow in pregnant ewes exercised to exhaustion. The fetuses† showed signs of compromise due to reduced uterine blood flow, although this reduction was tolerated well.

The investigations of Lotgering, Gilbert & Longo (1983) found that uterine blood flow in sheep was reduced by up to 25% when exercise was both prolonged and strenuous. Their data, obtained using electromagnetic flow probes, suggest that the degree of uterine vasoconstriction is proportional to both the intensity and duration of the exercise. Reduced uterine perfusion may be due to compensated haemoconcentration resulting from the loss of circulating blood volume to the exercising muscles and by augmented uterine arteriovenous oxygen extraction. Findings suggest that the reduction in uterine blood flow in sheep was adequately compensated by various mechanisms to maintain uterine oxygen uptake (Lotgering *et al* 1983, 1984, & 1985).

The fetus† may be capable of responding to theoretical challenges of exercise induced hypoxaemia by extracting amounts of oxygen adequate to support its metabolic needs (Lotgering 1988). However, the extent of this physiological reserve is not known and the applicability of these findings to exercising pregnant women remains unclear.

Measurement of heart rate provides a valuable tool in assessing fetal† well-being. Typical changes in FHR are known to reflect hypoxic† and non hypoxic stress, hypoxia† or asphyxia† and sympathetic and parasympathetic activity. The human FHR response to maternal exercise has been studied repeatedly since it was introduced as a clinical test for 'uteroplacental insufficiency' by Hon & Wohlgemuth (1961). Monitoring of FHR is a non invasive ultrasound† technique used in clinical obstetrics to detect 'fetal distress' and to predict outcome of the fetus. Severe bradycardia† (FHR less than 100 bpm), tachycardia† (FHR greater than 160 bpm), loss of variability† (bandwidth less than 5 bpm) and the presence of 'late' decelerations† (occurring outwith a contraction) are empirically associated with fetal† distress and poor fetal† outcome. Positive indications of fetal† well-being and outcome are suggested by good variability† and accelerations in FHR (Sweet & Tiran 1997).

A number of studies reported the findings on measurements of FHR response and fetal breathing movements in pregnant women before, during and following exercise. All findings suggest that, although there was some kind of fetal† response to exercise, it remains unclear whether the fetus† experiences hypoxic† stress. It is often technically difficult to assess blood flow and changes during exercise, therefore interpretation of results made after exercise should be treated with caution. It is possible that uterine blood flow might very rapidly return to, or above, the pre-exercise level.

An increase in FHR is a normal response to maternal exercise. A number of studies demonstrate the FHR response to maternal aerobic exercise involves a gradual increase in FHR between 10 and 20 beats per minute (bpm) during exercise and returns to pre-exercise baselines within 20 minutes following the exercise (Dressendorfer & Goodlin 1980; Hauth, Gilstrap & Widmer 1982; Collings *et al* 1983; Collings & Curet 1985; Carpenter, Sady, Hoegsberg *et al* 1988; Wolfe, Hall, Webb *et al* 1989b).

Hauth *et al* (1982) did not observe any episodes of fetal† bradycardia† during maternal exercise on regularly active healthy women (n=7). They investigated the consequences of maternal jogging on fetal† status using a non stress test before and after jogging. A reactive non-stress test was defined as two FHR accelerations of at least 10 bpm in association with fetal† movement during a 20 minute period of observation of the mother at rest. This non-stress test was generally considered as an indication of fetal† well-being. FHR was noted to have increased after jogging on every occasion. A reactive nonstress test was noted on all testing occasions. Fetal heart rate (FHR) was not monitored during jogging sessions and it was possible that an existing fetal bradycardia† was undetected.

Carpenter *et al* (1988) conclude from their study (n=45) that the average fetal† heart rate does not change during exercise. One episode of fetal bradycardia† was noted during submaximal maternal exertion. This observation was in contrast to fetal bradycardia† commonly reported following maximal exertion. Similar results from a case study of a professional athlete were presented by Bung *et al* (1991). No changes in FHR were observed following submaximal maternal exercise but fetal bradycardia† was recorded during strenuous exercise.

Under most conditions, the human FHR directly reflects fetal† cardiac output. The Frank Starling mechanism, which regulates cardiac output, is not well developed in the fetus†. However, more recent studies of FHR response support the hypothesis that some fetuses† may experience hypoxia† during or following maternal aerobic exercise. Results of investigations suggest the presence of episodes of fetal bradycardia† during and following maternal exercise (Dale, Mullinax & Bryan 1982; Javonic *et al* 1988; Watson, Katz, Hackney *et al* 1991; Manders, Sonder, Mulder *et al* 1997). Fetal bradycardia† has the potential to adversely effect the fetus† if it was sustained during exercise or if there was a delay after exercise in the recovery of FHR to pre exercise levels.

Dale *et al* (1982) reported a transient fetal bradycardia† of approximately three minutes duration during short term moderately stressful jogging on a treadmill which returned to normal levels following the exercise. These findings suggest that exercise stimulus does not seriously compromise uteroplacental function.

Javonic *et al* (1988) studied FHR and fetal movement before during and following mild-moderate exercise on a bicycle ergometer. Healthy women (n=6) who had regularly exercised during pregnancy were selected for testing during the third trimester† of pregnancy. Exercise was graded to reach the individual woman's exercise regime. Mild to moderate exercise was associated with a decrease in FHR within 30 to 60 seconds of exercise which then persisted for the duration of exercise and returned to normal after one minute in the recovery period. During the exercise, FHR accelerations were not accompanied with corresponding fetal movement but fetal movement did accompany accelerations in FHR within one minute of recovery. This level of maternal exercise was not deemed harmful to the fetus† due to the immediate recovery of FHR observed following exercise.

Similar evidence of transient fetal bradycardia† was noted in a study undertaken by Watson *et al* (1991). They found that fetal bradycardia† occurred in 15% of subjects following vigorous exercise during 20 minutes bicycle ergometry and tethered swimming in healthy untrained subjects (n=15) at 25 and 35 weeks gestation†. A total of four trials were undertaken by each subject. Exercise was graded on the bicycle ergometer and resistance was provided to grade exercise while swimming. FHR was recorded, before exercise and intermittently for 20 minutes following exercise. Six episodes of transient fetal bradycardia† were noted. Findings from this study extend the observation of fetal bradycardia† to exercise undertaken in the water. All women delivered healthy infants at term†.

In contrast to the findings above, Manders *et al* (1997) conclude that moderate to heavy exercise clearly affects the human fetus† with signs of transient fetal† impairment after heavy exercise. This conclusion was based on findings from a study of women (n=12) who performed submaximal exercise testing around 30 weeks gestation†. Fetal heart rate (FHR) was monitored before and following exercise and compared with non exercise FHR recordings. An increase in FHR was observed after exercise with variations in FHR being reduced when compared with control levels. Fetal bradycardia† was observed in two women for 20 minutes following exercise.

In summary, evidence based on animal and human studies, suggest that the fetus may experience transient hypoxia during maternal exercise. There is concern that this may have adverse effects on the fetus. Numerous studies have documented fetal physiological response especially in FHR response to maternal exercise. Findings suggest that FHR changes during maternal exercise are transient and do not interfere with normal fetal development and growth. Since a reduction in FHR is assumed to reflect fetal† distress, it is advisable that further more detailed study is carried out in this field.

2.5.3 Clinical Outcome

There has been growing concern that physical activity undertaken during pregnancy may have harmful effects on the growing fetus† or result in pregnancy loss or preterm† labour. High levels of circulating norepinephrine have been noted during exercise (Gorski 1985). Theoretically this may stimulate uterine contractions and result in preterm† labour (Zuspan, Cibils & Pose 1962). Preterm† delivery occurs before 37th completed weeks of the 40 week gestation† period and may compromise the well-being of the newborn (Sweet & Tiran 1997).

A number of studies conclude that physical activity during pregnancy does not influence the incidence of preterm† labour (Pomerance, Gluck & Lynch 1974; Veille, Hohimer, Burry *et al* 1985; Clapp 1989 & 1990; and Botkin & Driscoll 1991).

Veille *et al* (1985) reported that exercise did not increase post exercise uterine activity during the last 8 weeks of pregnancy. Clapp (1989) compared early pregnancy outcomes of physically fit, active pregnant women who continued aerobic exercise (n=90) with a control group (n=29) who were intermittently active. He concludes that exercise, maintained at a high intensity level during the period of conception and early pregnancy, does not appear to alter early pregnancy outcomes. Evidence from a similar study concludes that exercise does not trigger preterm† labour in healthy women (n=87) who regularly exercised during pregnancy (Clapp 1990).

A previous retrospective study reported that exercise during pregnancy was not associated with preterm† delivery among Olympic athletes (Zaharieva 1972) and more

recently a case study of an elite athlete during pregnancy supported these findings (Bung, Huch & Huch 1991).

In contrast, Clapp & Dickstein (1984) carried out a prospective study of pregnant women who participated in exercise or were sedentary. They reported that women (n=29) who continued to exercise after 28 weeks had significantly shorter gestation† than either those women (n=47) who had ceased exercise before 28 weeks gestation† or sedentary women (n=149).

Mayberry, Smith & Gill (1992) evaluated the short term effects of exercise on uterine activity in women (n=10) who were classified as being at 'high risk' of preterm† labour. Results indicated that there were minimal changes in the frequency of uterine contractions following a protocol of conditioning exercises. They recommended that future research was needed to evaluate short and long term effects of exercise on high risk pregnancies.

In general, the available data suggests that there are no important effects of exercise on shortening of gestation† which should be reassuring to healthy women who wish to exercise during pregnancy.

Misra, Stobino, Stashinko *et al* (1998) conducted a study on a cohort of low income women to determine the effect of physical activity on the risk of preterm† birth. Current recommendations regarding leisure time and daily living activities were supported by the findings. However the two activities of climbing stairs and walking appeared to increase the risk of preterm† delivery among low income women. Similar findings were reported by Hedegaard, Secher & Wilcox (1995); Grisso, Main, Chiu *et al* (1992); Klebanoff, Shiono & Carey (1990) and Homer, Beresford, James *et al* (1990).

Findings from a prospective cohort of women (n=4259) suggest that standing and walking at work during the second trimester† of pregnancy may present a particular risk for preterm† delivery (Hedegaard *et al* 1995). In a small study, physical activities such as prolonged standing, heavy lifting, or structured exercise did not appear to affect uterine contraction rates in a cohort (n=81) of low risk pregnant women using continuous ambulatory cardiotocography† for 72 hours three times during pregnancy. Although

walking and climbing stairs did show a significant and persistent effect on uterine activity during the third trimester† of pregnancy (Grisso *et al* 1992).

Klebanoff *et al* (1990) studied a cohort of pregnant women (n=7101) prospectively to evaluate employment and non employment related physical activity. They reported an association between prolonged periods of standing with a modestly increased risk of preterm† delivery. No association was found between heavy work or exercise and preterm† delivery. However, Homer *et al* (1990) concludes that women, who undertook jobs characterised by high levels of physical exertion, experienced a higher rate of preterm† labour and low birthweight† (less than 2.5 kg) babies. Work-related high physical exertion may be deleterious to pregnancy due to the blood supply to the uterus may be halved and increased twenty fold to leg muscles (Chamberlain 1991).

In general, exercise during pregnancy has promoted the belief that physical fitness will ease labour† and delivery. Many women hope that physical activity will enable them to cope more efficiently with the exhausting early days of motherhood. The facilitation of labour† as a result of physical conditioning would be a logical expectation due to both an enhanced maternal working capacity and improved function of specific muscles employed in the active stage of labour†. However, labour† is a very complex process and many factors such as parity, maternal age, fetal† size and position and the use of analgesic medications could alter the course of labour.

Recent research has focused on clinical issues related to the outcome of labour† and delivery. Existing studies have used the duration of the stages of labour† as an indication of the difficulty of labour† and the Apgar† score for assessment of the newborn. Labour† involves three stages: the first stage is passive and begins from the onset of regular, rhythmic, uterine contractions until full dilatation of the cervix, the second stage is defined from full dilatation of the cervix until delivery of the baby and third stage occurs from delivery of the baby until expulsion of the placenta† and membranes (Sweet & Tiran 1997). Apgar† score is a traditional way of assessing the newborn. It is a numerical score devised by Dr Virginia Apgar (1953) and grades five clinical features of the infant at one, five and ten minutes following birth (cited in Robertson 1993). Higher scores indicate a

positive outcome for the newborn to adapt to extra uterine life while lower scores indicate poorer outcome with potential problems of varying degrees.

Botkin & Driscoll (1991) suggests that maternal aerobic exercise may affect the experience of labour† for the mother and fetus†. They carried out a retrospective study with women (n=44) who had given birth in the preceding seven months. The women were grouped into a non exercise or exercise group according to their exercise history. Women in the exercise group experienced a significantly shorter time in the active second stage of labour† when compared to the control group. A reduction in the incidence of obstetric complications was reported in the exercise group. No difference was noted between the groups in terms of birthweight†, Apgar† scores and length of the babies. It is difficult to draw conclusions from these findings due to the small sample size used in this study.

Similar findings were reported by Kupla, White & Visscher (1987) who studied healthy women (n=85) during pregnancy. Women were allocated to either a control group (n=47) or an exercise group (n=38) who participated in an individualised aerobic exercise programme. Primigravid† subjects were reported to have a significant shorter active stage of labour† than primigravid† control subjects. However, results did not differ significantly between exercising and sedentary multigravid† subjects. No difference was noted between the two groups in terms of Apgar† score, birthweight†, or in the incidence of obstetric complications or fetal† distress. Again, the small sample size within this study makes it difficult to draw conclusions from these findings.

A number of studies tend to support the safety of aerobic exercise during a healthy pregnancy. These include the studies of Kupla *et al* (1987); Hall & Kaufmann (1987); Clapp (1990); Rafla & Whitelaw (1996) and Pivarnik (1998).

Hall & Kaufmann (1987) studied birth outcome from clinical records in a large group of pregnant women (n=845) undertaking aerobic conditioning. Subjects were divided into four groups consisting of one control group (n=393) who did not exercise and three exercise groups participating in low (n=82) medium (n=309) and high levels (n=61) of exercise. Pregnancy outcomes were found to be more favourable in the exercise groups with a significant reduction in the incidence of operative deliveries† and higher Apgar†

scores of babies in the high exercise group. Women in the exercise group were also noted to have a shorter stay in hospital compared to sedentary women.

An interesting prospective study of healthy well conditioned athletes carried out by Clapp (1990) included recreational runners (n=67) and aerobic dancers (n=64). The exercise group (n=87) continued to exercise throughout pregnancy at a high level of performance and women (n=44) who spontaneously stopped exercise in the first trimester† of pregnancy were allocated to the control group. Findings indicate that exercise is associated with shorter labours†, less need for obstetric intervention and fewer signs of fetal† distress. There was no evidence to support the concern that exercise increased the incidence of membrane rupture before the onset of labour†. However, there was an indication that exercise at these levels in late pregnancy possibly had a positive effect on cervical ripening and uterine co-ordinate activity. The researchers recognised that self selected participants was not representative of the general population of pregnant women.

More recent studies by Lee (1996) and Kardel & Kase (1998), have also found no differences, in relation to pregnancy and birth outcomes, between women participating in different levels of physical activity. Lee (1996) conducted a study of primigravid women (n=370) who exercised during pregnancy. Women, who had expressed an interest in undertaking exercise during pregnancy, were randomly assigned to either participate in a regular structured aerobic exercise programme from 20 weeks gestation onwards or a control group of women. The two groups were found to be comparable for gestational age at delivery, vaginal delivery and Apgar score of the newborn. No significant difference was found between the groups in relation to the active stage of labour and birthweight or maternal and neonatal outcomes. Significant differences were noted between the groups in relation to the amount of pain experienced during labour.

Kardel & Kase (1998) investigated the effects of exercise on birth outcome with women (n= 42) who self selected into medium and high intensity exercise programmes throughout and following pregnancy. No differences were found between the groups in relation to the duration of labour†, birthweight† or Apgar† score at one and five minutes. Kardel & Kase (1998) conclude that healthy, pregnant and well conditioned women may take part in exercise during pregnancy without compromising fetal† growth and

development as judged by birthweight or complications during the course of pregnancy and labour†.

Many researchers agree that there is no difference between women who exercise during pregnancy and sedentary women in relation to parameters of labour† and birth outcome which included Apgar† score of infant, birthweight† (Rose, Haddow, Palomaki *et al* 1991; Collings *et al* 1983; Pomerance *et al* 1974), infant length and head circumference (Pomerance *et al* 1974). Other researchers conclude that physically well conditioned women had a greater sense of well-being, shorter labours† and fewer obstetric interventions when compared with other women (Hall & Kaufmann 1987; Clapp 1990; Wang & Apgar 1998). Findings in the area of labour and birth outcome remain controversial and further research is required to allow conclusions to be established.

Clapp & Dickstein (1984) report that women who continued with endurance exercise during pregnancy, at or near preconception levels, gained significantly less weight (mean -4.6Kg); delivered earlier (mean -8 days) and delivered lighter infants (mean -500g) than either sedentary women or those women who discontinued exercise before 28 weeks gestation†. Subjects who discontinued exercise gained more weight than sedentary women but delivered infants with similar birthweight†. It was uncertain whether this difference in birthweight† represented a deleterious effect. The study also supported the theory that women who exercised and their inactive counterparts had similar incidence of operative deliveries† and intrapartum† complications. In contrast to these findings, Slavin *et al* (1988) found that women who exercised during pregnancy until delivery delivered babies of average birthweight and there was no difference compared to sedentary women.

A number of studies found no difference in respect of birthweight†, maternal weight gain and gestational age† of the newborn. In a retrospective non experimental survey, Zeanah & Schlosser (1993) found no significant difference in maternal weight gain, birthweight† or gestational age† of newborn between women who exercised moderately (n=132) through the third trimester† of pregnancy and those women (n=173) who exercised with heart rate intensity of 150 bpm for 40 minutes or longer. Women who had exercised for a longer duration and those women who had exercised at a moderate intensity had significantly fewer operative deliveries†.

Jarrett & Spellacy (1983) conclude from a retrospective questionnaire study that jogging during pregnancy by healthy women (n=67) accustomed to such activity was not harmful to the newborn. No correlation was found between the number of miles run during pregnancy or in the third trimester† alone and either birthweight† or gestational age†. Findings from a study conducted by Dale *et al* (1982) indicate no evidence of any difference between the running group (n= 33) and the control group (n= 11) in relation to maternal weight gain and birthweight†.

Bell, Palma & Lumley (1995) assessed the effect of birthweight† on a continuing programme of vigorous exercise into late pregnancy. 'Potential exercisers' (n=58) continued to exercise during pregnancy and were compared with control group of women (n=48) who did not exercise on a regular basis. Women in the exercise group who participated in more than four sessions of vigorous exercise per week at 25 weeks gestation were reported to have babies with a mean birthweight† of 315g lower than those in the control group. They suggest that some other lifestyle factor of the women in the control group may have been responsible for the higher birthweight† .

Clapp & Capeless (1990) prospectively monitored maternal body composition during pregnancy (n=132) and infant body composition and birthweight†. It was noted that women who exercised (n=77) during pregnancy gave birth to infants 500 grammes lighter in weight than infants born to women in the control group (n=55) who did not plan to exercise. The difference in birthweight† was primarily due to a reduction in fetal fat mass in women who continued to exercise through late gestation†. This did not create clinical difficulty in the neonatal period† and it was speculated that if the leanness continued there could be a potential long-term cardiovascular benefit in later life. There is a potential problem that the difference in birthweight† could put the preterm† infant at greater risk of morbidity and mortality.

Clapp, Simonian, Lopez *et al* (1998) investigated the infants of women who had continued to exercise during pregnancy (n=52) compared with infants (n=52) of women from a control group. At birth, the infants of exercising women weighed less and had less body fat. However, at one year of age all morphometric parameters were similar and normal growth and development occurred during the first year of life.

Pivarnik (1998) concludes, from his review of the literature, that there was a mixed relationship between the potential effects of maternal physical activity on birthweight†. Current evidence suggests that participation in moderate to vigorous activity throughout pregnancy may enhance birthweight† while more severe regimes may result in lighter infants. Careful caloric calculations and quantification in chronic exercise is needed before further conclusions can be drawn.

Lokey *et al* (1991) carried out a meta analysis of studies examining the effects of physical exercise on pregnancy outcomes. The studies reviewed involved 2314 pregnant women, 1357 experimental and 957 control subjects. Overall results indicate that there were no apparent adverse effects of exercise in the studies reviewed. They suggest that limitations should not be imposed on the level of exercise undertaken during pregnancy.

Physical activity increases the secretion of endogenous opioids and abnormally high amounts of beta endorphins have been measured in the blood plasma of exercising subjects. Beta endorphins are known to have an opiate effect on the Central Nervous System and this has resulted in much speculation in recent years about their role in pain perception. Moore (1982) offered 'endorphin produced pain desensitisation' as a possible explanation for athletes' ability to ignore painful injuries. At present, there is only circumstantial evidence to support this theory.

There is agreement in the literature regarding the increased secretion of beta endorphins during labour† (Raisanen, Paatern, Salminen *et al* 1984). It is reasonable to hypothesise that if labour† is considered to be a combination of intense physical exercise and bouts of acute painful stimulation, then the stimulus for endogenous opioid secretion will be maximal during this period.

Varassi, Bazzano & Edwards (1989) studied multigravid† women (n=36) to determine whether plasma beta endorphin levels could be elevated by exercise conditioning during pregnancy. Women were randomly assigned to either a control group (n=21) or exercise group (n=15) who participated in an exercise training programme designed for flexibility, strength and aerobic capacity. The exercises were carried out on a bicycle ergometer under supervision. Subjects were familiarised with pain assessment

which was quantified using a visual scale. Both groups of women had pain perception assessments carried out during labour† and blood samples taken at regular intervals to determine beta endorphin and other hormone levels. Women in the exercise group reported lower levels of pain assessment and beta endorphin levels were elevated throughout labour† compared with women in the control group. They conclude that exercise conditioning during pregnancy appeared to be beneficial in reducing both perception of pain and stress levels during labour†.

In summary, recent research has focused on the effects of exercise on pregnancy and birth outcomes. Literature suggests that exercise during pregnancy does not influence the incidence of preterm labour. Numerous studies have reported on the clinical issues surrounding the process of labour and delivery in relation to duration of labour, mode of delivery and the incidence of obstetric complications. Findings in relation to the effects of exercise on labour and delivery outcomes remain inconclusive. This is mainly due to studies conducted with small sample size and self selected subjects which makes it difficult to generalise the findings to other pregnant women. Other studies have focused on the effects maternal exercise may have on birthweight and neonatal well-being. Findings agree that there are no adverse effects to neonatal well-being at birth. However findings in relation to birthweight tend to be controversial. Further research needs to be conducted with large well controlled studies to allow detailed investigation of the effects of exercise on pregnancy and birth outcome.

2.5.4 Maternal Muscle and Skeletal Considerations

Pregnant women need to be cautious when undertaking any physical activity during pregnancy as they experience increased laxity of their ligaments due to increased production of the hormone relaxin. Change in joint laxity during pregnancy is analogous to that in someone who has just had surgery on the joints and ligaments (Artal Mittlemark *et al* 1991a). These factors contribute to pregnant women being more prone than normal to soft tissue and skeletal injury (Huch & Erkkola 1990). During pregnancy, the relaxation of ligaments combined with lordosis, changes in the centre of gravity and weight gain, should increase stress in most joints. Weight-bearing exercises and sudden movements generate significant torque and sheer stress to the joints. Despite this apparent increased

susceptibility, there are no reports of any increase in injury rate when exercise is performed during pregnancy (Clapp 1994).

The encumbrance and additional weight of the fetus† could constitute additional stress in any physical activity involving weight support. Spinal and pelvic insufficiency is common during pregnancy. As a result of these factors, there is growing concern about the incidence of low back pain experienced by women during and following pregnancy.

Berg, Hammer, Moller-Neilsen *et al* (1988) carried out a large prospective study of pregnant women (n=862) in Sweden. Low back pain was reported for short periods of time during pregnancy by 49% of women and back pain was experienced for longer than six months of pregnancy in 6% of all women. Reports of severe pain in 9% of women, classified as medically unfit for work, resulted in referral to an orthopaedic surgeon for orthoneurological examination. The most common diagnosis was sacro-iliac joint instability. Backache tended to remain a problem after delivery in 60% of these women who had experienced severe pain during pregnancy. However, backache was resolved in all women by twelve months postpartum†.

Parsons (1994) recommends that, during early pregnancy, women should be encouraged to do some gentle exercise to offset some of the mechanical strain that arises with postural changes as pregnancy progresses. Hall & Kaufmann (1987) found that subjects who had stopped exercising for longer than two weeks reported recurrence of common aches and pains especially low back pain. Andrews & Neill (1994) suggests that pelvic (hip) tilt exercises appears to be effective in reducing ligament pain intensity and duration.

There is currently little specific information available about the incidence of sports injuries during pregnancy. Anecdotal reports suggests that there are few problems in highly trained, well conditioned athletes who maintain their endurance activities into the second trimester† (Jarrett & Spellacy 1983, Cohen, Prior, Vigna *et al* 1989).

Debate surrounds the factors contributing to subsequent weakness of the pelvic floor muscles following vaginal delivery. As a result of traumatic damage, many women experience some degree of urinary incontinence following childbirth although between

60% and 80% of problems do regress spontaneously (Candy 1994). Some authors suggest that exercise is beneficial to assist the muscles in returning to their pre-pregnant condition and minimise pelvic floor damage during delivery (Shephard 1983; Henderson 1983; Gordon & Logue 1985; Morkvid & Bo 1996). These exercises were originally designed to increase the elasticity and tonicity of the perineum and to prevent perineal tears during delivery of the baby. No scientific evidence is available to support this theory and research in the mid 1980's questions the effectiveness of this type of exercise. Sleep & Grant (1987) suggest that pelvic floor exercises are of limited value in preventing damage although others suggest that weakness following vaginal delivery results from damage to the innervation of pelvic floor muscles rather than the stretching of muscles (Snooks, Setchell,Swash *et al* 1984).

Gordon & Logue (1985) recommend that regular general exercise improves the tone of the pelvic floor muscles. Valancogne & Galaup (1993) suggest that perineal exercise, abdominal exercise and physical activity are not contradictory, but complementary and should be adapted to the individual woman.

There is limited available literature in relation to the psychological effects of exercise during pregnancy. Current findings have been previously discussed in section 2.3.3.

2.6 The Use of Guidelines for Exercise during Pregnancy

The American College of Obstetricians and Gynecologists (ACOG) introduced the first set of guidelines for women exercising during pregnancy in May 1985. These were developed in response to a growing number of requests from women and health professionals who wished information in this area. The initial guidelines were controversial as they were not based on hard data and were thought to be too specific to be general guidelines (Gauthier 1986). However, it was intended that the guidelines should only be used with the 'common sense' approach and should not prevent women from adopting a more individualised approach to exercise.

Zeanah & Schlosser (1993) conducted a study to determine the extent to which exercising women adhered to the ACOG guidelines and the effect of non adherence on pregnancy outcome. The study was a non experimental retrospective study of women (n=

173) who exercised during pregnancy. The majority of women (83%) were aware of the guidelines however only 53% adhered to the guidelines while exercising. They conclude that women who exercised regularly before conceiving and during uncomplicated pregnancy did not adversely affect their own health. These women exercised in excess of the ACOG guidelines and all reported positive pregnancy outcomes.

At present, recommendations for pregnant and postpartum† woman are based on limited knowledge acquired in the exercise laboratory and on clinical observations and experience. However, over recent years, specific programmes for exercise in pregnancy have improved considerably. Past reviews of many highly specific programs reveal medical content that was in many cases inappropriate, inaccurate or incomplete (Artal Mittlemark *et al* 1991c). Guidelines have been regularly updated to consider the changing needs of women who exercise and new information gained about exercise during pregnancy (ACOG 1991 &1994).

2.7 Gaps in the Literature

There are many legal and ethical aspects to be considered when investigating human subjects in relation to exercise during pregnancy. Therefore, a great deal of research has been undertaken with human subjects in supervised laboratory conditions or with animal models. Experimental paradigms and species difference in physiologic response make it difficult to apply any findings to the human condition (Mottola 1996).

The two major deficits in published studies are the lack of prospective adequately controlled experimental design and inadequate quantification of physical activity. Limitations with the methodologies of many of the studies discussed include small sample sizes; self selected groups; sparse or intermittent episodes of exercise; poor adherence to the exercise programmes; limited monitoring of variables and retrospective data collection over varying periods of time.

In many trials, the method of treatment allocation is either not described or involved non random selection. Most did not specify the number of subjects; compliance to the exercise programme; the reasons for loss of subjects or any follow up studies. Many studies had eliminated those women who developed complications and therefore did not

report data on either the number of affected subjects or the resulting conditions or outcomes.

Some of the studies attempted to generalise findings from exercise programmes of different levels of intensities for different periods of time and relate these findings to the effects of exercise on pregnancy outcome. The assumption that exercise conducted at different intensities for different periods of time all have the same effect on pregnancy and birth outcome is a major concern.

An element of bias of some researchers was suspected towards the positive outcome of pregnancy by women undertaking exercise. Many of the studies discussed have indicated that women who exercised during pregnancy can have a positive outcome to their pregnancy. However, the validity of any overall conclusion about the effects on pregnancy remains questionable.

Design of controlled investigations on psychological effects of physical conditioning during pregnancy is troublesome since adherence to exercise is difficult to maintain during long term prospective studies. Psychological variables are easily affected by subjects attitudes and beliefs and studies discussed allowed group selection which may have improved adherence to the assigned exercise group but results may be invalidated due to selection bias.

Healthy pregnant women who engage in regular aerobic exercise in pregnancy are likely to be more fit than their more sedentary peers, but knowledge of the risks and benefits for themselves and their infants will require studies that are better controlled than those many trials discussed within the review.

There is a wealth of research evidence available in relation to the physiological effects of exercise during pregnancy but to date there is very little research which considers the psychological aspects during the process of childbirth. The benefits of exercise on psychological well-being of non pregnant women is well documented in the literature but there are few studies documenting the psychological effects of exercise during and following pregnancy.

It is evident from reviewing the literature that well controlled human studies are needed to provide information on the effects of exercise on pregnancy and pregnancy outcome, and the impact on the physiological and psychological well being of the woman. Unfortunately, the available data is insufficient to show important risks or benefits for mother and baby although theoretical advantages of exercise during pregnancy are positive and worthy of further investigation. In view of the current trend towards a more physically active society, health professionals have an obligation to investigate, design, and promote activities that are safe and maintain maternal and fetal† well-being.

2.8 Summary of the Literature Review

The physical and psychological benefits of exercise are well documented. The suggestion that exercise may benefit women during childbirth has been recognised for many years. Women, today, now regard exercise as part of their normal life and wish to continue to exercise during pregnancy. There are concerns that exercise may adversely effect the on the normal progress of pregnancy and the developing fetus. A wealth of scientific research has been undertaken to investigate the effects that exercise may have on pregnancy and birth outcomes.

Over the past three decades, a significant body of evidence supports the hypothesis that healthy women can perform acute exercise of moderate intensity and duration without jeopardising fetal† well-being. Findings agree that maternal exercise is well tolerated by the fetus†. There are no published reports of fetal compromise or adverse outcome of pregnancy as a result of maternal exercise

There is agreement in the literature that women who exercise during pregnancy experience both physiological and psychological benefits. Findings from the literature suggest that exercise does not have any influence on the incidence of preterm labour or any adverse effects to the fetus. In fact, there is evidence to suggest that the fetus can tolerate physiological effects of maternal exercise. Findings remain inconclusive in relation to the effects of exercise on pregnancy and birth outcomes. It is, generally, considered to be safe for healthy women to undertake regular moderate exercise during pregnancy without any risk to pregnancy or the baby.

Research studies involving human pregnant studies has many legal and ethical considerations. As a result, animal studies have been used to investigate physiological effects of pregnancy and there is difficulty in trying to generalise these findings to pregnant women. Studies undertaken with human subjects tend to have flaws in the research design such as self selected subjects and small sample size. Well controlled studies are required to investigate in detail the effects of exercise during pregnancy. The potential impact of occasional, regular and prolonged exercise during pregnancy on outcomes of clinical importance for the mother and infants remains unknown.

2.9 The Present Study

The present study investigated and compared the effect of a structured exercise programme on 'low risk' pregnant women by a two group randomised controlled trial during and following their first pregnancy. The control group of women continued with the existing antenatal education programme offered to women in Ayrshire which was designed to prepare women for pregnancy, labour[†] and the transition to parenthood. The women in the exercise group also continued with the existing antenatal education programme and, in addition, participated in a structured exercise programme during and following pregnancy. Women were studied from twelve weeks of pregnancy until four months after delivery of the baby.

The outcome measures mainly focused on the psychological aspects of pregnancy. These included how the women felt about themselves and their bodies, how well they felt they could cope, their attitudes to marital relationships, sex, pregnancy and the baby. Pregnancy and birth outcomes were also investigated in addition to the amount of physical activity undertaken throughout the study.

2.9.1 Statement of Aims

The study aimed to compare an exercise and control group of healthy first time prospective mothers during and following pregnancy. Comparisons were made in early pregnancy (12-16 weeks), late pregnancy (36-40 weeks) and post pregnancy (12-16 weeks) in relation to:

- Psychological 'well-being' in terms of perceptions in coping assets (positive psychological well-being), perceptions of coping deficits (negative psychological well-being) and postnatal emotional well-being and depression
- Perceptions of physical well-being
- Perceptions of somatic symptoms experienced
- Perceptions of body image
- Maternal attitudes to marital relationships and sex
- Maternal attitudes to pregnancy and baby
- Pregnancy outcomes in terms of: Length of gestation†; duration of labour†; mode of delivery
- Birth outcomes in terms of: Apgar† score; birthweight†; neonatal complications
- Maternal medical or obstetric conditions experienced
- Physical activity levels in early pregnancy
- Physical activity participation
- Drop out rate from the study

CHAPTER 3

METHODOLOGY

This chapter reports on the methodology of a study in which the effects of a structured aerobic exercise programme during and following pregnancy were investigated with healthy first time pregnant women undertaking antenatal care in Ayrshire Central Hospital, Irvine. The study utilised a two group randomised experimental design with psychological variables being measured during and following pregnancy. Data was collected from women at three time points during the course of the study: early, late and post pregnancy. Further relevant data relating to pregnancy and birth outcomes was obtained from medical casenotes.

3.1 Research Design

The study was a two group randomised controlled trial. The control group of women continued with the existing antenatal care programme offered in Ayrshire to prepare women for pregnancy, childbirth, postpartum† period and transition to parenthood. Women allocated to the exercise group also continued with the existing antenatal care programme with the addition of undertaking a structured aerobic exercise programme during and following pregnancy.

3.1.1 Planning

Initially, a small multidisciplinary group of health professionals was established to assist in planning the study. This group included a physiotherapist, a midwife, an obstetric registrar, a midwifery sister from the antenatal clinic, an administrator, a consultant obstetrician and the researcher. Individual members had knowledge and expertise in their own field of interest to assist in the development of the study. Once the planning stage was completed, both the midwifery sister and consultant obstetrician remained in close liaison throughout the study.

At this stage, careful consideration was given to the three issues identified by Steptoe (1992) as potential areas of concern when attempting to link physical activity and psychological well-being. These issues included: the appropriate measures of

psychological experience, the factors that potentially confound studies of this topic and the problem of the drop out of subjects from activity programmes.

The planning stage also consisted of locating a suitable venue for the exercise class, submitting applications for funding to support the cost of the study and preparing the researcher to become qualified and experienced as an antenatal and postnatal aerobic instructor.

3.1.2 Pilot Study

Initially a pilot study was undertaken to test the methodology prior to the main study. This pilot was designed to be completed within one year to gain an overview of the proposed methodology during each stage of the study. A summary of the pilot study will be presented in this section with more detailed information available in Appendix 2.

The overall aim of the pilot was to evaluate and assess the methodology in terms of: the efficiency and effectiveness of recruitment and allocation of subjects to either control or exercise group; retention of subjects; the content, timing and convenience of the exercise programme; data collection tools; method of collation and storage of data; response rate to the questionnaires and the relevance and value of data obtained from the study.

Women were recruited at the first three of five data collection points i.e. first, second and third trimesters[†] of pregnancy. Once recruited, women remained in the pilot for at least two data collection points which included data collected over the final two data collection points following delivery i.e. in the immediately postnatal period[†] and again at three months. This was to allow completion of the pilot in a shorter time span. Following the pilot study, a semi-structured interview was conducted by the researcher with the women and health professionals involved in the study to gain subjective views and constructive feedback about all aspects of the study. Data collated was reviewed in conjunction with the statistician and research supervisors. All information obtained from the pilot study was evaluated and assessed to ensure that the final methodology would be efficient and appropriate to the study aims.

The following changes to the methodology for the main study were based on evaluation and findings from the pilot study. The recruitment procedure, which was identified from the semi-structured interviews as being inefficient to midwives and both inconvenient and time consuming for women, was streamlined to be more efficient. Allocation of subjects to groups was made via the appointment system with a follow-up postal information pack contributing to the time delay which resulted in poor data response in early pregnancy. This delay was addressed by issuing prepared and coded information packs once consent for the study was obtained. This gave women the opportunity to complete the initial questionnaire during the available time within the first clinic appointment.

Data collection tools were found to be time consuming to complete and issued too frequently. This contributed to poor response rate and return of incomplete information. Evaluation of data collated was undertaken in conjunction with the statistician. This resulted in a reduction in the number of data collection points to the three time points identified as being essential to gain meaningful information i.e. early pregnancy (12-16 weeks), late pregnancy (36-40 weeks) and post pregnancy(12-16 weeks). Information was removed which was identified as being irrelevant or superfluous to the study aims. Subsequently, a 'user friendly' booklet of questionnaires was designed to collect all relevant information.

Women allocated to the exercise group were advised to attend three structured exercise classes per week provided within the maternity hospital venue. This would allow women to meet the current recommendations for physical activity, which were that adults should accumulate thirty minutes or more of moderate-intensity physical activity on most, preferably all, days of the week (American College of Sports Medicine 1990; Pate, Pratt & Blair *et al* 1995). However, attending this number of classes per week proved to be difficult for women to achieve. All women attended one exercise class per week and two exercise classes on a few occasions. Women did report participation or attendance at other physical activities which they wished to continue as it suited their social lifestyle. This was reviewed and discussed at length with research supervisors. It was decided to encourage women to attend two exercise classes per week but to extend the study to include a variety

of other agreed physical activities such as aquanatal classes and swimming, brisk walking and golf (Pate *et al* 1995). This incorporated a flexible approach to meet the needs of the women. An activity diary of all forms of physical activity was maintained by women in both the exercise and control groups (Appendix 14). This allowed the total number of physical activities to be recorded over the course of the study. It also enabled women to accurately summarise their average weekly episodes of physical required at each data collection point.

Undertaking the pilot study proved to be a worthwhile exercise. Findings from the pilot study contributed to amendments being made to the research design for the main study. A summary of these amendments include: a more efficient process for the recruitment of subjects; the removal of irrelevant data and reduction in the number of data collection points; the design of an 'easy to use' questionnaire booklet for data collection and the inclusion of additional physical activities and activity diaries within the study.

3.1.3 Main Study Subjects

Subjects were first time prospective mothers who attended the antenatal clinic at Ayrshire Central Hospital, Irvine for their first antenatal appointment in early pregnancy i.e. before 12 weeks gestation†.

Inclusion criteria for subjects in the study were agreed by consultant obstetricians (Appendix 1). These included healthy women with no obstetric history or medical conditions and who had a healthy singleton pregnancy confirmed by obstetric assessment and ultrasound† scan at the time of recruitment. Women did not continue if they developed any complications which threatened their health or pregnancy including any bleeding in pregnancy, high blood pressure or intra-uterine growth retardation (Appendix 1).

Pre-existing chronic conditions such as diabetes mellitus; hypertension and heart disease were clear reasons to discourage the already 'at risk' individual from exercising while pregnant (Cooper & Cooper 1972; Carbon 1994). An ultrasound† scan routinely performed during this appointment confirmed pregnancy and provided other obstetric assessment which included gestational age† of the fetus†.

3.1.4 Ethical Permission

Ethical permission was sought and granted from the ethics committee of Ayrshire & Arran Health Board who have responsibility for monitoring research in Ayrshire Central Maternity Hospital. Emphasis from the committee was placed on the following issues: the inclusion of obtaining informed consent from women to join the study; the obstetricians' agreement of the suitability of women for inclusion in the study; keeping women well informed on all aspects of their allocated group (Sieber 1992) and ensuring adherence to the guidelines for the aerobic exercise programme.

Confidentiality of the women in the study was maintained at all times (United Kingdom Central Council 1996) with strict compliance with the Data Protection Act in relation to personal and health details (Department of Health 1984 & 1994). Permission was granted from North Ayrshire & Arran NHS Trust to review obstetric casenotes and the birth register to obtain relevant obstetric and medical information. Close liaison with obstetric staff was maintained when appropriate. Annual progress reports were forwarded to the ethics committee throughout the course of the study.

3.2 Procedure

The data gathering stage of the study was undertaken from August 1996 until October 1998. The main study was developed from the initial pilot study conducted. The duration of the study for each woman was approximately 52 weeks i.e. from 8 weeks gestation† of pregnancy until 20 weeks following delivery of the baby.

3.2.1 Recruitment

Recruitment was conducted by the medical clerkess and midwifery staff in the antenatal clinic. On arrival for the first antenatal appointment, all primigravid women with no previous obstetric / medical history were initially given a brief letter requesting them to participate in a research study (no further information was given at this point). Women were recruited to the study once consent was obtained and the obstetrician agreed that the obstetric criteria for entry to the study were met.

Initial consent to participate in the study was obtained from women at the first antenatal clinic appointment in early pregnancy which was approximately at eight weeks

gestation† (Appendix 5). The consultant obstetrician consented to each woman's suitability for the study during the first consultation with the woman and this was retained within the obstetric casenotes (Appendix 6). Information leaflets about the allocated groups were issued to women at the time of recruitment (Appendices 10-11) and women signed a further consent form for their group allocation (Appendices 8-9). All consent forms from women were retained by the researcher. Information letters were available for issue to individual general practitioners and midwives at the woman's request (Appendix 7). Contact numbers were readily available to all women and health professionals involved with the study. Women were informed that if they wished then they could leave the study at any time (Appendices 10-12).

Recruitment of subjects commenced in August 1996 and continued until October 1997 to ensure an adequate number of subjects completed the study.

3.2.2 Sample Size

Sample size was estimated using the outcome variables of perceptions of body image and perceptions of coping assets (positive psychological well-being) to determine the overall sample size necessary to gain statistical significance. The range of possible scores for perception of body image was 12 - 48. The typical score for the exercise group and control group at 16 weeks gestation† was estimated to be = 30 with subsequent scores at 36 weeks gestation† estimated to be 25 (-5) for the exercise group and 20 (-10) for the control group. Based on this assumption, the study required a minimum of thirty women to complete the study in each group for a power of 0.90 (Machin & Cambell 1991). Based on these calculations and taking drop out rate from the pilot study into consideration, it was recommended that at least fifty women should be recruited to each group.

3.2.3 Randomisation

Women were first identified on the appointment system as being primigravid† women attending for their first antenatal appointment. Consent for participation in the study was obtained from both the women and consultant obstetrician. The women were then issued with a sealed and coded envelope which gave information about the study and their allocated group. Women were only aware of allocated group once the information pack

had been opened. None of the staff involved in the recruitment process had knowledge of the group allocation. An equal number of sealed and coded information packs, which had been previously prepared prior to recruitment of subjects, were issued to the antenatal clinic staff for distribution. Each woman had an equal chance of being allocated to either of the two groups. Personal details and assigned code numbers were forwarded to the researcher.

3.2.4 Control Group

This group of subjects continued with the existing antenatal education programme for the preparation of women for pregnancy, childbirth and the transition to parenthood. During pregnancy, this included routine regular obstetric care undertaken by midwives, general practitioners and consultant obstetricians. Routine midwifery care involved individualised care planned in partnership with women and midwives. Women were routinely invited to attend structured classes for the preparation for pregnancy, labour† and the transition to parenthood in either the hospital or community areas; workshops specifically for preparation of breastfeeding; and postnatal reunion and support groups. Aquanatal classes were an optional extra and classes were offered by most of the local leisure centres in conjunction with maternity service providers.

The information pack for women in the control group included a consent form to participate in the study (Appendix 9), an information leaflet giving details of the control group (Appendix 10), a letter giving details of the information required (Appendix 12), a questionnaire booklet for completion in early pregnancy (Appendix 13), activity diary sheets (Appendix 14), and the researcher's contact number. Women were not given any information about the structured exercise programme but were free to continue with their usual leisure time activities. They were given information about additional activities and were asked to complete an activity diary of any episodes of physical activity (Appendix 14). This was intended to help women summarise information about all physical activity undertaken in terms of the type, duration and frequency of physical activity. This provided information about the episodes of activity which could be then be divided into appropriate classifications of exercise i.e. aerobic activity, structured exercise classes, strength training, yoga etc. A stamped addressed envelope was provided for the return of the

following information for the early pregnancy data collection point i.e. consent form, completed initial questionnaire booklet and activity diary. Women were encouraged to contact the researcher to discuss other physical activities they either wished to participate in or had undertaken for their possible inclusion in the study.

Women and babies in the control group were invited to a 'postnatal reunion' on completion of the study. The aim of this reunion was to thank the women for their contribution to the study and finalise collation of relevant data.

3.2.5 Exercise Group

This group of subjects continued with the existing antenatal education programme for the preparation of women for pregnancy, childbirth and the transition to parenthood in addition to participating in a structured aerobic exercise programme. The aerobic exercise programme was designed to consider the physiological changes of pregnancy with adherence to current guidelines (Appendices 3 & 4).

The information pack for women in the exercise group included a consent form to participate in the study (Appendix 8), an information leaflet giving details of the exercise group (Appendix 11), a questionnaire booklet for completion in early pregnancy (Appendix 13) a letter giving details of the information required (Appendix 12), activity diary sheets (Appendix 14), details of the exercise group location with a map for directions, and the researcher's contact number. Women were given information about additional forms of activity and were asked to complete an activity diary of any episodes of physical activity (Appendix 14). This was intended to help women summarise information about additional physical activity undertaken in terms of the type, duration and frequency of physical activity. It provided information about the episodes of activity which could be then be divided into appropriate classifications of exercise i.e. brisk walking, cycling, strength training, yoga and other structured exercise classes such as aerobics and aquanatal. A stamped addressed envelope was provided for return of the following information for the early pregnancy data collection point i.e. consent form, completed initial questionnaire booklet and activity diary.

Women were also asked to sign a register of attendance at the structured exercise classes (Appendix 16). This was intended to provide an overall total of all structured exercise classes attended at the end of the study. Women could also take the opportunity at the exercise class to record other physical activities undertaken in addition to the structured exercise class provided.

Again, women and babies in the exercise group were invited to a 'postnatal reunion' on completion of the study. The aim of this reunion was to thank the women for their contribution to the study and finalise collation of relevant data.

3.2.6 Exercise Programme

This was a specially designed programme which complied with the ACOG guidelines for exercise during pregnancy and the postpartum† period (ACOG *cited in* Artal Mittlemark *et al* 1991c; Appendix 3). The exercise programme was based on the London Central YMCA 'Antenatal and Postnatal Exercise Programme' (Gaskill 1992) which has been endorsed by the Royal College of Midwives (Appendix 4). The design of this aerobic exercise programme followed sound ergonomic principles. It considered the anatomical, physiological and structural changes of pregnancy and the possible impact of aerobic exercise on these changes.

The intensity of the exercise undertaken by women during the aerobic exercise class was monitored to assess the adequacy and severity of their aerobic activity by two different methods i.e. assessment of heart rate by women recording their own pulse rate and 'Ratings of Perceived Exertion' (RPE) based on the Borg's Category Scale.

The preferred method of assessment was monitoring of heart rate by women recording their radial or carotid pulse rates at times of peak aerobic activity (ACOG 1991). Target heart rates (65%-75% of maximum heart rate) were identified according to the age of each woman within the exercise programme (Appendix 3). Women were informed of their individual target heart rate. Individual information, instruction and practice was given to enable women to become familiar with locating and recording their pulse rates. Heart rates were recorded for thirty seconds during the aerobic component of the exercise programme. This heart rate was subsequently doubled to ensure heart rate per minute was

within the identified target range for each woman. Women who reported a heart rate above their target rate were asked to reduce their exercise level and the heart rate was recorded again to recheck that rate was within the target range. Women working under their target rate were asked to increase their exercise level.

Women were also given information and instruction on assessing the adequacy and severity of RPE based on the Borg's category scale, during the aerobic exercise programme. The RPE scale is reported to equate subjective feelings of effort with numerical values derived from a standardised scale. The RPE scale has been most commonly used to assess difficulty of physical tasks by asking individuals to estimate their effort during physical exertion (Dunbar 1991) and has been shown to be valid in terms of productivity (Glass, Knowlton & Becque 1992). It is a simple method to follow once individuals are familiar with the use of the scale. However, it has been suggested that pregnant women may consistently underestimate their rate of actual physical exertion when using RPE scales even when women are familiar with this method of assessment (0'Neill, Cooper, Mills *et al* 1992). However, this 'simple to use' visual scale provided an alternative to recording heart rate only when it was identified to be a problem for individual women to locate and record pulse rate during aerobic exercise. Large posters of the RPE scale were readily visible at the exercise class and women were also given a smaller card detailing the scale for individual use. Women were asked to estimate their perceived exertion rate (RPE) according to the scale during aerobic activity. In addition, their pulse rate was recorded by an assistant to ensure that heart rate was within the target range. However, women were encouraged to continue to practice recording their heart rate in order to transfer to this method when they felt confident to do so. Both methods of assessing exercise intensity had the advantage of being readily transferable to other physical activities performed outwith the exercise class setting.

Women were encouraged to attend two exercise classes per week in addition to other physical activities of their choice. This allowed women to accumulate thirty minutes or more of moderate-intensity physical activity on most, preferably all, days of the week which came within the current guidelines (ACSM 1990; Pate *et al* 1995). Other physical activities included; London Central YMCA 'The complete pre- and postnatal fitness plan

video' for home use (Gaskill 1992), aquanatal and other exercise classes, swimming, brisk walking, and cycling (Pate *et al* 1995). The aerobic exercise video for home use was 40 minutes in duration and followed the same format and design of the aerobic exercise class. The aquanatal classes in the local leisure centres were of 45 minutes in duration with exercises in the water designed to take account of the physiological changes of pregnancy and the associated physiological effects of exercise in the water. Funding was available to reimburse women with the admission cost of one physical activity per week at a leisure centre. Women were recommended to contact the researcher to discuss other physical activity undertaken for inclusion in the programme.

3.4 Psychological Outcome Measures

A number of psychological variables were assessed during early pregnancy to measure baseline values and any changes over time. A questionnaire booklet was prepared to collect data which included all outcome measures and additional information required for the study at each of the time points i.e. early, late and post pregnancy (Appendix 13).

3.4.1 Psychological Well-being Questionnaire

Evidence linking physical activity with psychological well-being comes from a number of sources already discussed within the literature review. Mental health is one of the important components of complete well-being that has been associated with exercise. Physical activity may help people cope with stress more effectively and reduce emotional reactions to stressful life events.

One of the first issues to be considered for exercise studies was the selection of suitable measures of psychological experience. Many measures, such as questionnaires or interviews, are designed to assess psychopathophysiology. This may reveal scores which might warrant clinical attention and therefore their application to the general population may not be appropriate. Scores from the general population may initially be so low before training (floor effect) that there would be limited scope for further gains.

Outcome measures widely used in exercise studies such as the Profile of Mood States (POMS) developed by McNair, Lorr & Droppleman (1981) were better adapted for assessing *affect* in the general population. However, even these measures failed to capture

the positive feelings of well-being that are experienced and reported by the general population which were more than just the absence of anxiety or depression.

The outcome measurement tool chosen for this study was the psychological well-being questionnaire which was developed and validated by Moses *et al* (1989). It was a 'self report' questionnaire designed for use in a normal population. It consists of thirty six items selected from the literature concerning responses to exercise and is intended to assess perceptions of coping ability, feelings of mastery and subjective changes that accompanied exercise. Validity and reliability of thirty of the thirty six items in the questionnaire had been previously confirmed by factor analysis performed on questionnaires completed by volunteers (n=102) from which emerged three distinct factors of: perceptions of coping assets i.e. perceived ability to cope; perceptions of coping deficits i.e. perceived inability to cope; and perceptions of physical well-being. Perception of coping assets (14 items) predominantly contains positive coping statements and feelings about 'self' while the perception of coping deficits (10 items) consists of negative feelings and poor competence. Perception of physical well-being (6 items) is concerned with perceived physical status. The internal reliability of the scales showed satisfactory levels of consistency across items and separate presentations of the questionnaire. Internal consistency was found to be satisfactory with the same subjects (n=75) on the two separate occasions. The remaining six items were excluded from the analysis during the validity and reliability studies (Moses *et al* 1989).

The thirty items analysed in the validity and reliability studies by Moses *et al* (1989) were incorporated into the present subject questionnaire. As each question was scaled on a 5 point scale (0-4), the perception of coping assets score could range from between 0 to 56; with perception of coping deficits ranging from between 0 to 40 and perception of physical well-being ranging between 0 to 24. Higher scores for perceived coping assets and perceived physical well-being reflected positive perceptions of both coping assets and physical well-being whereas lower scores for perceived coping deficits signified a positive response in subjects.

The psychological indicators of perceptions of coping assets and coping deficits encompass psychological and emotional factors contributing to perceptions in the ability

to cope. Therefore, for the purpose of this present study, the three psychological indicators of well-being assessed by this questionnaire will be identified as perceptions of coping assets (positive psychological well-being), perceptions of coping deficits (negative psychological well-being) and perceptions of physical well-being.

The 'self report' questionnaire was designed for a normal population but had not been used during pregnancy. Following consultation with the authors, it was suggested that there was no reason why the questionnaire could not be used as a measurement tool for outcomes of psychological well-being with pregnant women.

3.4.2 Maternal Adjustments and Attitudes Questionnaire

Kumar, Robson & Smith (1984) developed this 'self report' measurement tool which was to assess the psychological condition of a woman during pregnancy and the ways she views herself, her baby and those close to her. The background for the development of the questionnaire was the indication that pregnancy, especially the first pregnancy, was a watershed in a woman's life and childbirth was associated with increased risks of both psychotic and neurotic disturbance (Brockington, Winokur & Dean 1982; Kumar 1982; Kumar & Brockington 1988). There was also a suggestion that psychological stresses in pregnancy can adversely affect the physical health of both mother and baby (Erikson 1976).

The development and validation of the questionnaire was designed specifically to investigate patterns of change in the perceptions of maternal adjustment to pregnancy, attitudes to marital relationships and attitudes to the baby. The acronym MAMA refers to maternal adjustment and maternal attitudes.

The reliability of the 60 item questionnaire was carried out by Kumar *et al* (1984) on first time mothers (n=119) with reliability being examined in two ways by test-retest and split-half reliability. Validity of the questionnaire was approached by comparing findings obtained by different methods *i.e.* self reported scoring of the somatic symptoms subgroup category compared with interview response on several symptoms which were followed through with t-tests. Interview ratings of satisfaction with marital relationship were made on a four point scale and followed through with t-tests. This was repeated with three of the

other four subgroup categories. Comparison with interview findings and questionnaire data provided good evidence for criterion validity. The two estimates of reliability were found to be reassuringly high and taken together with the measure of criterion related validity, suggested that women did not respond haphazardly and the questionnaire was actually measuring the subgroup categories.

Until reliability and validation of this questionnaire was undertaken there had been some criticism of the use of self-rating questionnaires aimed at assessing marital relationships (Quinton, Rutter & Rowland 1976) and self assessment of sexual function (Bentler & Abramson 1981). However, the relevant scales of the MAMA questionnaire were found to meet these essential requirements. The questionnaire has been used widely in psychological research for the measurement of psychological well-being in studies during pregnancy (Green 1990a; Green, Coupland & Kitzinger 1990).

The questionnaire can be completed without difficulty by most women in under ten minutes. It was also found to be acceptable, interesting and perceived as relevant to women (Kumar *et al* 1984). There has been no attempt to disguise the purpose of the questions and the questionnaire does not contain a *'lie'* score. There was random rotation of the rating scales (n=30) which was intended to reduce *'response set'*. The questionnaire specifically assesses perceptions of body image, perceptions of somatic symptoms, attitudes to marital relationships, attitudes to sex, and attitudes to pregnancy and the baby. Scores range from between 1 and 4, with 1 classed as the *'most desirable'* score and 4 the *'least desirable'* score. However, for the purpose of the present study, scores obtained were presented in the opposite direction from the original questionnaire. This was intended to facilitate the demonstration of similar trends in either a negative or positive direction when comparing the findings from these dependent variables and other dependent variables being investigated.

3.4.3 Edinburgh Postnatal Depression Scale

The Edinburgh Postnatal Depression Scale (EPDS), derived from the earlier work of Snaith, Constantapoulas, Jardine *et al* (1978), was developed by Cox, Holden & Sagovsky (1987) as a screening instrument to detect depression among women in the early

postpartum† period. Its principle feature is the emphasis on psychological rather than somatic symptoms of depression. This avoids the possible confounding of psychological symptoms of depression with normal physiological functions associated with childbearing. The measure was found to have satisfactory sensitivity and specificity in the detection of postnatal† depression when compared with diagnosis made by standardised interview (Cox *et al* 1987; Harris, Huckle, Thomas *et al* 1989). The measure has the benefit of being short with only ten items and has been found to be widely acceptable and easy to use by postnatal† women in the community (Cox *et al* 1987; Murray & Carothers 1990; Leverton & Elliot 1993). As a result the EPDS has become the measure of choice in studies of depression in childbearing.

The measure has been satisfactorily validated as an assessment of the emotional well-being of women during the antenatal period (Murray & Cox 1990; Hannah, Adams, Lee *et al* 1990; Green, Snowdon & Stratham 1991) and postnatal† period (Harris *et al* 1989; Murray & Carothers 1990). Therefore, the EPDS is a suitable tool for measurement of emotional well-being through pregnancy, the postpartum† year and beyond (Kumar & Robson 1984). Its usefulness in estimating psychological well-being in the postnatal† period was confirmed by Harris *et al* (1989) who found the EPDS to be superior to other scales for measuring depression such as the Beck Inventory (Beck *et al* 1979).

Timing and frequency of administration of the EPDS and the attitude and knowledge of the person administering the scale are factors which need to be considered. Disadvantages identified may include: false negative and positive readings; stereotyping of individuals as already being *'depressed'* when it was known that they had been required to repeat the questionnaire; and the potential ethical situation arising when there was doubt about the score obtained (Cox & Holden 1993). These issues were considered in relation to this present study and it was recommended, that it would be appropriate for this study, to administer this 'once only' questionnaire to women between 12 and 16 weeks in the postpartum† period to provide information on psychological well-being.

3.5 Pregnancy and Birth Outcome Measures

Numerous studies have investigated the effects of exercise during pregnancy on pregnancy and birth outcomes. In general, there is agreement that regular moderate exercise during pregnancy is safe for mother and baby (Huch & Erkkola 1990; Kramer 1996; Pivarnik 1998). There is inconclusive evidence to support any relationship that exercise during pregnancy can influence labour† and delivery. There remains concern that exercise during pregnancy may cause a risk of preterm† delivery, prolonged and difficult labour†, fetal† compromise and adverse effects on the newborn.

3.5.1 Pregnancy and Birth Outcomes

Obstetric and medical conditions which developed during and following pregnancy were recorded in terms of minor and major complications. Any condition that could affect the health of mother or baby was categorised as a major complication i.e. threatened abortion, antepartum haemorrhage, pre-eclampsia, hypertension, and maternal infections (Appendix 1). Minor disorders included the disorders of pregnancy and other minor conditions that did not affect the mother or pregnancy e.g. mild nausea and vomiting, heartburn and constipation.

Delivery details included:

- Length of the gestation (weeks)
- Duration of labour (hours)
- Mode of delivery i.e. normal spontaneous vertex† delivery (SVD), instrumental delivery (forceps and ventouse extraction) and operative† delivery (lower uterine segment caesarean section LUSCS)
- Maternal complications experienced

Baby details included:

- Birthweight†
- General condition of the baby at birth as assessed by Apgar† score at one and five minutes
- Congenital† or neonatal† complications

In the first instance, this factual information was obtained by postal questionnaire from the women (Appendices 13 & 15). This information was retrieved from the obstetric casenotes by the researchers when information was either not directly available from the women who had dropped out of the study or the information provided needed to have more detail.

3.6 Recording Physical Activity

Physical activity is a complex behaviour, and patterns of activity fluctuate between and within individuals. It was extremely difficult to obtain reliable data about habitual levels of physical activity due to disagreement in the literature about what constitutes consistent levels of physical activity (Durnin 1992).

The subjective method of maintaining an activity diary is suggested to be the most pragmatic measures for monitoring physical activity (LaPorte *et al* 1985). However, there have been few attempts to examine the validity and reliability of subjective methods (Lamb & Brodie 1991).

Activity diaries were included to enable episodes of physical activity to be recorded and monitored during the course of the study (Appendix 14). This had the additional benefit of providing women with opportunity to record this information which could then be summarised more accurately at each data collection point. Women in both groups were asked to describe physical activity undertaken in terms of when the activity was undertaken, the type of activity, duration, and frequency (Appendix 14). This information was requested at the three data collection points i.e. early pregnancy (12-16 weeks), late pregnancy (36-40 weeks) and post pregnancy(12-16 weeks). An attendance register was

maintained at the exercise class for the women in the exercise group who could use this to give additional information of other physical activities undertaken (Appendix 16).

This information was categorised into:

- Types of structured classes
  e.g. aquanatal, aerobic, strength training, yoga classes
- Swimming
- Cycling
- Brisk walking
- Golf
- Badminton and tennis sessions
- Treadmill / nordic ski-ing exercise
- Home exercise video

3.7 Timing of Outcome Measures

At recruitment 8-12 weeks	Personal details and activity levels in early pregnancy
12 -16 weeks	Psychological Well-being questionnaire *i.e. perceptions of coping assets (positive psychological well-being), coping deficits (negative psychological well-being) and physical well-being* MAMA questionnaire *i.e. perceptions of body image and somatic symptoms; and attitudes to marital relationships, sex and pregnancy* Summary of physical activity and health status
36 - 40 weeks	Psychological Well-being questionnaire *i.e. perceptions of coping assets (positive psychological well-being), coping deficits (negative psychological well-being) and physical well-being* MAMA questionnaire *i.e. perceptions of body image and somatic symptoms; and attitudes to marital relationships, sex and pregnancy* Summary of physical activity / health status
12 -16 weeks Postpartum†	Psychological Well-being questionnaire *i.e. perceptions of coping assets (positive psychological well-being), coping deficits (negative psychological well-being) and physical well-being* MAMA questionnaire *i.e. perceptions of body image and somatic symptoms; and attitudes to marital relationships, sex and baby* Edinburgh Postnatal† Depression Scale *i.e. emotional well-being and depression* Summary of physical activity / health status Summary of pregnancy / birth outcomes *i.e. length of gestation†, duration of labour†, method of delivery, Apgar† score at one and five minutes after birth, birthweight† and any maternal or neonatal† complications*
On completion	Total number of physical activities *i.e. from 12-16 weeks of pregnancy until 12-16 weeks following delivery*

3.7.1 Follow up of Outcome Measures and Retention of Subjects

The initial questionnaire in early pregnancy was enclosed within the information pack given at the time of recruitment. If this was not returned, a second questionnaire was posted out with an accompanying information letter about the study (Appendix 12). This letter gave a reminder of the study and informed the women that postal questionnaires would continue to be sent to their home address at the appropriate data collection points unless they contacted the researcher. A poster giving details of the exercise class was enclosed for those women allocated to the exercise group who did not return questionnaires or who did not attend the exercise class. Postal questionnaires were issued to all subjects within the two week period before the data collection time point. Questionnaires were re-issued three weeks later if the original questionnaire was not returned.

Three postnatal reunions at the maternity hospital were organised during the course of the study. This was an informal gathering of all women in the study and their new babies. Invitations were sent out to women in both groups who had delivered their babies and remained in the study.

3.8 Controlling Threats to Validity

Threats to the validity of the research study consisted of two types; internal validity related to the experiment itself and external validity related to generalising of the results to other situations (Rees 1997). These issues were given careful consideration in the planning of this present study to reduce the threats to validity of the research design.

Random selection had been identified as the key to controlling threats to external validity. Randomisation of subjects to groups allowed the assumption that the subjects were equivalent at the beginning of the research. This design controlled for past history and testing with the maturation of groups occurring equally (Thomas & Nelson 1990). This allowed control of the sources of invalidity based on non equivalency of groups which included selection biases and selection maturation interaction. The inclusion of only first time prospective mothers as subjects and the introduction of a control group reduced

any confounding bias. The validity and reliability of the outcome measures for the dependent variables have been previously discussed.

A potentially confounding variable was the 'expectation effect' of the subjects knowing that they were in a research study and being aware of the effort and time spent with them. Jamieson & Flood (1993) have suggested that few experiments paid sufficient attention to this particular issue of the 'expectation effect'. This was an important factor to consider from the point of view of the research design in relation to the subjects in the control and exercise groups. As the main researcher, I tried to ensure that the intervention was the only difference between the two groups.

The intervention was not an artificial setting but was a structured exercise programme in all respects i.e. designed aerobic exercise programme; exercise hall; qualified instructor. The potentially confounding variable introduced by inter instructor variability was avoided by having one instructor present at all classes. This factor, in itself, could have introduced the confounding variable of experimenter bias towards the intervention group.

Retaining subjects within the study was of concern especially due to the duration of subject participation. In general, it is common for subjects to drop out of randomised controlled trials of exercise interventions (Ward & Morgan 1984). This is mainly due to subjects not wishing to exercise in the first place. A drop out rate of 20% has been reported in controlled trials with some exercise studies having a drop out rate as high as 40-50% (Ward & Morgan 1984). It has been argued that 80-85% is the maximum possible retention in exercise studies even in populations with good facilities and positive attitudes to exercise. Steptoe (1992) suggests that the crucial problem for controlled trials of psychological response is not so much that drop out should be minimised but that drop out should not be selective across experimental conditions. However, it has been stated that retention of subjects cannot be controlled by any type of experimental design and that these problems can be handled in advance of the research by carefully explaining the research to the subjects and the need for them to carry it through and complete the study (Thomas & Nelson 1990).

3.9 Data Management

All subjects were given a unique code number which was used when handling data. Responses to information obtained from questionnaires and casenotes were entered into the database appropriately coded. Data for subjects was stored in the computer database using subject code number (DOH 1984).

3.9.1 Data Analysis

Statistical analyses were carried out using 'Minitab' statistics software package which is essentially a package for data exploration and data manipulation.

Repeated Measures Analyses of Variances (ANOVAs) were carried out to investigate differences between the two groups (i.e. exercise and control groups) at the three time points (i.e. early, late and post pregnancy). The Minitab GLM (General Linear Model) command was used to carry out the Repeated Measures ANOVAs. The time points of interest were; early pregnancy (12-16 weeks), late pregnancy (36-40 weeks), and post pregnancy (12-16 weeks). Significance level used was p-value <0.05. It is recognised that there is a risk of increased Type 1 errors with the number of comparisons which were being conducted. Some protection against this increased risk was available from the use of the multiple comparisons test.

A follow up Multiple Comparisons Procedure with a simultaneous 95% Confidence Level was undertaken if a significant ***interaction*** of exercise group/ time was indicated. This follow up procedure allowed further, more detailed investigation of any differences between the groups for each of the outcome variables in the amount of change reported from early pregnancy *(12-16 weeks)* to late pregnancy *(36-40 weeks)*, early pregnancy *(12-16 weeks)* to post pregnancy *(12-16 weeks)*, and late pregnancy *(36-40 weeks)* to post pregnancy *(12-16 weeks)*.

Repeated Measures ANOVAs were undertaken with the following outcome variables:

- Perceptions of coping assets (positive psychological well-being)
- Perceptions of coping deficits (negative psychological well-being)
- Perceptions of physical well-being
- Perceptions of body image
- Perceptions of somatic symptoms
- Attitudes to marital relationships
- Attitudes to sex
- Attitudes to pregnancy and the baby

The assumptions of the Repeated Measures ANOVA's were assessed by means of the tests of sphericity and residual and probability plots. All of the variables considered in the analysis showed no evidence against any of the assumptions using these approaches.

Two sample t-tests were also undertaken between the two groups (i.e. exercise and control) with each of the above outcome variables in early pregnancy. This allowed baseline comparisons of each of the outcome variables between the two groups before the intervention began.

Two sample t-tests were undertaken to compare the groups in relation to the following outcome variables measured on one occasion:

- Birthweight[†]
- Episodes of physical activity

The non parametric chi-square test allows comparison of the proportion of subjects from research groups who fall into varying categories. Chi-square tests were undertaken to investigate any differences between the control and exercise groups in terms of:

- Postnatal[†] emotional well-being and depression
- Length of gestation[†] (weeks)

- Duration of labour† (hours)
- Apgar† score of the baby at one and five minutes following birth
- Modes of delivery of the baby in each of the three categories of modes of delivery i.e. normal† (SVD), instrumental and operative† deliveries
- Physical activity levels reported in early pregnancy in each of the four categories i.e. inactive, occasionally active, regularly active and very active
- Drop out rate of subjects during the study

Correlation analyses were undertaken in post pregnancy using Pearson product moment coefficient of correlations. This analyses was conducted to determine if there was any relationship between the frequency of total activity and the responses of the three psychological indicators of coping assets (positive psychological well-being), coping deficits (negative psychological well-being) and physical well-being in post pregnancy.

Descriptive statistics were used to present the following findings:

- Line graphs illustrated any patterns of change in the outcome variables during and following pregnancy
- Bar graph demonstrated the frequency in the modes of delivery
- Frequency distribution of total activity for the control and exercise groups

Tables indicated relevant information related to:

- Demographic details of subjects
- Subjects in the study
- Mode of delivery
- Maternal complications
- Frequency and distribution of the types of physical activity undertaken during the study

CHAPTER 4

RESULTS

This chapter describes the analyses carried out and reports on the results from the randomised controlled study of healthy first time prospective mothers during and following pregnancy.

4.1 Subjects

Subjects were first time prospective mothers who attended the antenatal clinic at Ayrshire Central Hospital, Irvine for their first antenatal appointment in early pregnancy. All women recruited to the study were healthy women with no history of medical conditions or previous miscarriage and who had an uneventful and healthy pregnancy at the time of recruitment. The number and percentages of subjects in each group who were recruited to the study, dropped out of the study and completed the study are presented in Table 4.1.1.

The control group continued with the existing antenatal education programme during and following pregnancy while the exercise group had, in addition, a structured aerobic exercise programme. A total of 75 women were recruited to the control group of whom 48 (64%) completed the study. A total of 82 women were recruited to the exercise group of whom 50 (61%) completed the study.

Table 4.1.1 Number (%) of subjects in each group who were recruited, dropped out and completed the study

Group	Number Recruited	Number (%) who dropped out: Immediately	During	Number (%) Completed
Control	75	22 (29%)	5 (7%)	**48 (64%)**
Exercise	82	27 (33%)	5 (6%)	**50 (61%)**
Overall	157	49 (32%)	10 (6%)	**98 (62%)**

The drop out rate of subjects from each group was greatest following recruitment after consent was obtained and before any data was collected i.e. 22 (29%) from the

control group and 27 (33%) from the exercise group. Thereafter, the drop out rate from each group was minimal during the remainder of the study i.e. control group 5 (7%) and exercise group 5 (6%).

The age range, mean age, and the number and percentage of women in each age group are presented in Table 4.1.2. The age range and mean age of women in the two groups were comparable and a chi-square test indicated that the two groups were not significantly different in relation to the number of women within each age group. The average age was 28 years for the women in the control group and 27 years for the women in the exercise group. The majority of women in both groups were noted to be between 26 and 35 years of age.

Table 4.1.2 Age range and mean age of women and number (%) of women in each age group

Group	Age (years)		<20	21-25	26-30	31-35	>35
Control	**Range**	**Mean $_{SD}$**	5	10	35	20	5
(n=75)	17-38	28 $_{SD\,5}$	(7%)	(13%)	(47%)	(26%)	(7%)
Exercise	17-36	26 $_{SD\,7}$	7	13	34	24	4
(n=82)			(8%)	(16%)	(42%)	(29%)	(5%)
X^2= 0.90 DF = 4, P-Value = 0.92							

The number (%) of women in both groups in terms of relationship status and employment status are presented in Table 4.1.3. Of the women in the control group, 45 (60%) were married and 65 (94%) were in employment. In the exercise group, 50 (61%) of the women were married and 61 (74%) were in employment.

Table 4.1.3 Number (%) of women in each group in terms of relationship and employment status

Group	Relationship Status			Employment Status		
	Married	Partner	Single	Employed	Unemployed	Student
Control	45	18	12	65	10	0
(n= 75)	(60%)	(24%)	(16%)	(94%)	(6%)	(0%)
Exercise	50	25	7	61	18	3
(n=82)	(61%)	(30%)	(9%)	(74%)	(22%)	(4%)
X^2 = 2.41, DF = 2, P-Value = 0.30				**X^2 =5.11, DF =2, P-Value = 0.08**		

A chi-square test undertaken indicated that the two groups were not significantly different in terms of relationship status and employment status.

At the time of recruitment in early pregnancy, women were asked to identify their levels of activity i.e: inactive, if they did not take any form of physical activity; occasionally active if activity was not undertaken on any regular basis; regularly active if they had set episodes of activity per week; and very active if they exercised more than three times per week. Information was obtained from 53 women in the control group and 55 women in the exercise group The number (%) of women in each group, within each of the four classifications of activity levels reported in early pregnancy, are presented in Table 4.1.4.

Table 4.1.4 Classification of activity levels at time of recruitment for the number (%) of women in each group

Group	Classification of Activity Levels at Time of Recruitment (early pregnancy)			
	Inactive	Occasionally Active	Regularly Active	Very Active
Control (n=53)	14 (26%)	28 (53%)	8 (15%)	3 (6%)
Exercise (n=55)	9 (16%)	33 (60%)	7 (13%)	6 (11%)
$X^2 = 2.53$, DF = 3, P-Value = 0.47				

Inactivity was reported by 14 (26%) of the women in the control group and 9 (16%) of the women in the exercise group. The majority of the women in each group reported being active only on occasion i.e. 28 (53%) in the control group and 33 (60%) in the exercise group. A chi-square test was undertaken which indicated that both groups were not significantly different in relation to the levels of activity reported in early pregnancy.

4.2 Analysis

All analyses were carried out using the Minitab Statistics Package. The types of statistical tests carried out depended on the outcome variables being investigated and included Repeated Measures Analysis of Variance, Pearson product moment coefficient of correlation analysis, Two Sample T-Tests and Chi-square Tests.

Repeated Measures Analyses of Variances (ANOVAs) were carried out to investigate differences between the ***groups*** (i.e. two levels - exercise and control) at the ***time*** points (i.e. three levels - early, late and post pregnancy). The Minitab GLM (General Linear Model) command was used to carry out the Repeated Measures ANOVAs. The time points of interest were; early pregnancy (12-16 weeks); late pregnancy (36-40 weeks) and post pregnancy (12-16 weeks). Significance level used was $p < 0.05$.

A follow up Multiple Comparisons Procedure with a simultaneous 95% confidence level was undertaken if a significant ***interaction*** of time and exercise group was found. The main effects of exercise group or time were of limited interest when there was found to be a significant exercise group/time ***interaction*** since the groups were expected to be comparable in early pregnancy. This exercise group/time ***interaction*** was of prime importance because the two groups were 'expected' to be similar in early pregnancy and thus a significant ***interaction*** would arise due to the intervention where the difference between the two groups would only manifest themselves in late pregnancy and post pregnancy. Due to this exercise group/time ***interaction,*** then any overall differences (i.e. averaged over early, late and post values) would be of limited interest for the main effect of the exercise group because they should be similar in early pregnancy. This limited interest was similar for the main effect of time (i.e. averaged across the exercise and control group) because the patterns of the two groups across time were different. Thus, a significant exercise group/time ***interaction*** superseded any other (main) effect. The follow up tests allowed further, more detailed investigation, of any differences between the groups for each of the outcome variables measured in the amount of change reported from early (12-16 weeks) to late (36-40 weeks) pregnancy; early (12-16 weeks) to post (12-16 weeks) pregnancy, and late (36-40 weeks) to post (12-16 weeks) pregnancy.

Two sample t-tests were undertaken between the two groups (i.e. exercise and control), with each of the outcome variables in early pregnancy. This allowed baseline comparisons of each of the outcome variables between the two groups before the intervention began.

Two sample t-tests were undertaken to compare mean values of outcome variables measured only once during the study, such as length of gestation†, duration of labour†, birthweight† and episodes of physical activity. Chi-square tests were undertaken to compare the two groups in relation to demographic details; length of gestation, duration of labour, mode of delivery, Apgar scores, birthweight, postnatal emotional well-being, activity levels and subjects who dropped out of the study. Correlation analyses was undertaken in post pregnancy using Pearson product moment coefficient of correlation. This analyses was conducted to determine if there was a relationship between the frequency of total activity and the responses of the three psychological indicators of coping assets (positive psychological well-being), coping deficits (negative psychological well-being) and physical well-being.

Analyses were carried out following advice from a statistician in the Statistics Department, University of Glasgow.

4.3 Results

The results are reported on the following outcome variables each measured at the three time points (early, late and post pregnancy):

- Perceptions of Coping Assets (positive psychological well-being)
- Perceptions of Coping Deficits (negative psychological well-being)
- Perceptions of Physical Well-being
- Perceptions of Body Image
- Perceptions of Somatic Symptoms
- Attitudes to Marital Relationships
- Attitude to Sex
- Attitude to Pregnancy / Baby

The results are reported on the following outcome variables each measured on one occasion during the study:

- Postnatal† Emotional well-being / depression
- Pregnancy Outcomes: period of gestation†; length of labour† and delivery mode
- Apgar† score of baby at birth

- Birthweight†
- Activity levels in early pregnancy
- Episodes of physical activity
- Drop out rate of subjects
- Frequency of activity

4.3.1 Perceptions of Coping Assets (positive psychological well-being)

Perceptions of coping assets (positive psychological well-being) predominantly contained positive statements and feelings of 'self'. An increase in scores indicated a more positive perception in the ability to cope. In contrast, more negative perceptions were denoted by a decrease in scores i.e. a reduction in the perceived ability to cope.

Repeated Measures ANOVA showed a significant interaction ($p < 0.001$) between the two groups and three time points This interaction is depicted in Figure 4.3.1 and the ANOVA results are shown in Table 4.3.1. This interaction was a key result which indicated that any differences between the two groups in terms of the scores for perceptions of coping assets (positive psychological well-being) were not the same at the three time points for the two groups i.e. early, late and post pregnancy.

Figure 4.3.1 Mean scores for perceptions of coping assets (positive psychological well-being)

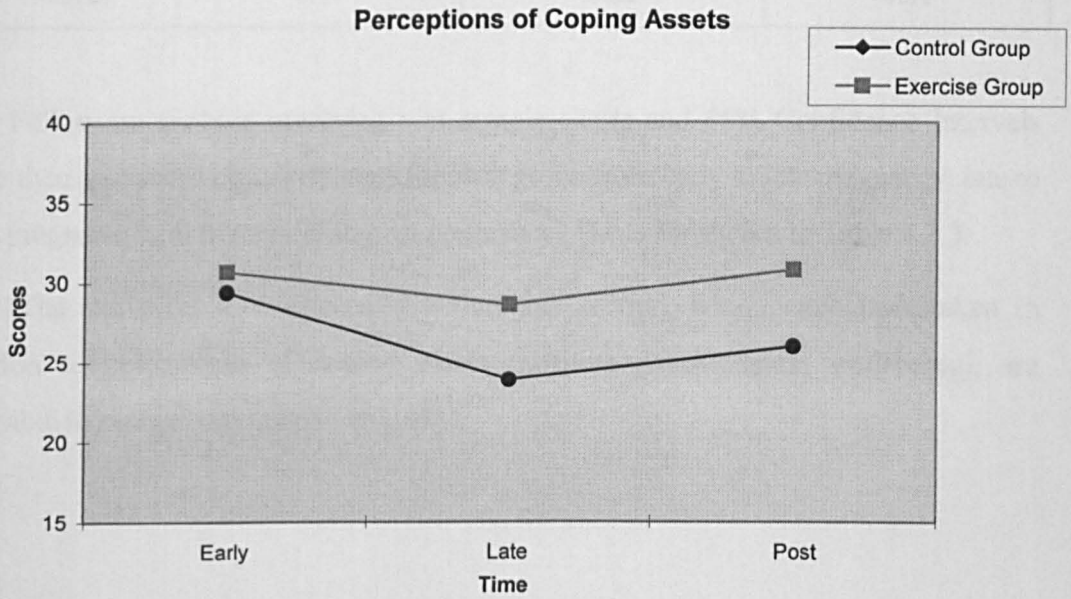


Table 4.3.1 ANOVA table for perceptions of coping assets (positive psychological well-being)

Perceptions of Coping Assets: Results of ANOVA across all 3 Time Points			
Source	**DF**	**F**	**P**
Exercise group	1	4.95	0.027
Time	2	5.66	0.004
Exercise group*Time	2	9.55	0.000
Subject	93	4.00	0.000
Error	160		
Total	258		

Mean scores and standard deviations for both groups at each time point are shown in Table 4.3.2 along with significance of the differences established by between group follow up tests. The follow up tests indicated that there was no difference between the two groups in early pregnancy but there were significant differences noted in both late pregnancy and post pregnancy.

Table 4.3.2 Mean (SD) scores for perceptions of coping assets in early, late and post pregnancy with between group follow up tests and p-values

Group	*Early Pregnancy*	*Late Pregnancy*	*Post Pregnancy*
Control	29.8 $_{SD\ 8.9}$	24.1 $_{SD\ 9.2}$	25.6 $_{SD\ 10.2}$
Exercise	30.4 $_{SD\ 8.9}$	28.9 $_{SD\ 9.4}$	31.1 $_{SD\ 9.0}$
P-value	**0.17**	**0.02**	**0.01**

Follow up analysis involving two sample t-tests and 95% Confidence Intervals were then calculated on the changes for each group from early to late pregnancy, late to post pregnancy and from early to post pregnancy. These are shown in Table 4.3.3.

(The statistical tests discussed within this section, which were undertaken in relation to perceptions of coping assets (positive psychological well-being), are available in more detail in appendix 17).

Table 4.3.3. Follow up Multiple Comparisons tests for perceptions of coping assets

Follow up Multiple Comparisons of 'Interaction' for Coping Assets Simultaneous 95% Confidence Intervals				
Changes from:		***Early Pregnancy***		***Late Pregnancy***
Group		***Late minus Early***	***Post minus Early***	***Post minus Late***
Control	Mean (SD) 95% CI	-6.8 (9.6) (-9.9, -3.7)	-4.8 (10.5) (-8.2, -1.3)	+1.6 (9.8) (-1.7, 4.8)
Exercise	Mean (SD) 95% CI	+0.2 (7.7) (-2.1, 2.6)	+2.1 (7.7) (-0.2, 4.4)	+1.6 (7.4) (-0.6, 3.8)
Exercise **minus** Control	Difference 95% CI	7.0 (3.2, 10.9)	6.9 (2.7, 10.9)	0 (-3.8, 3.9)
	P-value	<0.001	<0.001	>0.05

On the perception of coping assets scale, there was a significant difference found between the two groups in the amount of change from early to late pregnancy; the control group showed a significant decrease while the exercise group showed no significant change during the same period.

A significant difference was found between the groups in the amount of change from early to post pregnancy; the control group again showed a significant decrease in scores on average during this period while there was no evidence of change within the exercise group during and following pregnancy.

No significant difference was found between the groups in the amount of change from late to post pregnancy. There was found to be no significant change, on average, within either of the groups during this period.

From the findings, it can be concluded that the women in the exercise group showed, on average, a maintenance in the perceptions of coping assets from early to post pregnancy. This was in contrast to the women in the control group, who showed a significant decrease in the perceptions of coping assets during the same period.

4.3.2 Perceptions of Coping Deficits (negative psychological well-being)

Perceptions of coping deficits (negative psychological well-being) consisted predominantly of negative feelings and poor competence. An increase in the coping deficits score indicated a negative response in perceptions of deficits in the ability to cope. In contrast, if the score decreased this indicated a reduction in perceptions of deficits in coping which signified a more positive response.

Repeated Measures ANOVA showed a significant interaction ($p < 0.001$) between the two groups and three time points This interaction is depicted in Figure 4.3.2 and the ANOVA results are shown in Table 4.3.4. This interaction was a key result which indicated that any differences between the two groups in terms of the scores for perceptions of coping deficits (negative psychological well-being) were not the same at the three time points for the two groups i.e. early, late and post pregnancy.

Figure 4.3.2 Mean scores of perceptions of coping deficits (negative psychological well-being)

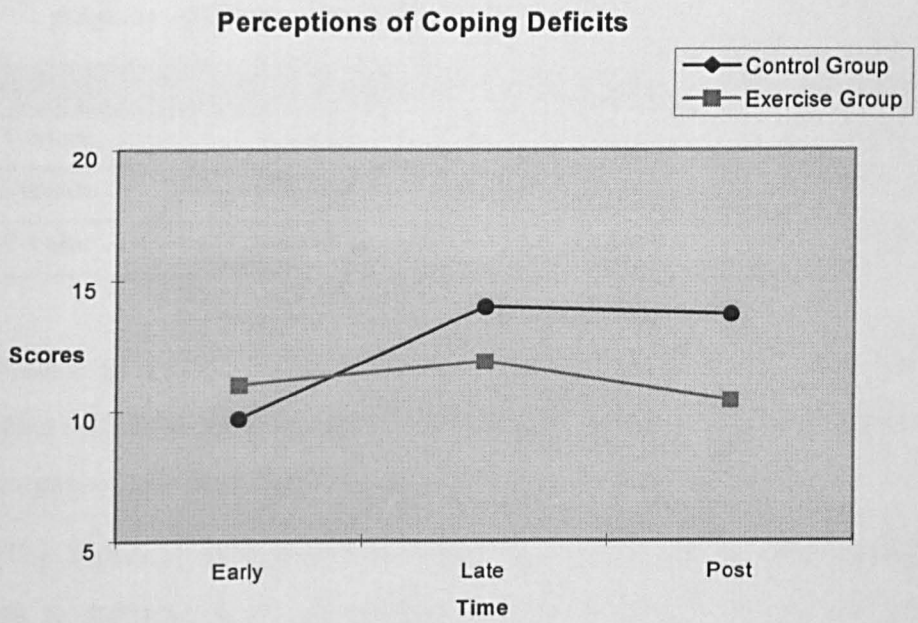


Table 4.3.4 ANOVA table for perceptions of coping deficits (negative psychological well-being)

Perceptions of Coping Deficits: Results of ANOVA across all 3 Time Points			
Source	**DF**	**F**	**P**
Exercise group	1	11.72	0.001
Time	2	7.78	0.001
Exercise group*Time	2	10.48	0.000
Subject	93	3.63	0.000
Error	164		
Total	262		

Mean scores and standard deviations for both groups at each time point are shown in Table 4.3.5 along with the level of significance of the differences established by between group follow up tests. The follow up tests indicated that there was no difference between the two groups in both early pregnancy and late pregnancy but there was a significant difference noted post pregnancy.

Table 4.3.5 Mean (SD) scores for perceptions of coping deficits in early, late and post pregnancy with between group follow up tests and p-values

Group	*Early Pregnancy*	*Late Pregnancy*	*Post Pregnancy*
Control	9.7 SD 3.7	14.4 SD 6.9	14.0 SD 6.9
Exercise	10.8 SD 5.2	11.7 SD 6.5	10.2 SD 6.8
P-value	**0.24**	**0.17**	**0.01**

Follow up analysis involving two sample t-tests and 95% Confidence Intervals were then calculated on the changes for each group from early to late pregnancy, late to post pregnancy and from early to post pregnancy. These are shown in Table 4.3.6.

(The statistical tests discussed within this section, which were undertaken in relation to perceptions of coping deficits (negative psychological well-being), are available in more detail in appendix 18).

Table 4.3.6 Follow up Multiple Comparisons tests for perceptions of coping deficits

Follow up Multiple Comparisons of 'Interaction' for Coping Deficits Simultaneous 95% Confidence Intervals				
Changes from:		***Early Pregnancy***		***Late Pregnancy***
Group		***Late minus Early***	***Post minus Early***	***Post minus Late***
1. Control	Mean (SD) 95% CI	+5.2 (6.5) (3.1, 7.3)	+4.4 (7.9) (1.8, 7.0)	-0.8 (8.8) (-3.7, 2.0)
2. Exercise	Mean (SD) 95% CI	+0.3 (5.1) (-1.2, 1.8)	-1.1 (6.4) (-3.0, 0.8)	-1.3 (5.6) (-2.9, 0.3)
Exercise ***minus*** Control	Difference 95% CI	-4.9 (-7.5, -2.4)	-5.5 (-8.7, -2.3)	-0.5 (-3.7, 2.7)
	P-value	<0.001	<0.001	>0.05

On the perceptions of coping deficits scale (negative psychological well-being), there was a significant difference found between the two groups in the amount of change from early to late pregnancy; the control group showed a significant increase while the exercise group showed no significant change during the same period.

A significant difference was found between the two groups in the amount of change from early to post pregnancy; the control group again showed a significant increase while the exercise group showed no significant change during the same period.

No significant difference was found between the two groups in the amount of change from late to post pregnancy. No significant change was found within either of the two groups during this period.

From the findings, it can be concluded that women in the exercise group experienced no significant change, on average, in perceptions of coping deficits (negative psychological well-being) from early to post pregnancy. In contrast, women in the control group experienced a significant increase in their perceptions of coping deficits which was more negative and indicated perceived deficits in coping during and following pregnancy.

4.3.3 Perceptions of Physical Well-being

Perceptions of physical well-being predominantly contained statements about physical well-being e.g. feelings of being healthy, strong, supple etc. An increase in scores indicated a more positive perception in physical well-being while negative perceptions of physical well-being were denoted by a decrease in scores.

Repeated Measures ANOVA showed a significant interaction ($p < 0.001$) between the two groups and three time points This interaction is depicted in Figure 4.3.3 and the ANOVA results are shown in Table 4.3.7. This interaction was a key result which indicated that any differences between the two groups in terms of the scores for perceptions of coping assets were not the same at the three time points for the two groups i.e. early, late and post pregnancy.

Figure 4.3.3 Mean scores of perceptions of physical well-being

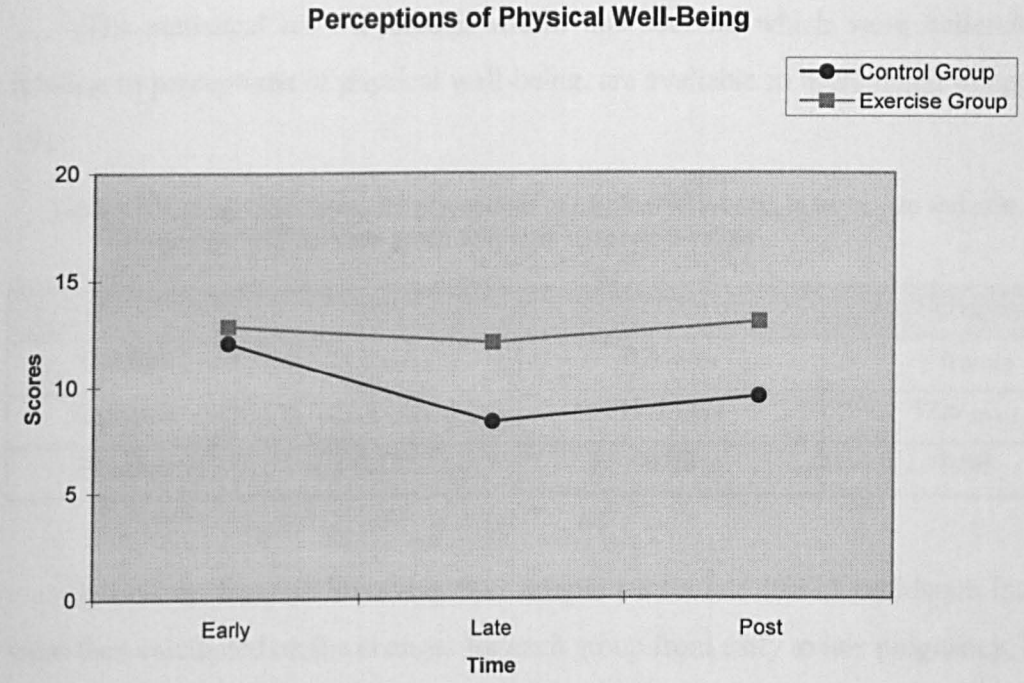


Table 4.3.7 ANOVA table for perceptions of physical well-being

Perceptions of Physical Well-being: Results of ANOVA across all 3 Time Points			
Source	**DF**	**F**	**P**
Exercise group	1	11.20	0.001
Time	2	7.50	0.001
Exercise group*Time	2	8.39	0.000
Subject	93	2.75	0.000
Error	162		
Total	260		

Mean scores and standard deviations for both groups at each time point are shown in Table 4.3.8 along with the level of significance of the differences established by between group follow up tests. The follow up tests indicated that there was no difference between the two groups in early pregnancy but significant differences were noted in both late pregnancy and post pregnancy.

(The statistical tests discussed within this section, which were undertaken in relation to perceptions of physical well-being, are available in more detail in appendix 19).

Table 4.3.8 Mean (SD) scores for perceptions of physical well-being in early, late and post pregnancy with between group follow up tests and p-values

Group	*Early Pregnancy*	*Late Pregnancy*	*Post Pregnancy*
Control	11.5 SD 3.4	8.3 SD 4.4	9.6 SD 4.9
Exercise	12.8 SD3.4	11.7 SD 4.8	12.6 SD 4.1
P-value	**0.12**	**0.00**	**0.00**

Follow up analysis involving two sample t-tests and 95% Confidence Intervals were then calculated on the changes for each group from early to late pregnancy, late to post pregnancy and from early to post pregnancy. These are shown in Table 4.3.9.

Table 4.3.9. Follow up Multiple Comparisons tests for perceptions of physical well-being

Follow up Multiple Comparisons of 'Interaction' for Physical Well-being Simultaneous 95% Confidence Intervals				
Changes from:		***Early Pregnancy***		***Late Pregnancy***
Group		***Late minus Early***	***Post minus Early***	***Post minus Late***
Control	Mean (SD) 95% CI	-3.8 (4.9) (-5.4, -2.2)	-2.9 (5.6) (-4.7, -1.1)	+0.9 (4.6) (-0.6, 2.4)
Exercise	Mean (SD) 95% CI	-0.1 (4.7) (-1.5, 1.3)	+0.6 (4.9) (-0.8, 2.1)	+0.9 (4.8) (-0.6, 2.3)
Exercise ***minus*** Control	Difference 95% CI	3.7 (1.6, 5.8)	2.3 (1.2, 3.5)	0 (-2.0, 2.0)
	P-value	<0.001	<0.01	>0.05

On the perception of physical well-being scale, there was a significant difference found between the two groups in the amount of change from early to late pregnancy; the control group showed a significant decrease while the exercise group showed no significant change during the same period.

A significant difference was found between the amount of change from early to post pregnancy between the groups; the control group again showed a significant decrease in scores on average during this period while there was no evidence of change within the exercise group during and following pregnancy.

No significant difference was found between the groups in the amount of change from late to post pregnancy. No significant change, on average, was found within either of the two groups during this period.

From the findings, it can be concluded that the women in the exercise group experienced, on average, a maintenance in the perceptions of physical well-being from early to post pregnancy. This was in contrast to the women in the control group, who experienced a significant decrease in the perceptions of physical well-being during the same period.

4.3.4 Perceptions of Body Image

Perceptions of body image predominantly consisted of statements about perceived attractiveness, body shape and to what extent women were pleased or disappointed in the shape of their body during and following pregnancy. An increase in scores indicated more positive perceptions in body image while more negative perceptions in body image were denoted by a decrease in scores.

Repeated Measures ANOVA showed a significant interaction ($p < 0.001$) between the two groups and three time points This interaction is depicted in Figure 4.3.4 and the ANOVA results are shown in Table 4.3.10. This interaction was a key result which indicated that any differences between the two groups in terms of the scores for perceptions of body image were not the same at the three time points for the two groups i.e. early, late and post pregnancy.

Figure 4.3.4 Mean scores for perceptions of body image

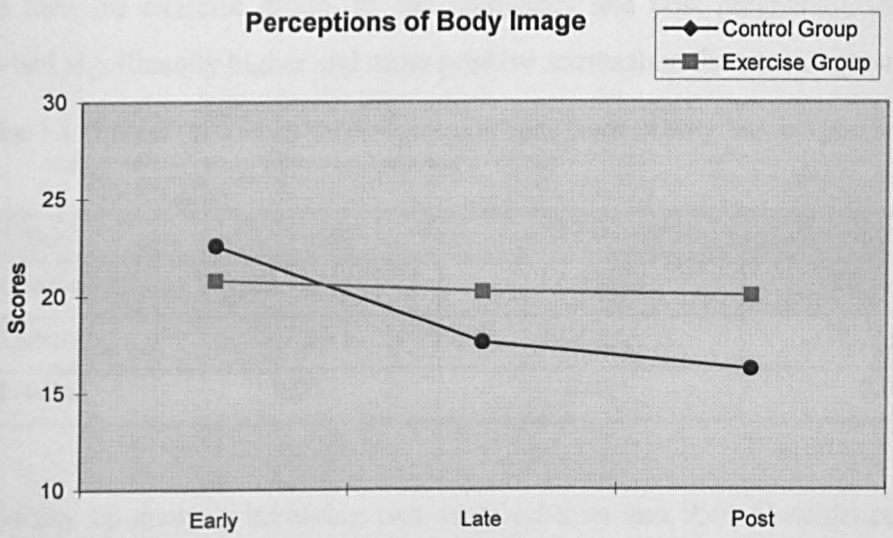


Table 4.3.10 ANOVA table for perceptions of body image

Perceptions of Body Image: Results of ANOVA across all 3 Time Points			
Source	**DF**	**F**	**P**
Exercise group	1	0.05	0.818
Time	2	22.94	0.000
Exercise group*Time	2	17.94	0.000
Subject	93	1.89	0.000
Error	155		
Total	253		

Mean scores and standard deviations for both groups at each time point are shown in Table 4.3.11 along with significance of the differences established by between group follow up tests. The follow up tests indicated that there were significant differences between the two groups in early pregnancy, late pregnancy and post pregnancy. In early pregnancy, the control group had significantly higher scores and more positive scores than the exercise group. In late pregnancy and post pregnancy, the exercise group had significantly higher and more positive scores than the control group.

Table 4.3.11 Mean (SD) scores for perceptions of body image in early, late and post pregnancy with between group follow up tests and p-values

Group	*Early Pregnancy*	*Late Pregnancy*	*Post Pregnancy*
Control	22.9 $_{SD3.3}$	17.6 $_{SD\ 5.2}$	16.1 $_{SD\ 4.4}$
Exercise	20.7 $_{SD\ 5.2}$	20.2 $_{SD\ 5.1}$	20.0 $_{SD\ 5.7}$
P-value	**0.03**	**0.01**	**0.00**

Follow up analysis involving two sample t-tests and 95% Confidence Intervals were then calculated on the changes for each group from early to late pregnancy, late to post pregnancy and from early to post pregnancy. These are shown in Table 4.3.12.

(The statistical tests discussed within this section, which were undertaken in relation to perceptions of body image, are available in more detail in appendix 20).

Table 4.3.12. Follow up Multiple Comparisons tests for perceptions of body image

Follow up Multiple Comparisons of 'Interaction' for Body Image Simultaneous 95% Confidence Intervals				
Changes from:		***Early Pregnancy***		***Late Pregnancy***
Group		***Late minus Early***	***Post minus Early***	***Post minus Late***
Control	Mean (SD)	-6.2 (7.4)	-8.5 (8.6)	-2.2 (5.3)
	95% CI	(-8.8, -3.6)	(-11.5, -5.6)	(-4.0, -0.4)
Exercise	Mean (SD)	-0.5 (4.8)	-0.5 (5.6)	-0.4 (5.8)
	95% CI	(-1.9, 1.0)	(-2.2, 1.1)	(-2.2, 1.3)
Exercise ***minus*** Control	Difference	5.7	8.0	1.8
	95% CI	(2.8, 8.6)	(4.7, 11.4)	(-0.7, 4.2)
	P-value	<0.001	<0.001	>0.05

On the perception of body image scale, there was a significant difference found between the two groups in the amount of change from early to late pregnancy; the control group showed a significant decrease while the exercise group showed no significant change during the same period.

A significant difference was found between the groups in the amount of change from early to post pregnancy; the control group again showed a significant decrease in scores on average during this period. In contrast, there was no evidence of change within the exercise group during and following pregnancy.

No significant difference was found between the groups in the amount of change from late to post pregnancy. There was noted to be a significant decrease in the amount of change within the control group during this same period.

From the findings, it can be concluded that the women in the exercise group showed, on average, a maintenance in the perceptions of body image from early to post pregnancy. This was in contrast to the women in the control group, who showed a significant decrease in the perceptions of body image during the same period.

4.3.5 Perceptions of Somatic Symptoms

Somatic symptoms experienced during pregnancy are those symptoms which affect the body in terms of health and well-being and include feelings of nausea and vomiting, constipation, swollen ankles, fainting and light-headedness, fatigue and tiredness.

Perceptions of somatic symptoms predominantly contained statements about the extent to which somatic symptoms were experienced. An increase in scores indicated a more positive perception in the extent to which somatic symptoms were experienced while more negative perceptions were denoted by a decrease in scores i.e. somatic symptoms were experienced to a greater extent.

Repeated Measures ANOVA showed a significant interaction ($p < 0.001$) between the two groups and three time points This interaction is depicted in Figure 4.3.5 and the ANOVA results are shown in Table 4.3.13. This interaction was a key result which indicated that any differences between the two groups in terms of the scores for perceptions of somatic symptoms were not the same at the three time points for the two groups i.e. early, late and post pregnancy.

Figure 4.3.5 Mean scores for perceptions of somatic symptoms

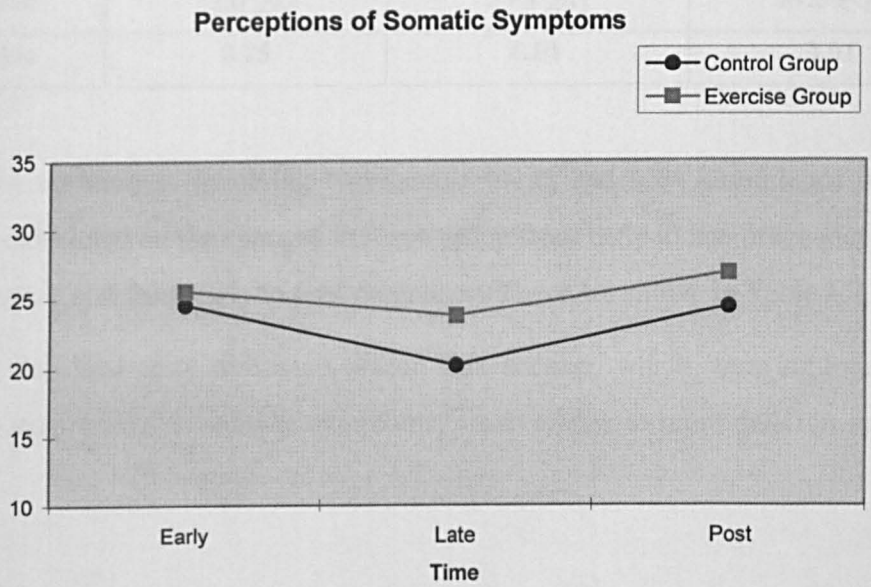


Table 4.3.13 ANOVA table for perceptions of somatic symptoms

Perceptions of Somatic Symptoms: Results of ANOVA across all 3 Time Points			
Source	**DF**	**F**	**P**
Exercise group	1	1.08	0.299
Time	2	18.24	0.000
Exercise group*Time	2	8.33	0.000
Subject	93	1.69	0.000
Error	152		
Total	250		

Mean scores and standard deviations for both groups at each time point are shown in Table 4.3.14 along with significance of the differences established by between group follow up tests. The follow up tests indicated that there was no difference between the two groups in early pregnancy but there were significant differences noted in both late pregnancy and post pregnancy.

Table 4.3.14 Mean (SD) scores for perceptions of somatic symptoms in early, late and post pregnancy with between group follow up tests and p-values

Group	*Early Pregnancy*	*Late Pregnancy*	*Post Pregnancy*
Control	24.7 $_{SD\,4.6}$	20.1 $_{SD5..5}$	24.5 $_{SD4.6}$
Exercise	25.6 $_{SD4.6}$	23.9 $_{SD4.2}$	27.0 $_{SD\,4.1}$
P-value	**0.25**	**0.01**	**0.01**

Follow up analysis involving two sample t-tests and 95% Confidence Intervals were then calculated on the changes for each group from early to late pregnancy, late to post pregnancy and from early to post pregnancy. These are shown in Table 4.3.15.

(The statistical tests discussed within this section, which were undertaken in relation to perceptions of somatic symptoms, are available in more detail in appendix 21).

Table 4.3.15 Follow up Multiple Comparisons tests for perceptions of somatic symptoms

Follow up Multiple Comparisons of 'Interaction' for Somatic Symptoms Simultaneous 95% Confidence Intervals				
Changes from:		***Early Pregnancy***		***Late Pregnancy***
Group		***Late minus Early***	***Post minus Early***	***Post minus Late***
Control	Mean (SD) 95% CI	-5.3 (7.1) (-7.7, -3.0)	-0.6 (7.2) (-2.9, 1.7)	+4.7 (5.4) (2.8, 6.5)
Exercise	Mean (SD) 95% CI	-0.1 (5.7) (-1.8, 1.7)	+ 3.4 (5.4) (1.8, 5.0)	+3.6 (4.7) (2.1, 5.0)
Exercise ***minus*** Control	Difference 95% CI	5.2 (2.4, 8.2)	2.8 (1.2, 6.8)	1.1 (-3.4, 1.2)
	P-value	<0.001	<0.01	>0.05

On the perception of somatic symptoms scale, there was a significant difference found between the two groups in the amount of change from early to late pregnancy; the control group showed a significant decrease while the exercise group showed no significant change during the same period.

A significant difference was found between the groups in the amount of change from early to post pregnancy; the control group again showed a significant decrease, on average, during this period while there was a significant increase within the exercise group during and following pregnancy.

No significant difference was found between the groups in the amount of change noted from late to post pregnancy. There was a significant increase found in the change, on average, within both groups during this period.

From the findings, it can be concluded that the women in the exercise group showed, on average, a maintenance in the perceptions of somatic symptoms from early to post pregnancy, which was in contrast to the women in the control group, who showed a significant increase in the perceptions of somatic symptoms during the same period.

4.3.6 Attitudes to Marital Relationships

A positive attitude to marital relationships was indicated by higher scores. Therefore, an increase in scores indicated a more positive attitude to marital relationships while more negative attitudes to marital relationships were denoted by a decrease in scores.

Repeated Measures ANOVA showed a significant interaction ($p < 0.001$) between the two groups and three time points This interaction is depicted in Figure 4.3.6 and the ANOVA results are shown in Table 4.3.16. This interaction was a key result which indicated that any differences between the two groups in terms of the scores for attitudes to marital relationships were not the same at the three time points for the two groups i.e. early, late and post pregnancy.

(The statistical tests discussed within this section, which were undertaken in relation to attitudes to marital relationships, are available in more detail in appendix 22).

Figure 4.3.6 Mean scores of attitude to marital relationships

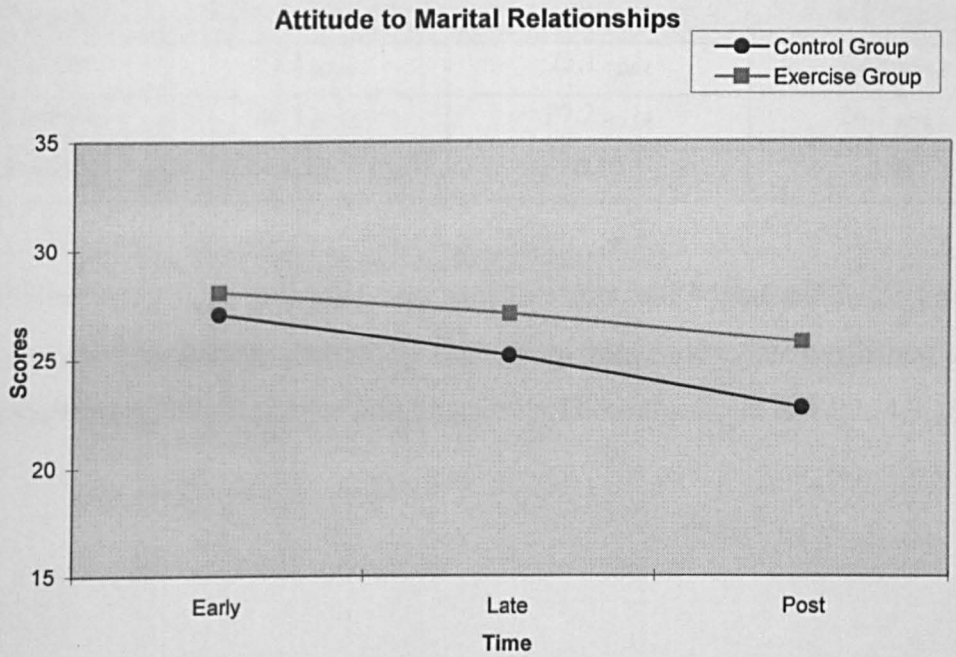


Table 4.3.16 ANOVA table for attitudes to marital relationships

Attitudes to Marital Relationships: Results of ANOVA across all 3 Time Points			
Source	**DF**	**F**	**P**
Exercise group	1	0.03	0.871
Time	2	25.5	0.000
Exercise group*Time	2	8.12	0.000
Subject	92	4.15	0.000
Error	151		
Total	248		

Mean scores and standard deviations for both groups at each time point are shown in Table 4.3.17 along with significance of the differences established by between group follow up tests. The follow up tests indicated that there was no difference between the two groups in early pregnancy and late pregnancy but there was a significant difference noted in post pregnancy.

Table 4.3.17 Mean (SD) scores for attitudes to marital relationships in early, late and post pregnancy with between group follow up tests and p-values

Group	*Early Pregnancy*	*Late Pregnancy*	*Post Pregnancy*
Control	27.1 $_{SD\ 5.8}$	25.1 $_{SD5.4}$	22.8 $_{SD\ 5.8}$
Exercise	28.3 $_{SD\ 5.9}$	27.2 $_{SD\ 5.4}$	26.1 $_{SD\ 6.2}$
P-value	**0.15**	**0.17**	**0.01**

Follow up analysis involving two sample t-tests and 95% Confidence Intervals were then calculated on the changes for each group from early to late pregnancy, late to post pregnancy and from early to post pregnancy. These are shown in Table 4.3.18.

Table 4.3.18 Follow up Multiple Comparisons tests for attitudes to marital relationships

Follow up Multiple Comparisons of 'Interaction' for Marital Relationships Simultaneous 95% Confidence Intervals				
Changes from:		***Early Pregnancy***		***Late Pregnancy***
Group		***Late minus Early***	***Post minus Early***	***Post minus Late***
Control	Mean (SD) 95% CI	-2.1 (5.8) (-4.0, -0.2)	-1.8 (4.9) (-7.5, -4.4)	-4.0 (6.5) (-6.2, -1.9)
Exercise	Mean (SD) 95% CI	-1.2 (4.1) (-2.4, 0.1)	-3.9 (4.9) (-3.4, -0.3)	-1.0 (4.8) (-2.4, 0.5)
Exercise ***minus*** Control	Difference 95% CI	0.9 (-1.3, 3.2)	4.1 (2.0, 6.2)	3.0 (0.5, 5.6)
	P-value	>0.05	<0.001	<0.05

On the attitudes to marital relationship scale, there was no significant difference found between the two groups in the amount of change from early to late pregnancy. The control group showed a significant decrease in attitudes to marital relationships while the exercise group showed no significant change during the same period.

A significant difference was found between the two groups in the amount of change from early to post pregnancy; both groups showed a significant decrease in scores on average during and following pregnancy.

No significant difference was noted between the groups in the amount of change found from late to post pregnancy. The control group continued to show a significant decrease while there was no difference found in the exercise group.

From the findings, it can be concluded that there was a significant difference in the amount of average change in attitudes to marital relationships during and following pregnancy with both groups demonstrating a significant decrease in their attitude to marital relationships throughout this period. Although both groups followed a similar pattern in decrease in their attitudes to marital relationships, the exercise group tended to decrease to a lesser extent than the control group and maintained more positive attitudes to marital relationships both during and following pregnancy.

4.3.7 Attitudes to Sex

A positive attitude to sex was indicated by higher scores. Therefore, an increase in scores indicated a more positive attitude to sex while more negative attitudes to sex were denoted by a subsequent decrease in scores.

Repeated Measures ANOVA showed a significant interaction ($p < 0.001$) between the two groups and three time points This interaction is depicted in Figure 4.3.7 and the ANOVA results are shown in Table 4.3.19 This interaction was a key result which indicated that any differences between the two groups in terms of the scores for attitudes to sex were not the same at the three time points for the two groups i.e. early, late and post pregnancy.

(The statistical tests discussed within this section, which were undertaken in relation to attitudes to sex, are available in more detail in appendix 23).

Figure 4.3.7 Mean scores of attitudes to sex

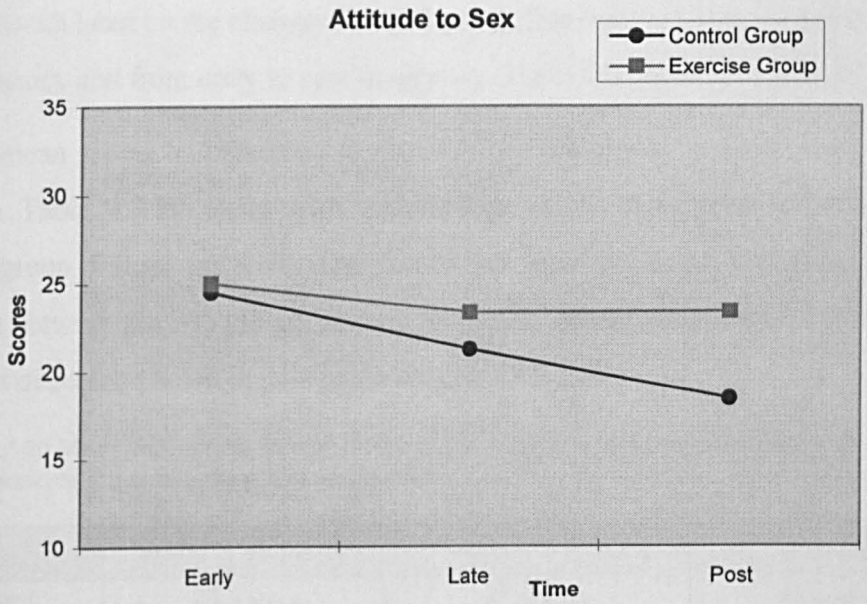


Table 4.3.19 ANOVA table for attitudes to sex

Attitudes to sex: Results of ANOVA across all 3 Time Points			
Source	**DF**	**F**	**P**
Exercise group	1	2.23	0.138
Time	2	16.76	0.000
Exercise group*Time	2	12.47	0.000
Subject	91	2.50	0.000
Error	140		
Total	236		

Mean scores and standard deviations for both groups at each time point are shown in Table 4.3.20 along with significance of the differences established by between group follow up tests. The follow up tests indicated that there was no difference between the two groups in early pregnancy but there were significant differences noted in both late pregnancy and post pregnancy.

Follow up analysis involving two sample t-tests and 95% Confidence Intervals were then calculated on the changes for each group from early to late pregnancy, late to post pregnancy and from early to post pregnancy. These are shown in Table 4.3.21

The mean scores and standard deviations for both groups at each time point are shown in Table 4.3.20 along with significance of the differences established by between group follow up tests. The follow up tests indicated that there was no difference between the two groups in early pregnancy or late pregnancy but there was a significant difference noted in post pregnancy.

Table 4.3.20 Mean (SD) scores for attitudes to sex in early, late and post pregnancy with between group follow up tests and p-values

Group	*Early Pregnancy*	*Late Pregnancy*	*Post Pregnancy*
Control	24.5 $_{SD\ 5.8}$	21.0 $_{SD\ 6.9}$	18.2 $_{SD\ 7.9}$
Exercise	25.2 $_{SD5.7}$	23.5 $_{SD\ 6.0}$	23.7 $_{SD5.4}$
P-value	**0.35**	**0.29**	**0.01**

Follow up two sample t-tests and 95% Confidence Intervals were then calculated on the changes for each group from early to late pregnancy, late to post pregnancy and from early to post pregnancy. These are shown in Table 4.3.21.

On the attitudes to sex scale, there was a significant difference found between the two groups in the amount of change from early to late pregnancy; the control group showed a significant decrease while the exercise group showed no significant change during the same period.

A significant difference was noted between the groups in the amount of change from early to post pregnancy; the control group again showed a significant decrease in scores on average during this period while there was no significant change noted within the exercise group during and following pregnancy.

Table 4.3.21 Follow up Multiple Comparisons tests for attitudes to sex

Follow up Multiple Comparisons of 'Interaction' for Attitudes to Sex Simultaneous 95% Confidence Intervals				
Changes from:		***Early Pregnancy***		***Late Pregnancy***
Group		***Late minus Early***	***Post minus Early***	***Post minus Late***
Control	Mean (SD)	-4.7 (6.9)	-7.9 (9.4)	-3.0 (6.7)
	95% CI	(-7.0, -2.3)	(-11.1, -4.6)	(-5.4, -0.7)
Exercise	Mean (SD)	-0.6 (4.2)	-0.3 (5.4)	-0.02 (6.2)
	95% CI	(-2.0, 0.7)	(-1.9, 1.4)	(-1.9, 1.8)
Exercise ***minus*** Control	Difference	4.1	7.6	2.98
	95% CI	(1.4, 6.7)	(4.0, 11.2)	(0.1, 6.0)
	P-value	<0.01	<0.001	<=0.05

No difference was found between the groups in the amount of change from late to post pregnancy. The control group continued to experience significant decrease in attitudes to sex while there was no significant change noted within the exercise group over this period.

From the findings, it can be concluded that the women in the exercise group experienced, on average, a maintenance in the attitudes to sex from early to post

pregnancy, which was in contrast to the women in the control group, who experienced a significant decrease in the attitudes to sex during the same period.

4.3.8 Attitudes to Pregnancy / Baby

Positive attitudes to pregnancy / baby are indicated by higher scores. Therefore, an increase in scores during pregnancy indicated a more positive attitude to pregnancy while negative attitudes were denoted by a decrease in scores i.e. more negative attitudes to pregnancy. This was similar for attitudes to the baby in the post pregnancy period.

Repeated Measures ANOVA showed a significant interaction ($p < 0.001$) between the two groups and three time points This interaction is depicted in Figure 4.3.8 and the ANOVA results are shown in Table 4.3.22. This interaction was a key result which indicated that any differences between the two groups in terms of the scores for attitudes to pregnancy / baby were not the same at the three time points for the two groups i.e. early, late and post pregnancy.

Figure 4.3.8 Mean scores for attitude to pregnancy / baby

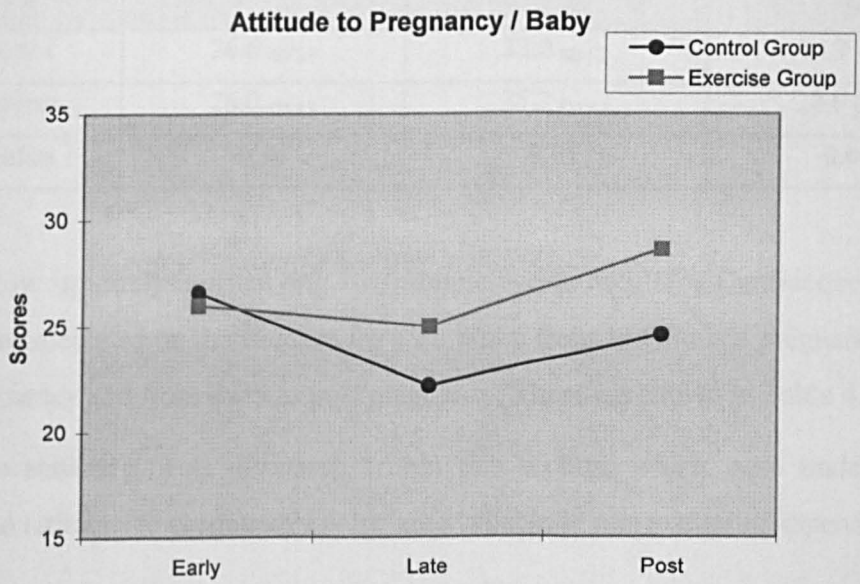


Table 4.3.22 ANOVA table for attitudes to pregnancy / baby

Attitudes to Pregnancy / Baby: Results of ANOVA across all 3 Time Points			
Source	**DF**	**F**	**P**
Exercise group	1	3.77	0.054
Time	2	17.62	0.000
Exercise group*Time	2	16.04	0.000
Subject	93	2.53	0.000
Error	156		
Total	254		

Mean scores and standard deviations for both groups at each time point are shown in Table 4.3.23 along with significance of the differences established by between group follow up tests. The follow up tests indicated that there was no difference between the two groups in early pregnancy but there were significant differences noted in both late pregnancy and post pregnancy.

Table 4.3.23 Mean (SD) scores for attitudes to pregnancy / baby in early, late and post pregnancy with between group follow up tests and p-values

Group	*Early Pregnancy*	*Late Pregnancy*	*Post Pregnancy*
Control	26.6 $_{SD\ 3.9}$	22.0 $_{SD\ 5.2}$	24.7 $_{SD5.1}$
Exercise	26.0 $_{SD\ 8.9}$	25.2 $_{SD\ 9.4}$	28.6 $_{SD3..8}$
P-value	**0.38**	**0.01**	**0.00**

Follow up analysis involving two sample t-tests and 95% Confidence Intervals were then calculated on the changes for each group from early to late pregnancy, late to post pregnancy and from early to post pregnancy. These are shown in Table 4.3.24.

(The statistical tests discussed within this section, which were undertaken in relation to attitudes to pregnancy / baby, are available in more detail in appendix 24).

Table 4.3.24. Follow up Multiple Comparisons tests for attitudes to pregnancy / baby

Follow up Multiple Comparisons of 'Interaction' for Attitudes to Pregnancy / Baby Simultaneous 95% Confidence Intervals				
Changes from:		***Early Pregnancy***		***Late Pregnancy***
Group		***Late minus Early***	***Post minus Early***	***Post minus Late***
Control	Mean (SD) 95% CI	-5.1 (5.6) (-6.9, -3.3)	-2.2 (6.7) (-4.4, -0.03)	+2.7 (5.3) (0.9, 4.4)
Exercise	Mean (SD) 95% CI	-0.4 (4.6) (-1.8, 1.0)	+3.3 (4.7) (-1.9, 4.7)	+3.7 (4.2) (2.5, 5.0)
Exercise ***minus*** Control	Difference 95% CI	4.7 (2.4, 6.9)	5.5 (2.9, 8.1)	1.0 (- 1.1, 3.18)
	P-value	<0.001	<0.001	>0.05

On the attitudes to pregnancy / baby scale, there was a significant difference found between the two groups in the amount of change from early to late pregnancy; the control group showed a significant decrease while the exercise group showed no significant change during the same period.

A significant difference was found between the two groups in the amount of change from early to post pregnancy; the control group again showed a significant decrease in scores on average during this period while there was no evidence of change within the exercise group during and following pregnancy.

No significant difference was noted between the groups in the amount of change found from late to post pregnancy. A significant positive change ,on average, was found within the two groups during this period.

From the findings, it can be concluded that the women in the exercise group experienced, on average, a maintenance in attitudes to pregnancy / baby from early to post pregnancy, which was in contrast to the women in the control group, who experienced a significant negative change in attitude to pregnancy during pregnancy with positive significant change in attitudes to the baby in post pregnancy.

4.3.9 Postnatal[†] Emotional Well-being / Depression

Postnatal emotional well-being / depression measured by the Edinburgh Postnatal Depression Scale (EPDS) has a possible range of scores between 0 and 30 points. Lower scores indicate positive emotional well-being with higher scores being more negative and indicating a decrease in emotional well-being states. The measurement tool (EPDS) is a screening tool designed to indicate a tendency towards depressive states with increasing levels of symptoms with scores >12 points (Cox *et al* 1987).

The number (%) of women, who responded within each of the three identified scoring categories (less than 4 points; between 5-8 points and greater than 8 points), is presented in Table 4.3.25. In both groups, a reduced number of women responded to this particular outcome variable i.e. 77% (n=37) women in the control group and 94% (n=47) women in the exercise group.

Table 4.3.25 Postnatal emotional well-being / depression scores

Group	<4 points	5-8 points	>8 points
Control (n=37)	7 (19%)	26 (70%)	4 (11%)
Exercise (n=47)	16 (34%)	30 (64%)	1 (2%)
X^2 =4.91, DF = 2, P-Value = 0.09			

The range of scores obtained from women was between 0 and 11 points for the control group and between 0 and 9 points for the exercise group. Mean score for the control group was 6.4 (SD 1.3) and 4.8 (SD 1.7) for the exercise group. Both groups of women responded with scores below 11 points which indicated positive emotional well-being. These findings suggested that there was no evidence of a tendency towards depressive symptoms since all scores were lower than 12 points. The majority of women in both groups obtained scores between 5 and 8 points i.e. 70% (n=26) and 64% (n=30) for the control group and exercise group respectively. Scores below 4 points were obtained from 19% (n=7) of women in the control group and 34% (n=16) in the exercise group. Only 11% (n=4) women in the control group and 2% (n=1) in the exercise group scored over 8 points.

Findings from a chi-square test indicated that there was no significant difference between the two groups although there was a tendency for women in the exercise group to have lower and more positive scores when compared to the women in the control group. These findings indicated that both of the groups demonstrated positive responses to postnatal† emotional well-being with no evidence of any tendency towards depressive states.

4.3.10 Pregnancy / Birth Outcomes

Pregnancy and birth outcomes of interest included the length of gestation†, duration of labour†, mode of delivery, Apgar† score, birthweight† and any maternal or neonatal† complications arising. This information was obtained from the questionnaire completed by the mother or directly from the obstetric casenotes when this was necessary. In relation to pregnancy and birth outcome, the amount of information obtained varied for both groups. This ranged from between 77% (n= 37) and 100% (n=48) for the control group and between 90% (n=45) and 100% (n=50) for the exercise group. The was due to this particular information either not being provided, available or accessible to the researcher.

4.3.10.1 Length of Gestation†

The period of gestation† indicates the length or the gestational age† of pregnancy with normal pregnancy being 40 weeks in duration. Preterm† delivery occurs before the 37th completed week of pregnancy (Sweet & Tiran 1997).

The number (%) of women who delivered before 37 weeks, between 38-40 weeks and after 40 weeks gestation, is presented in Table 4.3.26. The range of gestation was between 33 and 42 weeks for women in both the control and exercise groups. Mean length of gestation was 39.8 (SD 1.6) weeks and 40.1 (SD 1.9) weeks for the control group and exercise group respectively.

Table 4.3.26 Length of gestation (weeks)

Group	<37 weeks	38-40 weeks	>40 weeks
Control (n=37)	3 (8%)	23 (62%)	11 (30%)
Exercise (n=50)	4 (8%)	30 (60%)	16 (32%)
X^2 =0.05, DF = 2, P-Value = 0.97			

The majority of women in both groups delivered between 38 and 40 weeks gestation i.e. 62% (n=23) for the control group and 60% (n=30) for the exercise group. Preterm deliveries were experienced by 8% of women in both groups i.e. before 37 completed weeks gestation. Findings from a chi-square test undertaken indicated that there was no significant difference between the two groups in relation to the length of gestation at delivery.

4.3.10.2 Duration of Labour[†]

The number (%) of women and duration of labour experienced i.e. under 4 hours, between 5 and 8 hours and longer than 8 hours, is presented in Table 4.3.27.

Table 4.3.27 Duration of labour (hours)

Group	<4 hours	5-8 hours	>8 hours
Control (n=37)	10 (27%)	16 (43%)	11 (30%)
Exercise (n=50)	18 (36%)	24 (48%)	8 (16%)
X^2 =2.47, DF = 2, P-Value = 0.29			

The range in duration of labour was between 1 and 14 hours for women in both the control and exercise groups. Average duration of labour was 8.4 (SD 4.7) hours for women in the control group and 7.6 (SD 3.2) hours for the women in the exercise group. The majority of women in both groups experienced labour between 5 and 8 hours in duration i.e. 43% (n=16) and 48% (n=24) for the control and exercise group respectively. Findings from a chi-square test undertaken found no significant difference between the two groups in terms of duration of labour experienced.

4.3.10.3 Mode of Delivery

The number (%) of women, who delivered by each mode of delivery i.e. normal, instrumental and operative deliveries, is depicted in Table 4.3.28 and presented in Figure 4.3.9.

Table 4.3.28 Mode of delivery

Group	N	Normal (SVD)†	Instrumental	Operative†
Control	48	32 (67%)	12 (25%)	4 (8%)
Exercise	50	37 (74%)	11 (22%)	2 (4%)
X^2 =1.03, DF = 2, P-Value = 0.60				

Figure 4.3.9 Bar Chart of Mode of Delivery

The majority of women in both groups experienced a normal delivery i.e. 67% (n=32) women in the control group and 74% (n=37) women in the exercise group. Findings from a chi-square test indicated that there was no significant difference between the two groups in terms of mode of delivery.

4.3.10.4 Apgar† Scores of Baby

This is an initial assessment of the general well-being of the newborn routinely carried out at one and five minutes following all births. There are five assessments which include heart and respiratory rate, muscle tone, reflexes and colour. Each assessment is scored between 0 and 2 points with a maximum score of 10 points. Higher scores (>6 points) indicate a healthy baby while lower scores (<6 points) indicate varying degrees of birth asphyxia (Sweet &Tiran 1997).

The number (%) of Apgar scores recorded at one and five minute assessments is presented in Table 4.3.29. The range of Apgar† scores, for both control and exercise groups, was between 6 and 10 points at one minute and between 7 and 10 points at five minutes. Findings from chi-square tests found no significant difference between the groups in relation to Apgar scores at both one and five minute assessments.

Table 4.3.29 Apgar score at one minute and five minutes

Group	<7 points	7 points	8 points	9 points	10 points
Control (n=37)	2 (5%)	6 (16%)	23 (63%)	4 (11%)	2 (5%)
Exercise (n=50)	2 (4%)	8 (16%)	28 (56%)	8 (16%)	4 (8%)
X^2 =0.85, DF = 4, P-Value = 0.93					
Group	**7 points**	**8 points**	**9 points**		**10 points**
Control (n=37)	2 (5%)	15 (41%)	10 (27%)		10 (27%)
Exercise (n=50)	2 (4%)	10 (20%)	24 (48%)		14 (28%)
X^2 =5.61, DF =3, P-Value =0. 13					

4.3.10.5 Birthweight†

A baby weighing 2.5 kg or less is said to be of *low birthweight* and will need careful paediatric assessment and observation. *Low birthweight* babies may be either preterm i.e. delivered before 37 completed weeks of pregnancy, or small for gestational age (Sweet & Tiran 1997).

Distribution (%) of babies born within a range of birthweight groups is presented in Table 4.3.30. Both groups had comparable mean birthweight i.e. 3.3 (SD 0.4) kg for the control group and 3.4 (SD 0.6) kg for the exercise group

Table 4.3.30 Birthweight (Kg)

Group	<2.5 kg	2.5-2.9 kg	3.0-3.4 kg	3.5-3.9 kg	4.0-4.4 kg	4.5-5.0 kg
Control (n=37)	2 (5%)	8 (22%)	10 (27%)	10 (27%)	6 (16%)	1 (3%)
Exercise (n=50)	1 (2%)	12 (24%)	12 (24%)	20 (40%)	3 (6%)	2 (4%)
X^2 =4.13, DF = 5, P-Value = 0.53						

Only 5% (n=2) of babies in the control group and 2% (n=1) in the exercise group were identified within the category of being termed *low birthweight*. The majority of

birthweight was between 3.0 kg and 3.9 kg for both groups. Findings from a chi-square test indicated no significant difference between the groups in relation to the distribution of birthweight. A two sample t-test was undertaken to investigate the difference in mean birthweight and no significant difference was noted between the groups (Table 4.3.31).

Table 4.3.31 Two sample t-test for birthweight† (kg)

Two sample T for birthweight†	N	Mean	StDev	SE Mean
Control	37	3.3	0.4	0.1
Exercise	50	3.4	0.6	0.1
95% CI for mu (2) - mu (1): (-0.2, 0.3)				
T-Test mu (2) = mu (1) (vs not =): T= 0.43 **P=0.67** DF= 84				

4.3.10.6 Maternal or Baby Complications

The number of complications arising during or following pregnancy, depicted in Table 4.3.32, indicate that there were no major maternal complications reported in either the control or exercise group during pregnancy. All babies delivered were normal and healthy. However, one subject from the exercise group did require two surgical interventions between birth and 8 weeks following delivery to repair a severely traumatised perineum. Incidentally, this subject gave birth by instrumental delivery to a baby with a birthweight† of 5 kilogrammes.

Table 4.3.32 Maternal or baby complications

Group	During Pregnancy	Following Pregnancy	Baby
Control (37)	None	None	None
Exercise (45)	None	1 Major due to perineal trauma	None

4.3.10.7 Pregnancy and Birth Outcomes (drop out subjects)

Comparison of pregnancy and birth outcomes were repeated with all available information for those subjects from each group who failed to complete the study.

The number (%) of women in relation to length of gestation is presented in Table 4.3.33. The majority of women in both groups were found to deliver between 38 and 40 weeks gestation i.e. 74% (n=22) for the control group and 80% (n=20) in the

exercise group. No difference was found between the groups in length of gestation as indicated by a chi-square test.

Table 4.3.33 Length of gestation (drop out subjects)

Group	<37 weeks	38-40 weeks	>40 weeks
Control (n=30)	4 (13%)	22 (74%)	4 (13%)
Exercise (n=25)	1 (4%)	20 (80%)	4 (16%)
X^2 =1.45, DF = 2, P-Value = 0.48			

The number (%) of women in relation to reported duration of labour is presented in Table 4.3.34. The majority of women experienced labour of between 5 and 8 hours duration. No significant difference was found between the groups in relation to the duration of labour experienced as indicated by a chi-square test.

Table 4.3.34 Duration of labour (drop out subjects)

Group	<4 hours	5-8 hours	>8 hours
Control (n=23)	6 (26%)	13 (56%)	4 (18%)
Exercise (n=25)	4 (16%)	16 (70%)	5 (22%)
X^2 =0.74, DF = 2, P-Value = 0.70			

The number (%) of women who delivered by the three modes of delivery was comparable. Number and percentage of women delivering by each of the three delivery modes i.e. normal, instrumental and operative deliveries, is presented in Table 4.3.35. No difference was noted between the two groups in terms of mode of delivery as indicated by a chi-square test.

Table 4.3.35 Mode of delivery (drop out subjects)

Group	N	Normal (SVD)†	Instrumental	Operative†
Control	19	7 (36%)	6 (32%)	6 (32%)
Exercise	25	10 (40%)	10 (40%)	5 (20%)
X^2 =0.82, DF = 2, P-Value = 0.67				

The range of scores for both groups was between 6 and 9 points at one minute and between 7 and 10 points at five minutes. The number (%) of Apgar scores at one minute and five minute assessments is presented in Table 4.3.36. No difference was noted between the groups in relation to the distribution of Apgar scores at both one and five minute assessments as indicated by chi-square tests.

Table 4.3. 36 Apgar score at one minute and five minutes (drop out subjects)

Group	<7 points	7 points	8 points	9 points	10 points
Control (n=30)	3 (10%)	4 (13%)	7 (23%)	16 (53%)	0 (0%)
Exercise (n=25)	2 (8%)	5 (17%)	6 (45%)	12 (28%)	0 (0%)
X^2 =1.82, DF = 3, P-Value = 0.61					
Group	**7 points**	**8 points**	**9 points**		**10 points**
Control (n=30)	2 (7%)	4 (13%)	13 (43%)		11 (37%)
Exercise (n=25)	1 (4%)	7 (28%)	5 (20%)		12 (48%)
X^2 =4.3, DF =3, P-Value =0. 23					

The range of birthweight was between 2.5 kg and 4.4 kg for the two groups. Distribution of birthweight is presented in Table 4.3.37.

Table 4.3.37 Birthweight (drop out subjects)

Group	2.5-2.9 kg	3.0-3.4 kg	3.5-3.9 kg	4.0-4.4 kg
Control (n=29)	4 (13%)	11 (37%)	9 (30%)	5 (17%)
Exercise (n=25)	5 (20%)	9 (36%)	9 (36%)	4 (16%)
X^2 =0.35, DF = 3, P-Value = 0.95				

The majority of birthweight for both groups was between 3.0 kg and 3.9 kg i.e. 67% (n=20) for the control group and 72% (n= 18) for the exercise group. No difference was found between the groups in relation to the distribution of birthweight as indicated from a chi-square test undertaken.

There were no major maternal or baby complications reported during or following pregnancy. Details were forwarded to the researcher in relation to two women allocated to the control group in the antenatal clinic. At this initial appointment, both

of these women were diagnosed by ultrasound scan as having a non continuing pregnancy at seven and nine weeks gestation.

In conclusion, both groups of women who completed the study and those who dropped out of the study were investigated in relation to the average length of gestation† of pregnancy, duration of labour†, method of delivery, Apgar† scores and birthweight†. No significant difference was noted either between the exercise and control groups or between the groups who completed the study or dropped out of the study in relation to pregnancy and birth outcomes.

4.3.11 Physical Activity

Levels of activity recorded in early pregnancy and the number (%) of women, in each classification of activity levels, is shown in Table 4.1.3. A chi-square test undertaken on these activity levels indicated that there was no difference between the four different classifications of activity levels between the control and exercise groups in early pregnancy i.e. inactive, occasionally active, regularly active or very active. Comparisons of activity levels were not followed up during and following pregnancy due to insufficient data collected in relation to this particular response.

Episodes of physical activity were recorded during and following pregnancy by the women in both groups. The method of collecting this information was by the completion of an activity diary followed by subsequent summary of the number of physical activity sessions in early, late and post pregnancy or on completion of the study (appendix 14). The exercise group also completed an attendance register at the structured exercise classes (appendix 16).

The frequency (%) of the total number of physical activity sessions, including structured exercise sessions, is presented in Table 4.3.38. The total number of structured exercise classes attended by women in the exercise group was 1405 sessions which was 51% of the total physical activity sessions undertaken by women in the exercise group and also 38% of the total physical activity undertaken by women in both groups. Additional physical activity undertaken by both groups was recorded and

classified into categories when the type of activity was identified. The women in the control group participated in 25% (940) of the total activity sessions (3734) recorded.

Both groups recorded similar types of activities in relation to exercise classes, brisk walking and swimming during the study. There were no recordings of strength training, cycling and yoga type activities in either of the two groups. Two women, both in the exercise group, reported regular tennis and badminton sessions until early third trimester of pregnancy. One of these women reported regular use of the treadmill and Nordic ski-ing until the third trimester of pregnancy and then again following delivery.

Table 4.3.38 Frequency (%) of the total number of physical activity sessions including structured exercise sessions

Group	Structured Aerobic Classes	Other classes e.g. Aerobic /Aquanatal	Brisk Walk	Swim	Golf/ Tennis	Treadmill/ Nordic ski	**Total number**
Control (n=48)	0 (0%)	425 (45%)	300 (32%)	215 (23%)	0 (0%)	0 (0%)	**940**
Exercise (n=75)	1405 (51%)	300 (11%)	275 (10%)	450 (17%)	284 (10%)	80 (1%)	**2794**
		$X^2 = 398$, DF = 5, P-VALUE = 0.00					
Total	1405 (38%)	725 (20%)	575 (16%)	665 (18%)	180 (6%)	80 (2%)	**3734**

Findings from a chi-square test undertaken on additional physical activity sessions, indicated that women in the exercise group participated in a significantly higher proportion of additional activity sessions than the control group.

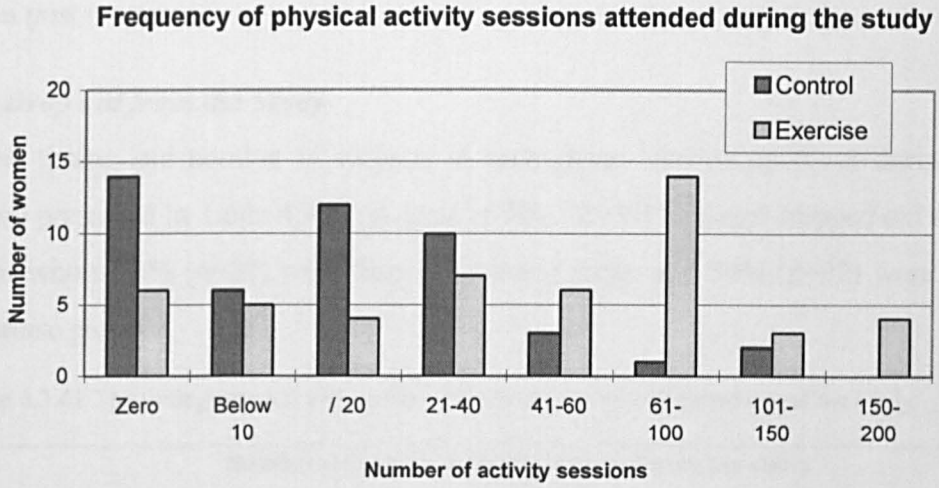
Findings from a two sample t-test indicated that there was a significant difference between the two groups in relation to the total average number of physical activity sessions undertaken during and following pregnancy (Table 4.3.39).

Table 4.3.39 Two sample t-test for physical activity sessions

Two sample T for Total classes	N	Mean	StDev	SE Mean
Control	48	18.7	48.5	6.9
Exercise	50	55.6	26.8	3.9
95% CI for mu (2) - mu (1): (21.2, 52.6)				
T-Test mu (2) = mu (1) (vs not =): T= 4.68 **P=0.0000** DF= 76				
Range for Control group: **0 - 120 sessions**		Range for Exercise group: **0 - 200 sessions**		

Figure 4.3.10 presents the total number of physical activity sessions recorded by women in both groups during the study. Sessions attended by the control group indicated that a number of women remained active during and following pregnancy. However, it can be seen from Figure 4.3.10 that the majority of these women participated in under a total of 60 sessions during the course of the study with only a few women undertaking between 61-150 sessions.

Figure 4.3.10 The total number of physical activity sessions attended by women during the study



The relationship between the frequency of physical activity undertaken during the study and the psychological indicators of coping assets (positive psychological well-being), coping deficits (negative psychological well-being) and physical well-being in post pregnancy was investigated by correlation analyses using Pearson product moment coefficient of correlations. The findings are presented in Table 4.3.40.

Table 4.3.40 Correlation co-efficients for the relationship between frequency of physical activity and psychological indicators

Psychological indicators	Correlation co-efficient	
Coping assets (positive psychological well-being)	r-value = 0.21	p-value = 0.15
Coping deficits (negative psychological well-being)	r-value = -0.14	p-value = 0.33
Perceptions of physical well-being	r-value = 0.16	p-value = 0.26

There was no significant relationship found between the frequency of reported physical activity and the responses of the three psychological indicators in post pregnancy.

Findings concluded that women in the exercise group did participate in a significantly higher number of physical activity sessions than the women in the control group. There was no significant relationship between the frequency of physical activity and the psychological indicators of coping assets (positive psychological well-being), coping deficits (negative psychological well-being) and perceptions of physical well-being in post pregnancy.

4.3.12 Drop out from the Study

The timing and number of subjects in each group who dropped out during the study are presented in Table 4.3.41. A total of 38% (n=59) subjects dropped out of the study of whom 36% (n=39) were from the control group and 39% (n=32) were from the exercise group.

Table 4.3.41 The timing (weeks) and number (%)of subjects who dropped out of the study

		Number (%) and Weeks of 'drop out' from the study				
Group	**N**	**12-20 weeks**	**24 weeks**	**28 weeks**	**32 weeks**	**Completed**
Control	75	**22 (29%)**	*2(3%)*	*1 (1%)*	*2(3%)*	**48 (64%)**
Exercise	82	**27 (33%)**	*1 (1%)*	*2(2.5%)*	*2(2.5%)*	**50 (61%)**
X^2 = 0.50, DF = 2, P-VALUE = 0.80						
Total sample(%)	157	**49 (32%)**	*10 (6%)*			**98 (62%)**
		Total number of drop out from the study = 59 (38%)				

The majority of subjects who dropped out of the study (32%; n=49) did so between recruitment and 20 weeks gestation i.e. 29% (n=22) from the control group and 33% (n=27) from the exercise group Few questionnaires were returned during this stage and, as a result, this information was not available for inclusion within the study. Thereafter, the number of subjects who dropped out of the study i.e. control 7% (n=5); exercise group 6% (n=5) did so at various times between 24 and 32 weeks gestation†. The remaining subjects completed the study i.e. 64% (n=48) in the control group and

61% (n=50) in the exercise group. Findings from a chi-square test indicated that there was no significant difference between the groups in relation to the subjects who dropped out of the study in the initial stages, during the study and those subjects who completed the study.

The age group of subjects who dropped out of the study is presented in Table 4.3.42. The majority of subjects in both groups were aged between 26-30 years i.e. 48% (n=13) for the control group and 44% (n=14) for the exercise group. No significant difference was found between the groups in relation to age group as indicated from a chi-square test.

Table 4.3.42 Age group of women who dropped out of the study

Group	<20 years	21-25 years	26-30 years	31-35 years	>35 years
Control (n=27)	2 (7%)	4 (16%)	13 (48%)	6 (22%)	2 (7%)
Exercise (n=32)	3 (9%)	5 (16%)	14 (44%)	9 (28%)	1 (3%)
X^2 =0.86, DF = 4, P-Value = 0.93					

Relationship status and employment status of subjects who dropped out of the study is presented in Table 4.3.43. In both groups, the majority of subjects who dropped out were married and in employment. In the control group, 44% (n=12) of subjects were married and 88% were in employment. In comparison, 63% (n=20) of subjects in the exercise group were married and 78% (n= 25) were in employment.

Table 4.3.43 Relationship and employment status of women who dropped out of the study

Group	Relationship Status			Employment Status		
	Married	Partner	Single	Employed	Unemployed	Student
Control(n=27)	12 (44%)	10 (37%)	5 (19%)	24 (89%)	3 (11%)	0
Exercise(n=32)	20 (63%)	9 (28%)	3 (9%)	25 (78%)	7 (22%)	0
	X^2 =0.34, DF = 2, P-Value =0.34			**X^2 =0.27, DF = 1, P-Value =0.27**		

Findings from chi-square tests indicated that there was no significant difference between the two groups in relation to relationship status and employment status of the subjects who dropped out of the study.

Data for activity levels in early pregnancy was only available from subjects who dropped out of this study if this information was provided. This information is presented in Table 4.3.44. Activity levels of the drop out rate of subjects were comparable between the two groups and no significant difference was indicated from a chi-square test undertaken.

Table 4.3.44 Activity levels of women who dropped out during the study

Group	Classification of Activity Levels at Time of Recruitment			
	Inactive	Occasionally Active	Regularly Active	Very Active
Control (n=5)	2 (40%)	1 (20%)	1 (20%)	1 (20%)
Exercise (n=5)	1 (20%)	1 (20%)	1 (20%)	2 (40%)
X^2 =0.67, DF = 3, P-Value = 0.88				

These findings indicate that the majority of subjects in both groups who failed to complete the study were married , employed and aged between 26 and 30 years of age.

Reasons for leaving the study were not given in the majority of cases especially for those subjects who failed to complete the initial questionnaire following recruitment i.e. excluding the two women from the control group who experienced a non continuing pregnancy before 10 weeks gestation. However, a few reasons were offered by the subjects in the exercise group which included:

'It was too tiring after work to come to the exercise class'

'I just do not have the energy'

'It was too far to travel to the hospital'

There was only anecdotal information obtained in relation to the reason for any of the subjects in the control group who failed to continue with the study. This information included comments that they wanted to exercise and therefore would have preferred to be in the exercise group. Another reason offered was that the women thought they were out of the study because they did not complete or return the questionnaire at the appropriate time.

CHAPTER 5

DISCUSSION

This chapter will discuss the findings of this study in relation to meeting the aims of the study and integrating the findings with current literature around the following themes: psychological indicators; pregnancy and birth outcomes; physical activity and retention of subjects within the study.

5.1 Psychological Indicators

The findings of this study suggest that women, who participated in regular physical activity, maintained their early pregnancy levels of psychological well-being during and following pregnancy which was noted to deteriorate within the women in the control group. Psychological parameters encompassed in well-being included; how women felt about themselves and their bodies; how well they felt they could cope; and their attitudes to marital relationships, sex, their pregnancy and baby.

In early pregnancy, no significant differences were found between the women in the control group and exercise group in relation to seven of the eight psychological outcome variables of interest. These included; levels in perceptions of coping assets (positive psychological well-being), coping deficits (negative psychological well-being), physical well-being, somatic symptoms experienced, and attitudes to marital relationships, pregnancy and sex. Due to random allocation of the women to the two groups, it was anticipated that baseline measures on all outcome variables would be comparable at commencement of the study prior to any intervention occurring. This randomisation process should have controlled for any confounding bias and ensured that all women had an equal chance of being allocated to either of the two groups. However, in contrast to the other psychological outcome variables, women in the control group entered the study with small but significantly higher perceptions of body image than the women in the exercise group. This finding is difficult to explain especially as the other outcome variables between the groups were comparable at this initial stage. Since this was an isolated finding, it can be explained by attributing it to a chance occurrence.

Significant differences were noted between the two groups in all the psychological variables investigated. These significant differences were noted from early pregnancy until four months after delivery. Women, who participated in regular physical activity, tended to maintain their perceptions in terms of how well they felt they could cope, physical well-being, somatic symptoms experienced, body image, and attitudes to sex and marital relationships during and following pregnancy. In contrast, the women in the control group, during the same period, reported significant reductions in their perceptions of how well they felt they could cope, physical well-being, somatic symptoms experienced and body image. These psychological variables, for the women in the control group, tended to improve following pregnancy but had not yet returned to early pregnancy levels by four months following delivery. In contrast, the women in the control group reported a significant increase in the perception of coping deficits (negative psychological well-being) which was further evidence of an inability to cope during this period. Following delivery, women in both groups showed positive increase in their attitudes to the baby but levels for women in the control group had not reached levels observed in early pregnancy.

These findings strongly suggested that participation in regular physical activity was associated with a beneficial protection or delay in a reduction of psychological well-being during and following pregnancy. In general, a reduction in psychological well-being is regarded as a normal and typical feature of pregnancy which does not imply abnormal or poor psychological adjustment (Niven 1992). Maintenance or delay in any deterioration of psychological well-being during pregnancy can only be beneficial during this emotional and vulnerable time as women strive to cope with anatomic and physiologic changes, physical discomforts, lifestyle changes and other social factors (Artal & Artal Mittlemark *et al* 1991b).

It has been generally recognised that the way in which a pregnant woman reacts to the profound body and social changes are influenced to a large extent by her personality, her lifestyle, her relationship with her partner and her feelings about herself, pregnancy, baby and her level of physical fitness (Artal & Artal Mittlemark *et al* 1991b; Wells 1992). Therefore, participation in regular physical activity within this study, may have influenced

several of these factors, which in turn, enabled women to experience pregnancy more positively and subsequently supported their transition to motherhood.

5.1.1 Perceptions of Coping Assets and Deficits

Pregnancy is a time of emotional and psychological change which may have a negative influence on the emotional and psychological well-being of women (Artal & Artal Mittlemark 1991b). The literature has suggested that pregnant women experience a range of emotional and psychological changes which include: increased anxiety, distress, irritability and depression (Condon 1987). It has been reported that anxiety levels increased as pregnancy progressed (Green 1990a) with women reporting more negative feelings towards the birth (Elliot *et al* 1983). A number of studies of postnatal depression have shown that women who are highly distressed, anxious or depressed during pregnancy are more likely to experience depression postnatally (Watson *et al* 1984; Elliot 1988, Sharp 1989). Niven (1992) recommends that maternal anxiety should be reduced to improve emotional and psychological well-being and that habitual coping style influences whether women had a sense of success and adequate self esteem as pregnancy progresses.

The findings from this present study indicated that there were significant differences between the two groups in relation to how women perceived they could cope during and following pregnancy. The women in the control group had a significant decrease in their perceived ability to cope during and following pregnancy and a significant increase in perceived coping deficits (negative psychological well-being). In contrast, the women in the exercise group tended to maintain their early pregnancy levels on both these indicators of psychological well-being during the same period.

These present findings support the existing literature pertaining to the non pregnant population which suggests that exercise contributes to achieving optimal psychological well-being. Physical activity has been positively associated with general well-being, more positive mood (Stephens 1988; Crammer *et al* 1991; Hughes 1984; Plummer & Koh 1987; Brown & Harrison 1986) and improvements in self-confidence, feelings of achievement and self-sufficiency (Brown & Harrison 1986). Other positive associations include lower

levels of anxiety (Steptoe *et al* 1989; Moses *et al* 1989; Roth & Holmes 1987; Morgan 1985) improved coping abilities and reduced tension (Morgan 1979, 1985).

Other researchers have used the psychological indicators of coping assets, coping deficits and well-being with the general population. Steptoe *et al* (1989) report a significant increase in coping assets and a significant decrease in coping deficits with normal healthy individuals over a training period. In this present study, the exercise group maintained early pregnancy levels in coping assets (positive psychological well-being) and coping deficits (negative psychological well-being) during and following pregnancy. This was in contrast to the control group who had significant reductions in coping assets (positive psychological well-being) and significant increase in coping deficits (negative psychological well-being) during the same period. It was not possible to make a comparison of baselines response to these psychological indicators with women in this present study since Steptoe *et al* (1989) report only the changes in the psychological indicators during the training period.

Loughlan (1995) studied healthy middle aged subjects (n=179) participating in a health related physical activity study over a period of six months. He assessed psychological well-being before and after the intervention using the psychological indicators of coping assets, coping deficits and physical well-being. He reported a significant improvement in coping deficits but there was no evidence of any difference in coping assets or physical well-being over the same period. In the present study, the exercise group had similar findings in coping assets (positive psychological well-being) and physical well-being but this group did not show any significant improvements in coping deficits which were actually maintained during the study. This was in contrast to the control group who showed a significant deterioration in coping assets (positive psychological well-being), coping deficits (negative psychological well-being) and physical well-being during the same period. It was interesting to note that, in the study by Loughlan (1995), the subjects reported both similar levels in coping assets and physical well-being to the early pregnancy levels of subjects in this present study. However, in the present study the early pregnancy levels of coping deficits (negative psychological well-being) tended to be more positive than the commencement levels of subjects in the study

conducted by Loughlan (1995). The subjects and duration of the intervention should be considered when comparing both studies. The present study had healthy young women (n=98) from early pregnancy until four months following delivery of the baby while in contrast, the other study was six months duration with both male and female subjects who were healthy and middle aged. Although limited, comparison with studies of the general population was informative as findings in the present study were similar to the psychological indicators in other populations. Since there was no available literature of similar studies during pregnancy, it was not possible to make comparisons of the psychological indicators of other women during and following pregnancy.

Although the majority of authorities currently agree that regular exercise improves psychological well-being, there remains uncertainty as to the mechanisms which can be directly attributed to these benefits. Several theories have been proposed to be responsible for the 'cause and effect' relationship existing between exercise and improved psychological well-being. However La Forge (1995) concluded, from his extensive review of the literature, that one theory could not solely be attributed for this relationship and that all current theories overlapped. He suggested that there was an extraordinary influence of biological transactions which included genetic, environmental, acute and adaptive neurobiologic processes.

There is very little available scientific information concerning the psychological aspects of exercise in pregnancy. There was no evidence of any relationship between the total physical activity undertaken and the psychological indicators of coping assets (positive psychological well-being), coping deficits (negative psychological well-being) and physical well-being. The findings from this present study, do suggest that regular physical activity maintains or delays the reduction in psychological well-being normally experienced during pregnancy. There is only agreement with the findings of this present study and other similar studies, in that, women who exercised regularly had significantly higher levels of psychological well-being when compared with sedentary or women in control groups. Therefore, the present findings only offer support to the general trend found in the limited number of studies which report on the psychological benefits of exercise during pregnancy. There was no evidence of any improvements on early

pregnancy levels for psychological indicators of well-being within this present study. In contrast, other researchers suggest that exercise during pregnancy enhances a sense of well-being, increases total self esteem (Sibley *et al* 1981; Wallace *et al* 1986) Wolfe *et al* 1989; Koniak-Griffin 1994) and reduces tension (Hall & Kaufmann 1987).

Findings, from all of these previous studies, suggests positive psychological benefits from the participation in exercise during pregnancy. However, one main disadvantage attributed to many of these studies, has been the use of self selected subjects which detracts from the credibility of the findings and limits their application. This recognised limitation in research design was considered when planning this present study. As a result, randomisation of women to either the control group or exercise group was used in an attempt to address this disadvantage within this study. The positive findings obtained from this present study in relation to the psychological well-being experienced by women in the exercise group compared with women in the control group during and following pregnancy can, hopefully, be generalised to all healthy primigravid† women.

In this present study, the psychological benefit gained by the women in the exercise group by the maintenance of perceived coping abilities may have been influenced directly by the exercise itself or indirectly by other numerous factors. Firstly, it is generally accepted that there are both physical and psychological benefits to be gained by regular exercise. These include improved stamina, agility and muscular strength, positive feelings of well-being and feelings of being in control (ADNFS 1992, Bouchard *et al* 1993). The women in the exercise group did participate in significantly more sessions of physical activity than the women in the control group. There was no significant relationship found between the total amount of physical activity undertaken and the responses of psychological indicators in post pregnancy. This suggests that it is not the frequency of undertaking physical activity which relates to the levels of psychological well-being experienced. It remains a strong possibility that the physical and psychological benefits reported from exercise participation may directly influence the psychological well-being experienced by the women in a structured exercise programme.

Other, equally important indirect factors, include the possible benefits gained from social interaction and planned recreational time for the women in the exercise group with

other pregnant women at the exercise class. There is a generally held belief in the literature, that psychosocial support has a positive influence on the mental health of individuals (Oakley 1992; Wheatley 1998). This psychosocial support is recognised as a key component in the psychological care of women during pregnancy (Hirst *et al* 1998). Pregnant women judged this support to be of good quality if it includes good interpersonal skills within a facilitative environment (Oakley 1992). When this is found to be the case, then it significantly enhances emotional well-being (Oakley 1992, Wheatley 1998) and helps women to be more confident and self reliant (Hirst *et al* 1998). From the limited research in the area of exercise during pregnancy, Lee (1996) reports that pregnant women who exercise regularly experience psychological and social benefits.

In this present study, the social interaction of women attending the class may have given them the chance to have a mutual sharing of similar worries and concerns relating to pregnancy and delivery with the peers they had befriended. The social support experienced by women attending the exercise class may have positively influenced their psychological well-being. This may have contributed to reduced anxiety, improved feelings of security, self worth and value which, in turn, prevented the reduction in psychological parameters normally experienced by women during pregnancy. There was the possibility, that participation in the study, contributed to women in the exercise group feeling valued and generally feeling better about themselves. Wheatley (1998) suggests that women, who feel accepted within a group and gain positive feedback from the interaction with their peers, experience reduced anxiety, reduced antenatal and postnatal depression, increased self esteem and increased confidence. The interaction with the aerobic instructor was also an important factor to consider. A positive interaction, existing between the instructor and the women in the exercise class, may have influenced some women. Possible contributing factors may include the gain of a positive attitude towards exercise and positive reinforcement for attendance at the class, general acceptance within the group, motivation and enthusiasm, and the possible development of a mutual friendship. The women may also have been more enthusiastic about completing the questionnaires and responding to the requests for information.

In contrast to the findings of the women in the exercise group, the women in the control group had a significant decrease in their perceptions of coping assets (positive psychological well-being) and increase in perceived coping deficits (negative psychological well-being) during the same period. A decrease in coping abilities is a typical and normal response experienced during pregnancy. The women in the control group participated in significantly less exercise sessions than the women in the exercise group. As a result, they may have been deprived of the physical and psychological benefits gained from exercise. Other factors including being part of a research study and social interaction with other pregnant women may have influenced women in the control group, especially, if they had wanted to be in the exercise group. This may have contributed to these women feeling resentful, demoralised, abandoned and left out of the study. The limited contact the women in the control group had with the researcher may have resulted in further feelings of abandonment. There was also less opportunity for women in the control group to gain social support from the benefits of group interaction with other pregnant women. One or more of these factors may have contributed to women in the control group having reduced enthusiasm, willingness and motivation to complete the questionnaires, provide valid information of their feelings and attitudes, and offer information willingly.

The women in the exercise group did maintain perceptions of coping assets (positive psychological well-being) and coping deficits (negative psychological well-being) in contrast to a deterioration of these perceptions for the women in the control group. There is a strong possibility that participation in regular exercise contributed to these findings but other factors such as social support may have contributed and need to be recognised as a possible influencing factor.

5.1.2 Perceptions of Physical Well-being and Somatic Symptoms

Pregnancy is a time of increased experiences of somatic conditions which may be due to the physiological adaptations of pregnancy itself or be exacerbated by physical and psychological concerns of women as pregnancy progresses towards impending labour and delivery of the baby (Niven 1992). Increased experience of the symptoms of pregnancy is associated with negative attitudes towards pregnancy (Raphael-Leff 1991).

Women, who participated in regular physical activity within this present study, maintained their perceptions of physical well-being during and following pregnancy when compared to women in the control group. There is no doubt in the literature, that regular physical activity contributes to improved stamina and physical well-being (Artal Mittlemark *et al* 1991b). Therefore, improvements in physical well-being would benefit women who participated in regular physical activity by preparing them to meet, both physical and emotional challenges, which are inherent in pregnancy and childbirth (Artal & Artal Mittlemark 1991).

In the present study, women who exercised regularly maintained their perception of the somatic symptoms experienced during and following pregnancy. This was in contrast to significantly negative perceptions in somatic symptoms experienced during pregnancy for the women in the control group. There is limited available literature of similar studies during pregnancy to enable comparisons of the findings from this present study. However, other researchers suggest that women who exercise regularly during pregnancy report significant increase in vigour (Koltyn & Schultes 1997), significantly lower incidence of physical symptoms (Wallace *et al* 1986), a decrease in physical discomforts during pregnancy (Horns *et al* 1996) and reductions in physical complaints after childbirth (Hall & Kaufmann 1987). Many of these studies included self selected subjects which limited the application of findings to only active pregnant women. This present study investigated the perceptions of physical well-being and somatic symptoms experienced as opposed to the frequency and measurement of physical discomforts. However, there was again agreement between present findings and other research in the general trend of findings that women who exercise during and following pregnancy have significantly more positive levels in relation to physical well-being and somatic symptoms experienced.

There are several possibilities for these differences between the women in both groups. Firstly, the participation in the physical activity may have improved muscular strength which is suggested to be beneficial to pregnant women during pregnancy by preventing back pain, improving agility and facilitation of additional weight and changing the centre of gravity (Artal & Artal Mittlemark *et al* 1991). Research findings also report that women who exercise regularly experienced improved posture and mobility (Lee

1996). Secondly, participation in the exercise programme itself, may have served as a form of distraction for women by diverting their thoughts and feelings about themselves and their bodily functions. Finally, the maintenance of perceptions of physical well-being and coping assets (positive psychological well-being) reported by women in the exercise group, may also have contributed to the maintenance of early pregnancy levels in perceptions of somatic symptoms experienced during and following pregnancy. The women in the control group tended to have less opportunity than the women in the exercise group to experience these possible physical and psychological benefits during and following pregnancy. In addition, the significant reductions in psychological well-being such as perceptions of body image, physical well-being and somatic symptoms experienced, may have negatively influenced the women in the control group to experience further coping deficits (negative psychological well-being) during pregnancy. As a result, the women in the control group demonstrated a deterioration in psychological well-being which is normally experienced during this period.

Women in the exercise group experienced a maintenance of physical well-being and somatic symptoms experienced during and following pregnancy. It is a strong possibility that participation in a regular exercise programme influenced these findings due to the benefits gained from exercise participation. Other influencing factors such as social support need to be acknowledged.

5.1.3 Perceptions of Body Image

Pregnancy is generally viewed as being an unattractive condition and there is acceptance that a reduction in perceptions of body image occur during this time (Leifer 1977; Raphael-Leff 1991). Strang & Sullivan (1985) suggest that the changes occurring to the body during pregnancy causes dissatisfaction to women which increases as pregnancy progresses to reach a peak following pregnancy. This reduction in body image was found to be even more profound in first time mothers keen to return to their pre-pregnant shape (Strang & Sullivan 1985). However, there are differing views in the literature as to how women perceive their body image after delivery. Some studies report that women were more positive to body image while others suggest that women are more negative to their body image during this period (Leifer 1977).

In the present study, women in the control group tended to have significantly more negative perceptions of body image during and following pregnancy despite having significantly higher and more positive perceptions than the women in the exercise group on commencement of the study. This was in contrast to a maintenance of perceptions of body image during and following pregnancy for the women in the exercise group during the same period.

There is limited available literature of similar studies of exercise and related body image during pregnancy. Slavin *et al* (1988) concludes that regular exercise during pregnancy allows women to have control over their bodies at a time of profound bodily changes. Artal & Artal Mittlemark (1991) suggest that exercise may have a positive role to play in the way pregnant women feel about themselves, their femaleness and their body.

It is suggested that one of the major contributing factors to the critical nature of the postnatal period was the changing body shape and appearance (Price 1993b). Therefore, the enhanced perception of body image experienced by women who participated in regular physical activity would, no doubt, have contributed to the maintenance of early pregnancy levels of psychological well-being reported throughout pregnancy and following delivery.

The maintenance in perceptions of body image experienced by the women who exercised during this study may have been influenced by the interaction of other psychological variables including the perceptions of physical well-being and the ability to cope (positive psychological well-being). Several possible factors may have, to some extent, influenced these perceptions either through direct or indirect gain from participation in regular physical activity. Factors directly gained from exercise participation included improved muscle tone and physical fitness, and improved feelings of physical and psychological well-being (ADNFS 1992; Bouchard *et al* 1994). Other, equally important, indirect influences may have occurred as a result of participating in the exercise programme which included social interaction, peer support with other pregnant women, having positive feelings of self worth and value, with being a subject in a research study and positive feedback, motivation and enthusiasm gained from the instructor.

In contrast, women in the control group experienced a significantly decrease in perceptions of body image during the same period. A decrease in how women perceive their body is the normal response experienced by pregnant women during pregnancy (Raphael-Leff 1991). However, women in the control group may have been negatively influenced by the interaction of the significant deterioration experienced in relation to the aspects of psychological well-being. This included perceptions of coping assets (positive psychological well-being), physical well-being, somatic symptoms experienced and attitudes towards partners, sex and pregnancy itself.

Women in the exercise group maintained their perceptions of body image during pregnancy in comparison to a deterioration in perceptions of body image experienced by women in the control group. Participation in a regular exercise programme may have been a strong influencing factor as women gained the reported physical and psychological benefits of exercise. Other factors such as social support may have influenced these findings.

5.1.4 Attitudes to Marital Relationships, Sex and Pregnancy / Baby

Pregnancy and new parenting occur within a compact time frame into which are compressed a variety of interpersonal, cultural and physical challenges. These factors need to be considered within the individual's sexual identity and shared relationships (Raphael-Leff 1991; Niven 1992). As pregnancy progresses, the attitudes of women are subject to change with a number of contributing factors suggested which include; the physiological adaptation to pregnancy itself, the impending changing roles and responsibilities of the woman and her partner, and concerns surrounding the birth process (Niven 1992).

Pregnancy causes major changes in marital and cohabiting relationships and it is proposed that the woman's experience of her body may extend to affect feelings of sex and postpartum relationships (Price 1993b). Niven (1992) suggests that the mother's adjustment to pregnancy may be dominated by her developing relationship to her baby, with the father taking second place for her love and attention.

Scott-Heyes (1984), in a study of love, marriage and childbearing, suggests that the major change in the relationship is concerned with the woman feeling that she receives

insufficient nurturing from her partner with the consequence of increasing dissatisfaction within the relationship. Women also tend to become more dependent on their partner as pregnancy progresses which may put them at risk from depression after delivery.

Findings from this present study were difficult to interpret within this very personal and complex situation as there are many psychological and social factors which contribute to the interaction of marital relationships and sex (Scott-Heyes 1984; Watson *et al* 1984; Raphael-Leff 1991). Significant differences were found between the women in the two groups in relation to their attitudes to marital relationships and sex during and following pregnancy. Women in the exercise group were noted to have no significant differences during and following pregnancy. In contrast, the women in the control group had significant negative reductions in their attitudes to marital relationships and sex during the same period which was more marked for the attitudes to sex following delivery of the baby. Comparison of these findings with other similar studies was not possible due to a lack of available literature in this field.

In this present study, the protection of early pregnancy levels of psychological well-being experienced by women in the exercise group in comparison to the women in the control group may have influenced the more positive attitudes to marital relationships and sex. This influence or interaction may have been in terms of more positive perceptions of how well they could cope, physical well-being, somatic symptoms experienced and body image. Psychological well-being may have better prepared women in the exercise group to meet and overcome any challenges or situations occurring within their marital relationships.

Barclay *et al* (1994) suggests that pregnancy is a time when alterations in sexual expression within relationships may be negative. The most important perceived negative aspect were the reduced frequency of sexual intercourse with variations in the extent and pace of adjustment to altered sexual interest between couples. There is general agreement in the literature that a woman's level of sexual interest changes during pregnancy and remains altered for weeks or months after the birth (Niven 1992; Barclay *et al* 1994).

Interpretation of the findings of the present study, in terms of attitudes to marital relationships and sex, was fraught by a number of diverse contributing factors such as social, cultural and lifestyle implications. However, it was possible that exercise directly or indirectly influenced the more positive attitudes noted in the women in the exercise group, especially in relation to maintaining the attitude to sex in the postnatal period†. An interaction of these influencing factors may have included more positive perceptions of body image, physical and emotional well-being, somatic symptoms experienced, the ability to cope in addition to the physical benefits gained through participating in regular exercise. Any positive interaction of these factors may have subsequently influenced more positive attitudes to marital relationships and sexual interest. There is a complex interaction between couples and the changes in women's sexual interest. However, the potential synergism of sexual interest and sexual behaviour within a relationship are poorly understood, especially in relation to pregnancy.

Findings from this present study indicated that women in the control group had significant decrease in their attitudes to pregnancy. This was in marked contrast to the women in the exercise group, who actually maintained their attitudes to pregnancy. The women in the exercise group tended to have protection of the decrease in attitudes to pregnancy normally experienced by pregnant women. Again, this may have been influenced by the physical and psychological benefits gained from participating in regular exercise. These women may have benefited from a positive influence or interaction of how women felt they could cope, how they felt about themselves and their bodies. Other possible factors may have included: a form of distraction from focusing on anxieties and fears, and the interaction of psychosocial support gained from attending an exercise class mainly in terms of positive feedback and reinforcement and the alleviation of worries of pregnancy, labour and delivery by sharing them with other pregnant and postnatal women.

The women in the control group, who had a significant decrease in their attitudes to pregnancy, had less opportunity than women in the exercise group to experience these physical, psychological and social benefits. This may have been further influenced by an interaction with the significant deterioration in how these women felt about themselves, their bodies and how they felt they could cope. In fact, women in the control group

experienced significant increased somatic symptoms which are reported to contribute to more negative feelings towards pregnancy (Raphael-Leff 1991). Increasing levels of anxieties and reduced coping abilities are suggested to contribute to more negative feelings in women, mainly in the later stages of pregnancy (Elliot *et al* 1983; Green 1990a).

Following delivery of the baby, women in both groups had positive and significant increases in attitudes to the baby with women in the control group not yet returning to early pregnancy levels and the women in the exercise group exceeding their early pregnancy levels. Findings from the women in the control group follow the normal trend experienced by pregnant women, who become more positive in their attitudes once the fears and anxieties related to the birth process are removed. The higher levels experienced in attitudes to pregnancy by the women in the exercise group may have been due to the positive influence or interaction in the protection of psychological well-being during pregnancy.

There is a strong possibility that participation in a regular exercise programme enable women in the exercise group to gain the psychological benefits of exercise. These benefits may have influenced the women in the exercise group to maintain psychological well-being which, in turn, influenced their attitudes towards themselves, pregnancy and relationships.

In this present study, no significant difference was found between the women in both groups in terms of postnatal emotional well-being and depression. All women experienced positive emotional well-being with no evidence of any tendency towards depressive states. However, more positive emotional well-being was observed for women in the exercise group when compared to women in the control group. More positive psychological well-being experienced during pregnancy by women in the exercise group may influenced postnatal emotional well-being. In contrast, the significant deterioration in the psychological well-being experienced during pregnancy by women in the control group may have influenced their levels of postnatal emotional well-being.

The findings from this present study, in relation to psychological outcome variables, will allow practitioners involved with the care of pregnant women (i.e. midwives and

general practitioners) to recommend regular participation in physical activity during pregnancy. This will enable women to maintain psychological and emotional well-being and self image during and following pregnancy. Childbirth is a recognised critical and emotional event in women's lives when it is important that physical and psychological well-being is either maintained or enhanced to make this experience as positive as possible for women.

5.2 Pregnancy and Birth Outcomes

The interaction between the physiological adaptation to exercise and pregnancy are complex and suggest that they should have an impact on each other (Artal Mittlemark *et al* 1991b). Based on the published literature to date, it has not been possible to conclude in any scientific way whether maternal exercise influences pregnancy and birth outcomes.

5.2.1 Pregnancy Outcomes

The effect of physical activity during pregnancy on preterm delivery and fetal growth has been controversial. Health professionals and the women themselves have concern that regular physical activity may result in preterm† delivery. There are many possible contributing factors to the onset of uterine activity which include obstetric and medical considerations, social, environmental and lifestyle factors. Preterm† delivery is one of the most important factors which affect infant mortality and morbidity. Undoubtedly, preterm delivery may compromise the fetus† and have possible adverse effects on the newborn (Sweet & Tiran 1997).

The concern in relation to exercise arises from the theoretical possibility that exercise-induced circulating noradrenaline may stimulate uterine activity (Gorski 1985). This consideration must be taken seriously, but to date, this concern persists due to the lack of agreement of findings in the current and limited available literature (Clapp 1991a).

In the present study, no significant difference was found between the groups in terms of the length of gestation† at delivery. These findings support much of the available literature that indicates regular exercise is not associated with the incidence of preterm† labour or has an adverse early pregnancy outcome (Pomerance *et al* 1974; Veille *et al*

1985; Clapp 1989 & 1990; Botkin & Driscoll 1991; Zeanah & Schlosser 1993). In contrast to these findings, Clapp & Dickstein (1984) report that women who exercise in the third trimester† of pregnancy have significantly shorter gestation† than either sedentary women or those who cease to exercise before this time.

In general, the findings of this present study suggests that there was no effect of physical activity on shortening of gestation† of pregnancy. However, when comparing and contrasting these findings with those from other studies, it is important to consider that women in this present study were 'low risk' primigravidae† who did not experience any medical or obstetric conditions which may have contributed to preterm† delivery.

There is a general belief among many women that exercise during pregnancy will promote physical fitness which, in turn, will ease labour and delivery and help women cope more efficiently with the exhausting early days of motherhood (Artal Mittlemark *et al* 1991a). The facilitation of labour, as a result of physical conditioning, would be logical to expect due to both an enhanced maternal working capacity and improved function of specific muscles employed in labour.

Findings from this present study did not find any significant difference between the two groups in terms of the total duration of labour and modes of delivery. The majority of women in both groups had normal deliveries at term†. Subjective experiences about the experience of labour were not investigated. There were no maternal, fetal† or neonatal† complications reported during pregnancy or labour with any of the women participating in the study. There was one incident of a woman from the exercise group who required two episodes of surgical intervention within the first six weeks following delivery due to severe trauma of the perineum during the delivery of a baby 5 kg in weight.

Other research has also focused on clinical issues related to the outcome of the labour† and delivery. Existing studies used the duration of the stages of labour† as an indication of the difficulty of labour†. The indication that the difficulty of labour† is related to the duration of the stages of labour† is questionable especially in modern day obstetric practice. However, this indication is perceived by women who generally associate short

labour† with a relatively easy labour† and more difficult labours† with a longer duration of labour†.

Research findings of the relationship of exercise and the positive outcomes for mother and baby are of interest to researchers. Numerous studies have investigated the effect exercise has on labour and delivery resulting in a wide variety of findings. Some findings indicate that there is no difference found in the duration of labour† between physically active and sedentary women (Pomerance *et al* 1974; Collings *et al* 1983; Rose *et al* 1991; Kardel & Kase 1998). Findings in the duration of labour† from this present study contributes to the support of similar findings in the literature.

However, other researchers report no significant difference between physically active multigravid† women and sedentary women but with primigravid† women having significantly shorter active stage of labour† than sedentary women (Kupla *et al* 1987) or women in a control group (Lee 1991). Findings from other studies indicate that women who exercise during pregnancy report significantly shorter time in the active second stage of labour† when compared to sedentary women (Hall & Kaufmann 1987, Botkin & Driscoll 1991; Zeanah & Schlosser 1993).

This present study investigated the total time of labour† from onset until delivery of the baby and timing of different stages of labour† were not identified. This made comparison with these other studies difficult as they report only the duration of the two stages of labour† and not the summation of findings in the duration of labour†.

Findings from this present study did not find any difference in the incidence of obstetric complications which agrees with similar research findings reported by Kupla *et al* (1987). In contrast, other researchers noted a significant reduction in the incidence of obstetric complications and interventions with women who exercise during pregnancy (Botkin & Driscoll 1991; Hall & Kaufmann 1987; Zeanah & Schlosser 1993).

However, labour† and delivery are very complex processes involving many factors that may contribute to the final pregnancy outcome. Factors that need to be considered include: parity, maternal age, fetal size and position, and the use of analgesic medications (Artal Mittlemark *et al* 1991b).

5.2.2 Birth Outcome and Birthweight

The concern that physical training may be deleterious to fetal† viability has been alleviated by studies which show that fetal† heart rate changes during maternal exercise are transient and do not interfere with normal fetal† growth and development (Collings *et al* 1983). Physiological effects of pregnancy were not investigated during this study but were recognised in relation to the potential considerations which may compromise the fetus† in utero.

Findings from this present study reported no significant difference between the two groups of women in terms of Apgar† score of the baby at one and five minutes after birth and birthweight. Apgar† score is a routine initial assessment made following delivery that gives an immediate indication of the general condition of the newborn. These findings agree with available literature which indicates that there is no significant difference in the Apgar† score of babies between women who exercised during pregnancy and women in a control group (Pomerance *et al* 1974; Collings *et al* 1983; Kupla *et al* 1987; Rose *et al* 1991; Lee 1996; Kardel & Kase 1998). It was positive to find no reports in the literature of any differences in Apgar† scores of babies between sedentary women, exercising women and women from a control group.

However, there are conflicting findings between birthweight† and maternal physical activity reported in the literature. Current evidence appears to indicate that participation in moderate to vigorous activity throughout pregnancy may enhance birthweight† while more severe regimes may result in lighter infants. This causes concern in terms of the mortality and morbidity of lighter for gestational age† in the event of preterm† delivery.

Findings from this present study indicated that there was no significant difference in birthweight† of babies born to both women in the exercise group and the control group. The range of birthweight† was comparable between the two groups with none of the babies, born to women who completed the study, being born small enough to be classified as low birth weight i.e. less than 2.5 kilogrammes. These findings agree with similar findings in birthweight† from numerous other studies over the past two decades (Dale *et al* 1982; Collings *et al* 1983; Jarrett & Spellacy 1983; Kupla *et al* 1987; Slavin *et al* 1988;

Botkin & Driscoll 1991; Rose *et al* 1991; Zeanah & Schlosser 1993; Lee 1996; Kardel & Kase 1998).

In marked contrast to these findings, a few studies report that women who exercise give birth to babies significantly lower than the birthweight† of babies born to women in control groups (Clapp & Dickstein 1984; Clapp & Capeless 1990; Bell *et al* 1995). These finding were given further support by other researchers who report that subjects who discontinue exercise, gain significantly more weight and deliver infants with birthweight† similar to sedentary controls (Clapp & Dickstein 1984; Clapp & Capeless 1990).

All of these previous studies discussed were undertaken using differing research designs. However, this present study only included healthy first time prospective mothers who continued to be healthy during pregnancy. These are important factors to consider when comparing these findings on birthweight† with findings from other studies.

Although numerous studies have found no difference in birthweight†, there remains cause for concern due to contrasting findings from research studies which suggest that women who exercise have smaller babies. This concern arises from the possibility that babies will be compromised by being born too small i.e. less than 2.5 kilogrammes. However, women may associate a smaller baby with an easier labour† and may find this a desirable prospect. In light of this fact, more conclusive evidence is needed to provide further information for women and assist health professionals to give appropriate advice related to exercise during pregnancy. In addition, more evidence is also needed to support research findings in relation to the effects of exercise on maternal and neonatal† anthropometry. It is also important to make comparisons of findings with a similar group and care should be taken to avoid the inappropriate generalisation of research findings.

Limitations in the current literature include the lack of follow up investigations of those subjects who failed to complete exercise studies and to what extent women in the control group participated in regular physical activity. This present study attempted to address these limitations. Pregnancy and birth outcomes of those women who failed to complete the study were investigated. No significant differences were noted in terms of

pregnancy and birth outcomes which included length of gestation†, duration of labour†, mode of delivery, maternal and baby complications, Apgar† score and birthweight†.

Findings of this present study support other researchers who conclude that healthy, pregnant, well conditioned women may take part in exercise during pregnancy without compromising fetal† growth and development as judged by Apgar score, birthweight or complications during the course of pregnancy and labour†.

In summary, this present study was undertaken with healthy prospective first time mothers who were recruited into the study with conservative medical and obstetric inclusion criteria. None of the women were deemed 'at risk' for obstetrical and medical complications and health and welfare was closely monitored for the duration of the study. In this respect, it was not anticipated that they were likely to develop any complications during pregnancy. These factors may have contributed to the positive outcomes experienced with all pregnancy and birth outcomes.

It can be concluded from the findings of this present study and available literature that regular moderate exercise during pregnancy undertaken by healthy women remains safe for mother and baby with women having the benefit of maintaining psychological well-being. It has been recommended that pregnancy should not be a state of confinement with women being encouraged to continue an active lifestyle, assuming no medical or obstetric conditions (Artal Mittlemark & Gardin 1991)

5.3 Physical Activity and Retention of Subjects

This present study had an intervention of a structured aerobic exercise programme in addition to the existing antenatal education programme offered to all pregnant women. However, this did not prevent either women in the exercise or control group from continuing with their normal levels of physical activity. These additional episodes of physical activity were recorded during the study. No significant difference was noted between the two groups in relation to reported activity levels in early pregnancy. On completion of the study a statistical difference was found between the two groups in relation to the number of episodes of physical activity undertaken from early pregnancy until four months following delivery. The women in the exercise group were noted to have

participated in significantly more episodes of physical activity than the women in the control group. No relationship was found between the total number of physical activity sessions and the prediction of responses of psychological indicators.

The regular weekly contact the women in the exercise group had with the exercise instructor may have contributed to these findings. Women who attended the structured exercise class may have been influenced to adopt a more active lifestyle that incorporated participation in other forms of physical activity. This could have been due to the experience of participating in the activity itself or due to other factors such as; social interaction with other pregnant women, the motivation from group interaction or the relationship with the class instructor, being in a research study or the habitual nature of the twice weekly classes.

Women in the control group also continued to participate in physical activities but this was significantly reduced when compared to the women in the exercise group. This could have been due to lack of motivation or encouragement, reluctance to attend activities with non pregnant participants, lack of opportunity to attend relevant activities or limited contact with the researcher.

The retention of subjects within this present study was always a concern especially when considering the nature and duration (52 weeks). No statistical difference was found between the two groups in relation to the drop out rate of women during the study (i.e. 36% for women in the control group and 39% for women in the exercise group). The majority of women in both groups dropped out of the study in early pregnancy immediately after recruitment (i.e. 29% from the control group and 33% from the exercise group). It is common for randomised controlled trials to lose subjects especially if they are allocated to a group to which the subject find undesirable (Ward & Morgan 1984). This factor may have contributed to this immediate drop out of subject from both groups with women wishing to exercise being recruited to the control group and women not wishing to exercise being allocated to the exercise group.

Drop out rate of subjects from randomised controlled trials have been estimated to be 20% and as high as 40% (Ward & Morgan 1984). The drop out rate from this present

study, although high, was within the accepted range for randomised controlled trials. Steptoe (1992) identifies the maximum retention of subjects in exercise studies to be 80-85% even in populations with good facilities and subjects with positive attitudes towards exercise. He suggests that the crucial problem for randomised controlled trials of psychological response is not so much that the drop out rate should be minimised but that the drop out rate should not be selective across experimental conditions (Steptoe 1992).

Factors which may have influenced women to remain in the study included: the psychological and physical benefits gained from the exercise programme itself, the group interaction and social interaction with other pregnant women; participation in a research study and the enthusiasm, positive reinforcement and motivation gained from the exercise instructor and other pregnant women.

5.4 Summary

A reduction in psychological well-being during pregnancy is regarded as a typical and normal feature of pregnancy which does not imply poor psychological adjustment (Niven 1992). Findings from this present study suggest that women, who participate in regular physical activity during pregnancy, experience a maintenance or delay in reduction of levels of psychological well-being both during and following pregnancy. This is in contrast to the deterioration in psychological well-being experienced by women in the control group during the same period. No significant relationship was found between the total amount of activity sessions and the responses in the psychological indicators of coping assets (positive psychological well-being), coping deficits (negative psychological well-being) and physical well-being in post pregnancy. This suggests that some one or other factors may influence psychological well-being of individuals other than frequency of physical activity. This may encompass the quality and type and format of exercise programmes undertaken by women other than the frequency of activity. The findings of this present study, contribute to the general agreement within the literature that suggests exercise has psychological benefits which may enhance individual's quality of life. Findings offer support to research findings of exercise during pregnancy which suggest that women experience positive psychological well-being.

The findings of the present study in relation to pregnancy and birth outcomes suggested that there was no difference between the groups and all women experienced positive pregnancy and birth outcomes. These findings contribute to the general agreement in the current literature which recommends that exercise during pregnancy is safe for healthy women and does not contribute any risk to the woman, pregnancy or baby.

Most published studies discussed within this section have suffered from major design flaws. In particular, subject selection bias and lack of control subjects limited the application of findings to only active women. These study design problems made it difficult to compare both the findings from the present study and results from different studies. Both this present study and other research studies discussed, have significantly contributed to current knowledge and understanding of the effects of exercise on pregnancy and have raised issues for further investigation.

CHAPTER 6

CONCLUSIONS

This chapter provides a brief summary of the current situation in relation to women who wish to exercise during pregnancy. The need for further research is highlighted to develop further knowledge and understanding of the impact of exercise on pregnancy. Conclusions to the present study are detailed along with implications for practice and areas identified for further research.

There is general agreement that regular exercise has both physical and psychological benefits which include an enhanced quality of life (Griffiths 1996). Therefore, it is understandable that women of childbearing years now wish to continue with their active lifestyle during pregnancy (Mottola & Wolfe 1994). It is suggested that physical and psychological benefits gained from regular exercise may help to prepare women for the emotional and physical challenges inherent in pregnancy and childbirth (Artal & Artal Mittlemark 1991).

Pregnancy involves profound physiological and psychological changes which are unique to pregnancy. This raises important fundamental questions which include the ways in which pregnancy alters a woman's ability to exercise and to what extent exercise during pregnancy influences the course of pregnancy and the development of the fetus.

Recent national strategies, which have acknowledged the health benefits of exercise, aim to promote regular activity to the general population with women being identified as a target group. In light of these developments, there is need to further investigate the effects of exercise during pregnancy through scientific research. There is also need for healthcare professionals to have a proactive approach to the provision of opportunities for women to adopt more active lifestyles during pregnancy.

This study was undertaken to address some of these important issues and findings have highlighted benefits to psychological well-being of women who undertake regular exercise.

6.1 Conclusions of the Study

The results of the study have been established in relation to the comparison of healthy prospective first time mothers who either continued with the existing antenatal education programme and with women who also participated in regular physical activity from early pregnancy until four months following delivery of the baby.

Regular physical activity during pregnancy and following pregnancy has benefits to psychological 'well-being' of women by maintaining early pregnancy levels of psychological well-being in terms of perceptions of coping assets (positive psychological well-being) and coping deficits (negative psychological well-being) , physical well-being, somatic symptoms experienced and body image.

Regular physical activity during pregnancy and following pregnancy has benefits to psychological 'well-being' of women by maintaining or delaying a reduction in early pregnancy levels of psychological well-being in terms of attitudes to marital relationships, sex and pregnancy / baby.

Regular physical activity during pregnancy does not significantly influence postnatal emotional-well being / depression, although, exercise is associated with more positive emotional-being.

There is no significant relationship between the total amount of physical activity and the responses to the psychological indicators of well-being in post pregnancy.

Regular physical activity during pregnancy does not influence pregnancy or birth outcomes in terms of the length of gestation, duration of labour and mode of delivery, birthweight and neonatal well-being as assessed by the Apgar score at birth.

Regular physical activity during pregnancy does not influence maternal or neonatal complications.

Therefore, it can be concluded from the findings of this present study that regular exercise has positive psychological advantages for pregnant women and there are no risks in terms of birth outcome or health of the fetus.

6.2 Recommendations for Practice

The following recommendations for practice are made in light of current knowledge of the effects of exercise and pregnancy and on the results of this present study.

Health professionals should have access to current and up to date information about the effects of exercise on pregnancy. This would enable them to provide accurate information and advice to meet the individual needs of pregnant woman.

In-service training should be provided to raise awareness of the physical and psychological benefits to be gained by women from participation in regular exercise. Information should be widely available on current guidelines and local practices in relation to exercise during pregnancy and the provision of services available locally.

Midwives, in particular, should incorporate the effects of exercise and pregnancy within their continued personal professional development. This would ensure their knowledge and understanding was updated and their practice was based on current research findings. This would enable them to confidently provide appropriate information and advice to pregnant women attending for midwifery care.

Providers of Maternity Services should ensure that exercise opportunities are incorporated within the existing antenatal education programmes. There should be close liaison with local leisure centres or other providers of exercise to be aware of, or involved with, the provisions available.

Appropriate 'antenatal and postnatal exercise' training for midwife practitioners involved with pregnant women should be available to allow those midwives with a special interest in this area to become fully qualified instructors.

6.3 Further Research

Over research decades, a wealth of literature has emerged which investigates the effects of exercise on fetal and maternal well-being during pregnancy and birth outcome. This present study has shown that healthy women who exercise regularly during pregnancy experience a maintenance of psychological well-being with no risk to either pregnancy or the baby. However, further research is needed in this area to enable conclusions to be drawn and provide further knowledge and understanding of the impact of exercise on pregnancy.

It would be an advantage to have further information available to allow the parameters of safe and appropriate exercise levels to be defined. These parameters should consider all categories of pregnant women in terms of exercise history, present health and activity levels, and obstetric and medical history.

It would be of interest to investigate the extent to which pregnant women adhere to exercise programmes. This should include reasons why women continue with exercise and the reasons why women do not continue with an exercise programme. This information would contribute to knowledge and understanding of adherence to exercise programmes during pregnancy and would allow necessary intervention to the provision of programmes.

More conclusive information is required to detect potential effects on maternal and infant health. The effects of exercise on fetal growth, gestational age and duration of labour are of particular importance. Studies in this area would need to be well controlled to provide conclusive information that can be generalised to other pregnant women.

Information is required to provide information on psychological well-being both in the antenatal and postnatal periods. Current research suggests that exercise provides psychological benefits and this would be an advantage to women during this important life event. A further area of interest would be during the intranatal period. Research should investigate if exercise influences women in relation to coping strategies during labour, subjective experience of labour and perceptions of pain.

Research findings suggest that exercise promotes mental health and prevents depression. Therefore, research should be extended to investigate further the effects of exercise on the mental health of women during pregnancy and the role exercise may have in the prevention of postnatal depression.

Future studies need to be well controlled to enable research findings to be generalised to pregnant women. Therefore consideration should be given to address the recognised limitations evident in current literature i.e. appropriate sample size, history, type, intensity of exercise during pregnancy, consideration of incidence of complications, change in weight, body composition and appropriate statistical calculations undertaken to allow application of the data to the general population.

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APPENDICES

Appendix 1. Criteria for Subjects

Women who wished to participate in the study required the agreement of the consultant obstetrician responsible for their antenatal care.

Typical criteria for determining 'low risk' pregnancy included:

- Healthy women having first pregnancy *i.e.* primigravid
- Singleton pregnancy
- Satisfactory ultrasound scan
- Satisfactory medical history
- Satisfactory history of pregnancy to date

No reported history of:

- Heart disease / Respiratory conditions
- Epilepsy / Diabetes
- Liver disease
- High blood pressure
- Low lying placenta
- Previous obstetric history
- Threatened abortion

Women who developed any complication or disorder during pregnancy which resulted in their transfer to *'Medical Care'* did not continue with the exercise programme.
This included:

- Threatened abortion
- Antepartum haemorrhage
- Intra uterine growth retardation
- Premature rupture of membranes
- High blood pressure

Appendix 2. Pilot Study

The pilot study was undertaken as a preparatory measure to test the methodology prior to the main study. It was important that the methodology was efficient and effective as the length of the main study was estimated to be approximately of two years duration.

Aims of the pilot study

1. Recruitment Procedure:

- To estimate the:

1. Uptake of women into the study
2. Number of women eligible for the study
3. Number of women who agreed to participate in the study

- To review the efficiency of the recruitment process. Both the efficiency and effectiveness of the recruitment process was assessed. This was to ensure that recruitment process encompassed all eligible women at their antenatal appointment to provide the opportunity for them to participate in the study
- To evaluate the consent and information forms and the recruitment procedures by discussion with the antenatal women and all health professionals involved in the study

2. Exercise Regime:

- To review the content / timing / convenience / venue of classes
- To evaluate subjective opinion of the:

1. Exercise classes
2. 'Self instruct' home tapes
3. Exercise leaflets

- To evaluate adherence to the exercise class sessions and the home exercise programme

3. 'Drop out':

- To evaluate the 'drop out' rate and the reason for 'drop out' from the study

4.Data Collection:

Questionnaires:

- To review / evaluate the:

1. Response rate
2. Time taken to complete questionnaires
3. Subjective views of questionnaires / other data collection tools
4. Distribution and retrieval process for questionnaires

Labour / Birth Details:

- To review / evaluate the:

1. Method of data collection during this stage
2. Method of coding subjects, data collection, storage and retrieval
3. Appropriateness of the data collection

4. Method and efficiency of monitoring progress of pregnancy and the information regarding any problems arising

Level of Physical Activity

- To review method of collating information in relation to physical activity

5. To review and evaluate data collation and analyses

6. To review resources involved with the study

7.To conduct an evaluation of the methodology at the end of the pilot study

Methodology

The methodology was designed within the limitations set by hospital management. Recruitment would be allowed within the maternity unit only if it did not involve any of the clinic staff. Two of the four antenatal clinics were used for the recruitment process.

Recruitment of Subjects

Over a ten week period subjects were recruited during the first antenatal clinic appointment. This was anticipated to be around 8 weeks gestation. Subjects were recruited at the first three of the five stages to allow the study to be completed in a shorter time span *i.e. first, second and third trimesters.* The two later stages following delivery *(4 & 12 weeks postpartum)* were covered by subjects recruited in the earlier stages of the study.

The main researcher had previously identified first time prospective mothers on the clinic appointment list.

The total number of women eligible for the study was: **n=77**

The medical records clerkess issued an initial recruitment letter to the women on arrival for their appointment. This letter was to be returned to the appointment desk and then forwarded to the researcher to arrange consent from the consultant obstetrician, where applicable.

The total number of women who agreed to participate was: **n=39** *i.e.* 100%

These women then met with the researcher after their initial appointment *(approx. 2 hours duration)* to obtain group allocation and further information.

The number of women who kept this appointment was: **n=25** i.e. 64%

The number of women recruited who failed to keep this appointment was: **n= 14** i.e. 36%

The total group allocation was (n=25): i.e. Control group n= 13; Exercise group n= 12

Details of Control group (n=13)

A further 3 women dropped out of the study by telephone before any data was collected. Therefore n=10 women remained in the study

The number of women who completed the study was: **n=8** i.e. 80% of women ***n=10***

Details of Exercise Group (n=12)

The number of women who did not attend any classes was n=6 i.e. 50%

A further n=1 woman attended one class only

Regular attendance of women at the exercise class was n=5 i.e. 42% of n=12 recruited and 83% of n=6 who attended the exercise classes

The number of women who completed the study was **n= 6** i.e. 50% of the total number recruited to the study

Exercise Programme

The exercise programme was designed to consider the physiological changes of pregnancy and was based on the London Central YMCA 'Antenatal and Postnatal exercise programme'. This programme, endorsed by the Royal College of Midwives, complied with the American College of Obstetricians and Gynecologists guidelines for exercise during pregnancy (*cited in* Artal Mittlemark *et al* 1991a).

Women were given instruction as how to take their own pulse rate during the exercise class. This was followed with practice sessions and an instruction leaflet for home use.

Evaluation of the study

This was in the form of a semi-structured interview and was mainly conducted by telephone with the women in the control group and either by telephone or *'face to face'* interview with women in the exercise group.

From evaluation of the ***recruitment process,*** the majority of women agreed that time was restricted at the clinic. This was due to other considerations e.g. transport; family members who had already been waiting for a few hours. The women felt that it would have been beneficial if they could have discussed the study with the clinic staff. The fact that the clinic staff *'knew nothing at all'* about the study was a disadvantage. Both the women and the clinic staff suggested that it would have been helpful if an information leaflet had been available to women and staff at time of recruitment.

This need was reinforced when several of the women were given information in error by the clinic staff. These women were not eligible for the study as they were not first time prospective mothers.

Staff evaluation of the recruitment process indicated that it would be improve efficiency if the clinic staff were to be involved in the recruitment process. Medical records staff had no problems with their involvement with the study and were satisfied to continue. However, they stipulated that casenotes could not be removed from Medical Records Department as they were required by other health professionals.

There were no problems found with any of the consent forms by any health professionals. However, two women objected to their general practitioner / midwife being notified of their participation in the study as the women felt that they would possibly be discouraged from attending the exercise class by these health professionals.

Recruitment for the study was found to be slow considering the number of women who were eligible for the study from the clinic appointment list. It was found that many women were either not being offered the opportunity to participate in the study or the obstetrician was not being asked to give consent for the woman to participate in the study.

Basically, the restrictions placed on the methodology by hospital management had contributed to an inefficient and inconvenient system of recruitment and data collection for both women and staff involved in the study.

The findings from the pilot were presented to hospital management and suggestions were made to improve the methodology. These amendments were agreed and their implementation was given full support.

Proposed amendments to recruitment procedure:

- Recruitment would take place at all four weekly clinics to ensure prompt recruitment of numbers for the study
- Midwives at the clinic would now be involved with the recruitment process *in terms of* gaining consent from subjects; gaining consent from consultant obstetrician and giving the women the sealed and coded information pack. These prepared information packages would be available for issue by the clinic staff at the time of gaining consent from the women. This would remove the further meeting with the researcher following this appointment, allow the women to be allocated to their group at this time and also enable women to complete the initial information during this appointment time
- Women would be followed up within one week of recruitment by a telephone call from the researcher to give the women opportunity to discuss the study further, if required
- All staff involved with the study would be invited to a presentation of the aims of the study, the importance of the recruitment of eligible subjects and the extent of the health professionals' role in the process
- Information letters to general practitioners / midwives were available but would only be issued at the woman's request

Exercise Programme

The class was offered at a variety of times and venues. The preferred time was early evening (6-7 p.m.) as the women felt this was more convenient if they were working and it also fitted in with evening parenthood education classes. The General Recreation Hall in the hospital was the venue of choice as it was conveniently placed and toilet and changing facilities were available.

Evaluation of the class was satisfactory in relation to content, duration and organisation. However, some of the women found it awkward to record their own pulse rate during the class. Audio cassettes of exercise programmes were not used but exercise videos were found to be useful. Postnatal women would have preferred to have their baby with them at the class as it was difficult to arrange baby sitters.

Adherence and Drop out

Women did not want to come to the class alone and felt it would be an advantage to initially bring along a friend. Also, the majority of women only wanted to attend the exercise class once or twice per week. Three times per week was impossible for many women due to other activities attended and parenthood education classes.

Many women currently attended the aquanatal classes provided in conjunction with the maternity unit and leisure centres in Ayrshire. One woman reported that she had 'dropped out' of the study as she had been apprehensive of locating her pulse rate and had only guessed the rate.

Women felt that it would have been easy to drop out of the study after they had missed one or two exercise classes. They felt obliged to return because it was important to the study.

Control Group

In general, the women felt that they either should not be exercising at all or restricted as to what exercise they were allowed to undertake. They also felt that they were just guessing as to whether they were regular or occasional exercisers as they could not remember the number of times they had exercised.

Women felt that there was so much information required by different people during pregnancy that they had forgotten the reason for the study by the time they had received the questionnaires. This made then averse to completing the questionnaire until the reminder phone call prompted them to do so.

Proposed amendments to the Exercise Programme

- Classes would now be offered twice per week between 6 and 7pm in the General Recreation Hall at Ayrshire Central Hospital
- Pulse rates would still be located and recorded during the exercise class but, in addition, the 'Borg's Perceived Rating of Exertion Scale'(RPE) would be available for those women who were initially finding difficulty in locating and recording their pulse rates. Information leaflets on locating and recording pulse rates and the use of 'PRE' scales would be available for women to utilise at other exercise sessions
- Women were welcome to bring along a friend if numbers permitted and a midwife friend would be available at the classes to take care of any babies who attended with their mothers
- Exercise videos *(YMCA Ante & Postnatal Exercise Programme)* would continue to be available for loan by individual women
- Other physical activities could now be included within the exercise programme to enable women to satisfactorily meet their weekly 'exercise' requirements. These activities included: other exercise classes such as aerobics or aquanatal classes at local leisure centres; swimming; cycling, golf, brisk walking etc.
- An activity diary would be incorporated within the study for use by women in both groups to enable an accurate summary of physical activity at the data collection points. This would also enable women to provide a total for the number of additional classes attended during the course of the study
- A class register would be introduced with a section for other physical activities to be included for use by women attending the exercise class
- A poster about the exercise group would be sent out at regular intervals to those women who did not attend the class for two - three weeks without any contact
- Women in the 'control' group would be reassured that they could continue with their usual lifestyle in terms of physical activity

Data Collection

All women (n=6) in the exercise group completed the required questionnaires. In the control group **eight** of the **ten** women completed the questionnaires. All women felt that these questionnaires were time consuming to complete and sometimes they were unsure of what was required in the response to the questions. There was also considerable delay in returning questionnaires and many were returned incomplete.

Gaining information from medical / obstetric notes proved to be difficult as these notes were usually being used elsewhere by other health professionals.

The retrieval process was satisfactory for data coded and stored in the computer database.

Amendments to Data Handling

- Information obtained was reviewed for relevancy within the context of the study. As a result information deemed irrelevant to the present study was subsequently removed e.g. perceptions of labour and delivery.
- A booklet of questionnaires was designed to incorporate all the information necessary. This included a summary of relevant information about health and labour / delivery details. Casenotes would only be required in the event of missing data or details which needed further investigation.
- A letter reminding subjects about the study was included with the issue of each questionnaire booklet. The first questionnaire would be included within the information pack. Thereafter subsequent questionnaires would be posted to the home address one week before the time range for data collection. A second questionnaire would be posted out two weeks within the four week range. Stamped addressed envelopes were included. In addition, the women could also give completed questionnaires to their midwife or other health professional for postage through the internal mailing system.
- Results were discussed with both the statistician and research supervisors. It was decided that the three time points identified as obtaining valuable information were to be retained i.e. early (12-16 weeks) pregnancy, late (36-40 weeks) pregnancy and post (12-16 weeks) pregnancy. There was poor response to the questionnaires issued during the second trimester and at delivery with most information being omitted or incomplete. These time data collection points did not reveal any informative data and were omitted from the main study. Sample size for the main study was calculated based on current results.

Sample size for the main study was estimated using the variables of perceptions of body image and coping assets coping assets (positive psychological well-being) to determine the overall sample size necessary to gain statistical significance: *e.g.* Perceptions of Body image - the range of possible scores was 12 - 48. Typical scores at 16 weeks gestation was estimated to be = 30 and at 36 weeks = 20. The range of changes was = 2 - 20. It was assumed that the intervention of exercise reduced typical scores from 30 at 16 weeks to a score of 25 at 36 weeks. Therefore, it was assumed that the control group over this interval of time would obtain scores between 30 -20 with scores of 30 - 25 for the exercise group scores over the same period of time. Based on this assumption then the study would require a minimum of thirty women in each of the two groups to complete the study for a power of 0.90. Based on these calculations, it was recommended to aim to recruit at least fifty women into each group once the drop out rate from the pilot study was considered.

Statistical tests would include Repeated Measures Analysis of Variances (ANOVAs) to determine if there were any differences between the two groups over time for each of the psychological variables. Follow up multiple comparisons tests with a simultaneous 95% confidence level would be undertaken when any significant differences were indicated. Two sample t-tests would be undertaken with those dependent variables measured once during the study e.g. length of gestation, duration of pregnancy, Apgar scores, birthweight and postnatal emotional well-being. Chi-square tests would determine if there were any differences in the mode of delivery of the baby and exercise levels in early pregnancy.

Funding: A proposal for funding would be submitted to: 1. North A & A NHS Trust Lottery Committee to request funds to purchase a music system for the large hall; floor mats; and exercise videos. 2. Ayrshire & Arran Health Board to reimburse the subjects with the admission fee for one activity per week at leisure centre of their choice for the duration of the study.

Appendix 3. Exercise Guidelines

American College Obstetrics and Gynaecology guidelines were followed (ACOG Guidelines *cited in* Artal Mittlemark *et al* 1991c).

These include:

Pregnancy and Postpartum

- Regular exercise *(at least three times per week)* is preferable to intermittent activity
- Vigorous exercise should not be performed in hot, humid weather or during a period of febrile illness
- Ballistic movements *(jerky, bouncy motions)* should be avoided
- Deep flexion or extension of joints should be avoided because of connective tissue laxity. Activities that require jumping, jarring motions or rapid changes in direction should be avoided because of joint instability
- Vigorous exercise should be preceded by a five minute warm up. This can be accomplished by slow walking or stationary cycling with low resistance
- Vigorous exercise should be followed by a period of gradually declining activity that includes gentle stationary stretching. Connective tissue laxity increases the risk of joint injury, therefore stretches should not be taken to the point of maximum resistance
- Heart rate should be measured at times of peak activity. Target heart rates and limits established in consultation with the physician should not be exceeded
- Care should be taken to rise gradually from the floor to avoid orthostatic hypotension. Some form of activity involving the legs should be continued for a brief period
- Liquids should be taken liberally before and after exercise to prevent dehydration. If necessary, activity should be interrupted to replenish fluids
- Women who have led sedentary life styles should begin with physical activity of very low intensity and advance activity levels very gradually

Pregnancy only

- Maternal heart rate should not exceed 140 bpm.
- Strenuous exercise should not exceed 15 minutes in duration.
- No exercise should be performed in the supine position after the fourth month of gestation is complete.
- Exercises that employ Valsalva manoeuvre should be avoided.
- Caloric intake should be adequate to meet not only the extra energy needs of pregnancy, but also of the exercises performed.
- Maternal core temperature should not exceed 38 degrees C.

N.B. Activity should be stopped and physician consulted if any unusual symptoms appear.

Table 1 Beats per Minute

Age	Limit*	Maximum
20	150	200
25	146	195
30	142	190
35	138	185
40	135	180
45	131	175

*Each figure represents 75% of the maximum heart rate that would be predicted for the corresponding age groups. Under proper medical supervision, more strenuous activity and higher heart rates may be appropriate.

Exercise for Pregnancy and the Postnatal Period

The value of exercise during pregnancy is well documented and research findings suggest that regular moderate exercise is likely to lead to an improved course of pregnancy when compared to women who lead sedentary lifestyles (Huch & Erkkola 1990).

The exercise programme has been specifically designed to take into consideration the physiological adaptations experienced during each trimester of pregnancy and in the postpartum period. A summary of the main physiological changes for considerations are presented which can be found in more detail within Chapter One.

Maternal considerations include:

- *Musculo-Skeletal System*

Gestationally induced changes in plasma hormone levels increase relaxation and joint mobility especially in the third trimester of pregnancy. All joints are affected resulting in connective tissue laxity and joint instability which renders joints susceptible to injury.

As pregnancy progresses, the enlarging uterus and breasts produce changes in the centre of gravity of the body (McNitt-Gray 1991, Sharp 1993). There is increased lumbar lordosis during pregnancy and increased strain on the sacroiliac and hip joints. This causes additional strain on the back and can create balance and co-ordination problems which increasing the risk of falls, especially during exercise. The abdominal muscles become weaker as pregnancy progresses and they become less efficient in their vital role of supporting the back and maintaining posture. Particular importance is placed on strengthening the abdominal muscles to maintain correct posture and to facilitate and promote correct lifting technique.

- *Cardiovascular*

Cardiovascular changes during pregnancy include substantial increase in blood volume. After the fourth month of pregnancy, the enlarging uterus is capable of interfering with venous return to the heart by compression of the inferior vena cava. This can cause supine hypotension, affecting cardiac output and interfering with uterine circulation (Ueland *et al* 1969). Exercises should **not** be undertaken in the supine position after the first trimester of pregnancy to prevent this occurring.

- *Respiratory*

The changes in the respiratory system are extensive, including anatomic and functional alterations. In the third trimester of pregnancy, the enlarging uterus displaces the diaphragm upwards resulting in a reduction in respiratory reserve. Pulmonary function is not impaired with exercise but it is important to be aware that exercise may result in general discomfort to the woman.

Appendix 4. Exercise Programme

Warm Up

Aims:

- To take the joints through the full range of movements
- To become familiar with and introduce the mind to the sensations of the movement and body
- To increase circulation and prepare the cardiovascular system by very low repetitive work. This allows the heart rate to gradually increase with exercise and provide the working muscles with adequate blood supply
- To prepare the neuromuscular response pattern
- To give the body time to prepare for more activity later
- To warm muscle groups to a temperature for optimum performance during exercise programme
- The warm up includes both stretching exercises and exercises that increase the activity of the heart and circulatory system

Aerobic Exercise

Aims:

- To improve and/or maintain aerobic capacity

Muscular Strength and Endurance

Aims:

- To make main muscle groups strong enough to support the skeletal structure and to maintain posture and body shape. Posture alters during pregnancy to compensate for the expanding abdomen. As a result, the pelvis often tips forward causing an excessive curve in the lumbar spine. This leads to the baby protruding in front of the mother with this resulting distribution of weight stressing the vulnerable areas of the lower back. Correcting this requires good use of the abdominal muscles and can also provide an excellent toning exercise to help regain a flat stomach following the birth. Women are encouraged to tilt their pelvis backward so that the baby is tucked in towards them and held securely by firm abdominal muscles. This stabilises the lower back for the lumbar spine.
- To improve muscular endurance to aid good posture, reduce the risk of strain to the back and to prepare for postpartum recovery.

Stretching

Aims:

- To reduce muscle tension and make the body feel more relaxed
- To maintain the range of movement of joints and muscles so that the body can work more efficiently
- To improve exercise technique by extending the range of body movement

Stretching exercises are valuable for women during pregnancy for the reasons described above. However, all stretching exercises are carried out with care and supervision.

Pelvic Floor Care:

- The pelvic floor literally bears the strain during pregnancy. These exercises are very important both during and following birth

Cool Down

Aims:

- To return the body gradually to the non exercising state
- To relax in order to reduce physical tension
- To assist the body to remove substances that may contribute to muscle soreness
- To assist the circulatory system to help control the venous return and adequate cardiac output

Exercise Session

- Duration of each session was 30 - 40 minutes
- Women were advised to undertake 3 exercise sessions per week
- Women were encouraged to attend two exercise sessions per week at the antenatal and postnatal exercise class and one physical activity of their own choice *e.g. swimming, aquanatal, aerobics, walking, cycling, golf etc.*
- Structured exercise classes were held twice per week in Ayrshire Central Hospital, Irvine
- Exercise videos 'The complete pre and postnatal fitness plan video' were available for home use by individual women
- Women were given initial instruction on how to locate and record their own pulse rate or use the Borg *'Perceived Exertion Scale'*
- Exercise sessions were either at a class session or self instruct tape/ video at home. The exercise programme was based on YMCA ante and postnatal exercise regime and ACOG guidelines (*cited in* Artal Mittlemark *et al* 1991c)
- Women were encouraged to carry out all exercises at their own pace
- Many exercises were undertaken either on the floor mats or standing
- Class register of attendance was maintained
- A record of all physical activity undertaken was kept by all the women in the study. This included: any other exercise classes attended e.g. aquanatal; swimming; brisk walking; cycling golf etc.
- Details of other physical activities included: the content, timing, duration, frequency and intensity. The women could discuss these activities further with the researcher if required.

Appendix 5. Recruitment Letter

Jean Rankin, Senior Midwife, Ayrshire Central Hospital, Irvine. Tel 01294 274191 Ext. 3395

Dear Mother to Be

I am undertaking a research study in conjunction with Ayrshire Central Hospital and the University of Glasgow. The information obtained from this study may have a valuable contribution when planning developments in antenatal care.

The study may only require women to undertake the existing available antenatal care offered to pregnant women or **in addition** to this care some women may be asked to undertake an exercise programme. The exercise class will be held in Ayrshire Central Hospital and will be taken by myself. All women in the study will be asked to complete a **total** of three questionnaires during and following pregnancy.

Please indicate below if you are interested in taking part in this study. This will be discussed with your consultant obstetrician at the appointment today.

If your obstetrician also agrees that you are fit and healthy then you will be given a sealed envelope which will give you further information of your group in the study and will include the first questionnaire for you to complete and return .

- Thank-you for taking the time to read this letter,
- Yours sincerely

Jean Rankin

Tear Off----------

Please circle your response below and return this slip to the Reception desk.

I am *interested* / ***I am NOT interested*** *in taking part in this study*

NAME _____ *DATE* _____

Appendix 6. Consent 1

Jean Rankin, Senior Midwife, Ayrshire Central Hospital, Irvine. Tel 01294 274191 Ext. 3395

Consultant Obstetrician

Re: _____

Dear Doctor _____

The above woman has consented to take part in the research study which aims to investigate the *'Effects of Exercise during Pregnancy'*

The woman will be randomly assigned to either :

1. The **'control'** group of subjects will continue with the existing antenatal preparation for childbirth and motherhood

OR

2. The **'exercise'** group of subjects will undertake a structured and supervised exercise class at ACH **in addition to** the existing antenatal preparation for childbirth and motherhood.

I would be obliged if you would agree to her participation in the study.

Yours sincerely

Jean Rankin

I **consent / do not consent** to this woman participating in this study.

Signature of Consultant _____Date _____

Please retain in Medical casenotes

Appendix 7. Information Letter 1

Jean Rankin, Senior Midwife, Ayrshire Central Hospital, Irvine. Tel 01294 274191 Ext. 3395

Information to General Practitioner / Midwife

re: _____

*Dear Doctor / Sister*_____

The above woman has consented to take part in a research study at Ayrshire Central Hospital, Irvine, which has received ethical approval from A.& A.H.B. Consent for participation in the study has also been obtained from her Consultant obstetrician.

The study is carried out in conjunction with the University of Glasgow and aims to investigate the ***Effects of Exercise during Pregnancy***.

The woman has been assigned to:

1.The **'control'** group of subjects who have the existing antenatal preparation for childbirth and motherhood.

OR

2.The **'exercise'** group of subjects who will undertake structured and supervised exercise class at Ayrshire Central Hospital **in addition** to the existing antenatal preparation for childbirth and motherhood.

Please do not hesitate to contact me if you wish to discuss this study further.
Yours sincerely,

Jean Rankin

Senior Midwife

Appendix 8. Consent Form 2

Jean Rankin, Senior Midwife, Ayrshire Central Hospital, Irvine. Tel 01294 274191 Ext. 3395

I consent to take part in this study and confirm that I have been given the following information:

- My obstetrician has agreed that I am fit and healthy and can take part in the study
- My general practitioner and named midwife may be informed with my permission
- It has been explained to me that I will undertake a structured exercise programme during and following pregnancy and I have received an information leaflet which gives me further details of the exercise programme
- I am aware that I can discontinue with the exercise class if I have any concerns and that I will be advised to stop the exercise programme immediately if I develop any complications during pregnancy
- I am aware that I will be asked to complete a total of three questionnaires during and following pregnancy and I have received information giving me further details
- I am aware that details of any complications, hospital admissions, and my labour and birth will be obtained from my medical casenotes for use in the study
- I have been given a telephone number to contact if I have any questions
- I am aware that I can discontinue with this study at anytime
- I understand that all information will be confidential

Signature of Subject _____ *Date* _____

Signature of Researcher _____ *Date* _____

Copy to: Subject / Researcher / Medical casenotes

Appendix 9. Consent Form 3

Jean Rankin, Senior Midwife, Ayrshire Central Hospital, Irvine. Tel 01294 274191 Ext. 3395

I consent to take part in this study and confirm that I have been given the following information:

- My obstetrician has agreed that I am fit and healthy and can take part in the study
- My general practitioner and named midwife can be informed with my permission
- It has been explained to me that I will be offered all available existing antenatal care during my pregnancy
- I am aware that I will be asked to complete a total of three questionnaires during and following pregnancy and I have received information giving me further details
- I am aware that details of any complications, hospital admissions, and my labour and birth will be obtained from my medical casenotes for use in the study
- I have been given a telephone number to contact if I have any questions
- I am aware that I can discontinue with this study at any stage
- I understand that all information will be confidential

Signature of Subject _____ *Date* _____

Signature of Researcher _____ *Date* _____

Copy to: Subject / Researcher / Medical casenotes

Appendix 10. Information Letter 2

Jean Rankin, Senior Midwife, Ayrshire Central Hospital, Irvine. Tel 01294 274191 Ext. 3395

Thank-you for agreeing to participate in this study.

- You have been assigned to the **'control'** group of subjects who will continue with the **existing available antenatal care** during pregnancy
- Your consultant obstetrician has agreed to your taking part in this study because you are a healthy women with a healthy pregnancy
- Your midwifery and medical notes will have an identification sticker attached to let midwifery / medical staff know that you are participating in this study
- I will monitor the progress of your pregnancy by keeping in contact with your consultant obstetrician, and from your medical notes
- I will collect information from your medical notes about any hospital admissions or any complications you may have during pregnancy
- Details of your pregnancy, delivery and birth may also be obtained from your medical notes for use in the study
- You will be asked to complete a booklet of questions asking you how you are feeling about yourself and your pregnancy on **three** separate occasions during and following pregnancy
- Your first questionnaire is in the information envelope and the next two questionnaires will be sent to your home address by post. A stamped addressed envelope with my address will also be issued to allow you to return the completed questionnaire to me
- Please keep your activity diary up to date. You should include the following information which will be helpful to you when you summarise your physical activities on the three questionnaires: Type of physical activity; duration and frequency of the activity. A total of all exercise classes you have attended should be kept . Do not hesitate to contact me if you need to discuss any forms of physical activities you have undertaken or wish to undertake
- All information about you will be kept confidential
- All information kept about you will be put under a code number
- You are able to leave the study at any time you wish

Please contact me at the telephone number above if you wish to discuss the study further.

Thank-you for your co-operation.

Appendix 11. Information Letter 3

Jean Rankin, Senior Midwife, Ayrshire Central Hospital, Irvine. Tel 01294 274191 Ext. 3395

Thank-you for agreeing to participate in this study.

- You have been assigned to the **exercise group** of subjects
- Your consultant obstetrician has agreed to your taking part in this study because you are a healthy women with a healthy pregnancy
- This means that you will have the existing available antenatal care offered to women during your pregnancy and **in addition** you will be asked to undertake **a structured exercise programme** during and following pregnancy
- The exercise programme used in the class is especially designed for pregnant women. Exercises will consist of gentle warm up, moderate aerobic exercises, stretching and body conditioning, and cool down. The session lasts for between 35 and 40 minutes. You may wear any comfortable clothes *e.g. tee shirt and leggings*
- The exercise class will be held twice weekly in Ayrshire Central Hospital. **In addition** you may undertake other physical activities *e.g.* aquanatal which is offered weekly at your local leisure centre, brisk walking or cycling. Exercise video tapes specifically for exercise during and following pregnancy are available for home use. Do not hesitate to contact me if you need to discuss any forms of physical activities you have undertaken or wish to undertake
- It is advised that exercise should be undertaken **three times per week.** It is advised that the exercise session should be attended whenever possible, preferably twice per week or at least once per week
- You may discontinue with the exercise classes at any time if you have any concerns and you will be asked to discontinue with the exercise programme immediately if you have developed any complications during your pregnancy
- Your midwifery and medical notes will have an identification sticker attached to let midwifery / medical staff know that you are participating in this study
- I will monitor the progress of your pregnancy by keeping in contact with your consultant obstetrician, and from your medical notes
- I will collect information from your medical notes about any hospital admissions or any complications you may have during pregnancy
- Details of your pregnancy, delivery and birth may also be obtained from your medical notes for use in the study

- You will be asked to complete a booklet of questions asking you how you are feeling about yourself and your pregnancy on **three** separate occasions during and following pregnancy
- Your first questionnaire is in the information envelope and the next two questionnaires will be sent to your home address by post. A stamped addressed envelope with my address will also be issued to allow you to return the completed questionnaire to me
- Please keep your activity diary up to date. You should include the following information which will be helpful to you when you summarise your physical activities on the three questionnaires: Type of physical activity; duration and frequency of the activity. A register is maintained of your attendance at the hospital classes
- All information about you will be kept confidential and put under a code number
- You are able to leave the study at any time you wish

Please contact me at the telephone number above if you wish to discuss the study further

Thank-you for your co-operation.

Appendix 12. Information Letter 4

Jean Rankin, Senior Midwife, Ayrshire Central Hospital, Irvine. Tel 01294 274191 Ext. 3395
Home Address: 113, Fergushill Road, Kilwinning, Ayrshire, KA13 7JU Tel 01294 552321

Dear_____,

Thank you for taking the time to participate in this study.
I have enclosed questionnaire number _____ for you to complete and return in the SAE provided.

Just a reminder about the study:

- The study is voluntary and you are under no obligation to continue
- This study is designed for first time mothers only
- Information will be obtained to find out about your physical well-being and how you are feeling about yourself, your pregnancy, your body and your relationships
- During the study you will complete a total of three of these questionnaires:

1. In early pregnancy when you join the study
2. During the last few weeks of pregnancy
3. Finally 12-16 weeks after your baby is born
   - In addition you are asked to keep an activity diary or record of your physical activity on a weekly/ monthly basis and give brief details of your labour / delivery

About the questionnaire:

- It will take about 10-15 minutes to complete
- Please answer the questions promptly
- You will be asked to write a brief summary of your physical activity from your personal diary. All exercise classes attended will be totalled at the end of the study

Please contact me if you wish to discuss any aspects of the study, if you do not wish to continue with the study or to keep me up to date with your activities or let me know when your baby is born.

If I do not hear from you then I will send out your next questionnaire routinely.

I hope you are keeping well,

Jean Rankin

Appendix 13. Questionnaire Booklet

Scoring of the Outcome Variables in the Questionnaire

Perceptions of coping assets (positive psychological well-being)
14 questions in total. Range of individual scores = 0 - 4.
Total score = 56 (higher score is positive)
Questions 1, 3, 5, 10, 11, 13, 15, 16, 18, 19, 20, 22, 23, 29

Perceptions of Coping deficits (negative psychological well-being)
10 questions in total. Range of individual scores = 0 - 4.
Questions 2, 4, 6, 8, 9, 12, 14, 17, 21, 28
Total score = 40 (higher score is negative)
Rotate question 6

Perceptions of Physical well-being
6 questions in total. Range of individual scores = 0 - 4. Total score = 24 (higher score is positive). Questions 7, 24, 25, 26, 27, 30

MAMA subscales Scores 1 - 2 = undesirable responses. Scores 3 - 4 = desirable responses
Perceptions of Body Image.
Questions 2, 12, 18, 19, 21, 31, 44, 47, 49, 53, 55, 57
Rotate questions 2, 12, 19, 21, 49, 53, 55, 57

Perceptions of Somatic symptoms.
Questions 1, 4, 6, 9, 17, 27, 32, 33, 35, 38, 41, 59
Rotate questions 1, 17, 33, 41

Attitudes to Marital Relationships.
Questions 3, 8, 15, 26, 34, 36, 37, 43, 48, 50, 52, 56
Rotate questions 8, 34, 36, 37, 48, 56

Attitudes to Sex.
Questions 5, 11, 13, 20, 23, 25, 30, 39, 42, 45, 46, 58
Rotate questions 5, 13, 20, 23, 42, 45, 58

Attitudes to Pregnancy / Baby.
Questions 7, 10, 14, 16, 22, 24, 28, 29, 40, 51, 54, 60
Rotate questions 24, 28, 29, 40, 60

Edinburgh postnatal Depression Scale
Scores 1-10. Lower score is the more positive response.
Score of individual questions = 0 - 3. Total score = 40

Code No:_____

MAMA QUESTIONNAIRE

Name:_____ Date: _____

Group:_____ Questionnaire No:_____

No. of weeks of pregnancy:_____ EDD:_____

No of weeks since delivery:_____ ***Date of Delivery:***_____

- *Thank you for taking the time to complete this questionnaire.*
- *Please use the back cover for any comments or messages.*
- *All information will be treated in confidence.*
- *Please return to Jean Rankin in the envelope provided.*

Summary of Physical Activity
Review your activities over the past four weeks from your activity diary.

1. Would you please **circle** the response which you feel best describes your present level of physical activity *e.g aquanatal; swimming; exercise classss; cycling, gym work, sports, hobbies etc.*

- ***Inactive*** *i.e. You have not taken any form of physical activity at all*

- ***Occasionally active*** *i.e. You have taken physical activity on an occasion only and not on any regular basis*

- ***Regularly active*** *i.e. You have regular set episodes of activity or exercise, daily or weekly etc.*

- ***Very active*** *i.e. You are exercising almost every day or every other day*

Summary of Physical Activity Exercise Diary

2. Would you please **circle** the response which best describes the average times you have taken any form of physical activity per week:

- ***None*** - ***once*** - ***twice*** - ***three times*** - ***more than 3 times***

3. List the types of physical activity you have undertaken:

On a regular basis:	*How often in one month:*	***Occasionally taken?***	*How often in one month:*

4. Please **circle** the statement which describes your intention to alter your level of physical activity:

- *I intend to increase* - *I intend to decrease* - *I intend to keep the same level of activity*

5. Please ***circle*** *the statement which describes how you have been during or following pregnancy:*

- ***Yes****, I have kept well* - ***No****, I have not kept well*

Reason, if unwell:

6. Please give ***brief details*** *of any hospital stays:*

Length of stay:	*Weeks of pregnancy/ postnatal*	*Reason*

Remember to keep a record of all your activity especially any classes you have attended. These details will be required at the end of the study.

Well-being

Below is a list of words and phrases that describe feelings that people have. Please read ***each one carefully****, then circle the response which best describes the extent to which you have had this feeling* ***during the past week including today.***

During the last week and including today ***to what extent have you been feeling:***

1. Self confident	*Not at all*	*A little*	*Moderately*	*Quite a lot*	*Extremely*
2. Easily irritated	*Not at all*	*A little*	*Moderately*	*Quite a lot*	*Extremely*
3. Enthusiastic	*Not at all*	*A little*	*Moderately*	*Quite a lot*	*Extremely*
4. Disappointed with yourself	*Not at all*	*A little*	*Moderately*	*Quite a lot*	*Extremely*
5. Uplifted	*Not at all*	*A little*	*Moderately*	*Quite a lot*	*Extremely*
6. Calm	*Not at all*	*A little*	*Moderately*	*Quite a lot*	*Extremely*
7. Refreshed	*Not at all*	*A little*	*Moderately*	*Quite a lot*	*Extremely*
8. Drained	*Not at all*	*A little*	*Moderately*	*Quite a lot*	*Extremely*
9. Easily upset	*Not at all*	*A little*	*Moderately*	*Quite a lot*	*Extremely*
10. Proud of yourself	*Not at all*	*A little*	*Moderately*	*Quite a lot*	*Extremely*
11. Elated	*Not at all*	*A little*	*Moderately*	*Quite a lot*	*Extremely*
12. Distressed	*Not at all*	*A little*	*Moderately*	*Quite a lot*	*Extremely*
13. Invigorated	*Not at all*	*A little*	*Moderately*	*Quite a lot*	*Extremely*
14. Bothered	*Not at all*	*A little*	*Moderately*	*Quite a lot*	*Extremely*

To what extent have you been feeling that you are:

15. Coping	*Not at all*	*A little*	*Moderately*	*Quite a lot*	*Extremely*
16. Achieving something	*Not at all*	*A little*	*Moderately*	*Quite a lot*	*Extremely*
17. Overwhelmed	*Not at all*	*A little*	*Moderately*	*Quite a lot*	*Extremely*
18. Overcoming difficulties	*Not at all*	*A little*	*Moderately*	*Quite a lot*	*Extremely*
19. Getting closer to your goals	*Not at all*	*A little*	*Moderately*	*Quite a lot*	*Extremely*
20. Well organised	*Not at all*	*A little*	*Moderately*	*Quite a lot*	*Extremely*
21. Under too much pressure	*Not at all*	*A little*	*Moderately*	*Quite a lot*	*Extremely*
22. Competent	*Not at all*	*A little*	*Moderately*	*Quite a lot*	*Extremely*
23. Getting things under control	*Not at all*	*A little*	*Moderately*	*Quite a lot*	*Extremely*

To what extent have you been feeling physically:

24. Healthy	*Not at all*	*A little*	*Moderately*	*Quite a lot*	*Extremely*
25. Strong	*Not at all*	*A little*	*Moderately*	*Quite a lot*	*Extremely*
26. Supple	*Not at all*	*A little*	*Moderately*	*Quite a lot*	*Extremely*
27. Fit	*Not at all*	*A little*	*Moderately*	*Quite a lot*	*Extremely*
28. Run down	*Not at all*	*A little*	*Moderately*	*Quite a lot*	*Extremely*
29. Attractive	*Not at all*	*A little*	*Moderately*	*Quite a lot*	*Extremely*
30. Well	*Not at all*	*A little*	*Moderately*	*Quite a lot*	*Extremely*

MAMA

*Please complete each question below by putting a circle around the answer which most closely applies to you. **Quickly** answer each question on how you have been feeling **during the past month**. If you have not considered some of these questions during the past month then **please answer them on your present feelings**.*

IN THE PAST MONTH

1. Have you felt out of breath easily?

Very often ***Often*** ***Rarely*** ***Never***

2. Have you felt attractive?

Never ***Rarely*** ***Often*** ***Very often***

3. Has there been a lot of tension between you and your partner- *i.e. irritability, unpleasantness, silence, etc.?*

Never ***Rarely*** ***Often*** ***Very often***

4. Have you been perspiring a lot?

Never ***Rarely*** ***Often*** ***Very often***

5. Have you found your partner sexually desirable?

Never ***Rarely*** ***Often*** ***Very often***

6. Have you vomited?

Never ***Rarely*** ***Often*** ***Very often***

7. Have you been worrying that you may not be a good mother?

Not at all ***A little*** ***A lot*** ***Very much***

8. Have arguments between you and your partner come close to blows?

Very often ***Often*** ***Rarely*** ***Never***

9. Have you felt faint or dizzy?

Never ***Rarely*** ***Often*** ***Very often***

10. Have you been worrying about hurting your baby inside you?

Not at all ***A little*** ***A lot*** ***Very much***

11. Do you think your partner has found you sexually desirable?

Very often ***Often*** ***Rarely*** ***Never***

12. Have you felt that your body smelt nice?

Never ***Rarely*** ***Often*** ***Very often***

13. Have you looked forward to having sexual intercourse?

Not at all ***A little*** ***A lot*** ***Very much***

14. Has it worried you that you may not have any time to yourself once your baby is born?

Not at all ***A little*** ***A lot*** ***Very much***

15. Have you found it easy to show affection to your partner?

Very often ***Often*** ***Rarely*** ***Never***

16. Have you regretted being pregnant?

Never ***Rarely*** ***Often*** ***Very often***

17. Have you experienced tingling sensations in your breasts?

Very often ***Often*** ***Rarely*** ***Never***

18. Have you felt that your breasts were too small?

Not at all ***A little*** ***A lot*** ***Very much***

19. Have you liked the shape of your body?

Not at all ***A little*** ***A lot*** ***Very much***

20. Have you felt shy about sex?

Very much ***A lot*** ***A little*** ***Not at all***

21. Have you felt that your face was attractive?

Not at all ***A little*** ***A lot*** ***Very much***

22. Has the thought of wearing maternity clothes appealed to you?

Very much ***A lot*** ***A little*** ***Not at all***

23. Have you felt that having sexual intercourse has been less private because there is a baby inside you?

Very much ***A lot*** ***A little*** ***Not at all***

24. Have you been feeling happy that you are pregnant?

Not at all ***A little*** ***A lot*** ***Very much***

25. Have you enjoyed kissing and petting?

Very much ***A lot*** ***A little*** ***Not at all***

26. Has your partner helped with the running of the house?

Very much ***A lot*** ***A little*** ***Not at all***

27. Have you suffered from constipation?

Never ***Rarely*** ***Often*** ***Very often***

28. Has the thought of having more children appealed to you?

Not at all ***A little*** ***A lot*** ***Very much***

29. Have you felt that pregnancy was unpleasant?

Very much ***A lot*** ***A little*** ***Not at all***

30. Have you been wondering whether having sexual intercourse might be harmful for baby?

Not at all ***A little*** ***A lot*** ***Very much***

31. Have you felt that your breasts are too big?

Not at all ***A little*** ***A lot*** ***Very much***

32. Have you felt full of energy?

Very often ***Often*** ***Rarely*** ***Never***

33. Have your ankles swollen up?

Very often ***Often*** ***Rarely*** ***Never***

34. Have you felt that your partner was paying you too little attention?

Very often ***Often*** ***Rarely*** ***Never***

35. Have you felt wide awake in the daytime?

Very often ***Often*** ***Rarely*** ***Never***

36. Has your partner seemed to ignore how you are feeling?

Very often ***Often*** ***Rarely*** ***Never***

37. Has your partner tried to share your interests?

Never ***Rarely*** ***Often*** ***Very often***

38. Have you suffered from indigestion or heartburn?

Never ***Rarely*** ***Often*** ***Very often***

39. Have you felt tense and unhappy at the thought of sexual intercourse?

Never ***Rarely*** ***Often*** ***Very often***

40. Have you been looking forward to caring for your baby's needs?

Not at all ***A little*** ***A lot*** ***Very much***

41. Have you felt nauseated *(felt sick)?*

Very often ***Often*** ***Rarely*** ***Never***

42. Have you felt that sex was unpleasant?

Very much ***A lot*** ***A little*** ***Not at all***

43. Have you felt that your partner went out too often without you?

Never ***Rarely*** ***Often*** ***Very often***

44. Have you felt proud of your appearance?

Very much ***A lot*** ***A little*** ***Not at all***

45. Have you felt that you were easily aroused sexually?

Never ***Rarely*** ***Often*** ***Very often***

46. Have you been having pleasurable daydreams about sex?

Very often ***Often*** ***Rarely*** ***Never***

47. Have you felt that your body was soft and cuddly?

Very much ***A lot*** ***A little*** ***Not at all***

48. Have you been feeling close to your partner since you became pregnant?

Never ***Rarely*** ***Often*** ***Very often***

49. Has your body felt awkward and ungainly?

Very much ***A lot*** ***A little*** ***Not at all***

50. Have you felt like putting your arms around your partner and cuddling him?

Very much ***A lot*** ***A little*** ***Not at all***

51. Have you been wondering whether your baby will be healthy and normal?

Not at all ***A little*** ***A lot*** ***Very much***

52. Has your partner shown affection to you?

Very often ***Often*** ***Rarely*** ***Never***

53. Have you felt that your complexion was poor?

Very much ***A lot*** ***A little*** ***Not at all***

54. Have you felt that life will be difficult after your baby is born?

Not at all ***A little*** ***A lot*** ***Very much***

55. Have you felt that your breasts were attractive?

Not at all ***A little*** ***A lot*** ***Very much***

56. Have you wished that you could rely more on your partner to look after you?

Very often ***Often*** ***Rarely*** ***Never***

57. Have you felt that you were too fat?

Very much ***A lot*** ***A little*** ***Not at all***

58. Have you wanted to have sexual intercourse?

Not at all ***A little*** ***A lot*** ***Very much***

59. Have you enjoyed your food?

Very much ***A lot*** ***A little*** ***Not at all***

60. Has the thought of breast-feeding your baby appealed to you?

Not at all ***A little*** ***A lot*** ***Very much***

MAMA (Postnatal version)

10. Have you been worried about hurting your baby?
14. Have you had enough time for yourself since you had the baby?
16. Have you regretted having the baby?
22. Have you felt proud of being a mother?
23. Have you felt that sexual intercourse is less private now that you have a baby?
24. Have you been feeling happy that you have a baby?
29. Have you felt disappointed by motherhood?
30. Have you felt inhibited about sex since you had the baby?
40. Have you enjoyed caring for your baby's needs ?
48. Have you been feeling close to your partner since the baby was born ?
54. Has life been more difficult since the baby was born ?
60. Have you enjoyed feeding your baby ?

Edinburgh Postnatal Depression Scale

*Underline or circle the **one** response to **each** of the following questions which comes closest to how you have felt **over the past seven days** and **not just** how you feel today.*

1. I have been able to laugh and see the funny side of things:

- As much as I always could
- Not quite so much now
- Definitely not so much now
- Not at all

2. I have looked forward with enjoyment to things:

- As much as I ever did
- Rather less than I used to
- Definitely less than I used to
- Hardly at all

3. I have blamed myself unnecessarily when things go wrong:

- Yes, most of the time
- Yes, some of the time
- Not very often
- No, never

4. I have felt worried and anxious for no good reason:

- No, not at all
- Yes, sometimes
- Hardly ever
- Yes, always

5. I have felt scared or panicky for no good reason:

- Yes, quite a lot
- Yes, sometimes
- No, not much
- No, not at all

6. Things have been getting on top of me:

- Yes, most of the time I haven't been able to cope at all
- Yes, sometimes I haven't been coping as well as usual
- No, most of the time I have coped quite well
- No, I have been coping as well as ever

7. I have been so unhappy that I have had difficulty sleeping:

- Yes, most of the time
- Yes, sometimes
- Not very often
- No, not at all

8. I have felt sad or miserable:

- Yes, most of the time
- Yes, quite often
- Not very often
- No, not at all

9. I have been so unhappy that I have been crying:

- Yes, most of the time
- Yes, quite often
- Only occasionally
- No, never

10. The thought of harming myself has occurred to me:

- Yes, quite often
- Sometimes
- Hardly ever
- Never

Please give brief details of your Labour and Delivery

Weeks of pregnancy: _____

Did you start labour yourself or were you induced?_____Duration of labour: _____hours

Details of any pain relief:_____

Type of delivery: *Normal, forceps, arranged section, emergency section, other*: _____

Did you need stitched? _____ Why?_____

Did you have any problems:_____

Baby's date of birth:_____ Boy / Girl:_____

Birthweight† _____

Any problems with baby? _____

How are you feeding baby?_____ How long did you stay in hospital? _____

Comments, use the back to write additional comments

Appendix 14. Activity Diary

Code number: _____ Date baby is due: _____Birth date of baby: _____

Month	Type of Exercise	Duration	How often?
Week 1			
Week 2			
Week 3			
Week 4			

This form may be used to record your physical activities.

Appendix 15. Details of Birth Outcome

Details of Labour and Birth Outcome

SUBJECT CODE:

Labour		***Pain Relief***	
POG	_____*wks*	*None:1 Entonox: 2*	
Spont: 1 Induced: 2		*Controlled Drug: 3*	
		Epidural: 4	
Length:	_____*hrs*		
		Perineum	
Delivery		*Intact: 1, Tear: 2*	
SVD:1; Forceps: 2		*Episiotomy: 3*	
C/S: Elective: 3			
Emergency: 4			

Maternal Complications

Length of Hospital Stay : _____*Days*

Comments:

Sex:		***Birthweight†***	***Apgar Score***	***Feeding***	
Girl: 1			*1 min.: ___*	*Breast 1*	
		_____lb. ____oz:			
Boy: 2			*5 min: ____*	*Bottle: 2*	
		_____Kg			

Baby Complications*:*

Appendix 16. Exercise Class Register

Week beginning: _____
Tick where appropriate

Code	Aerobics Mon	Aerobics Fri	YMCA Video	aqua	swim	brisk walk	Details of any other activities

Appendix 17. Results for Perceptions of coping assets (positive psychological well-being)

Analysis of Variance for Perceptions of coping assets

Source	DF	Seq SS	Adj SS	Adj MS	F	P
ExerGrou	1	615.17	190.63	190.63	4.95	0.027
Time	2	356.29	435.92	217.96	5.66	0.004
ExerGrou*Time	2	818.12	735.29	367.65	9.55	***0.000***
Subject	93	14332.11	14332.11	154.11	4.00	0.000
Error	160	6157.29	6157.29	38.48		
Total	258	22278.97				

Two sample T-Test and Confidence Intervals for Perceptions of coping assets (late pregnancy minus early pregnancy)

Two sample T for L-E (Time 1)	N	Mean	StDev	SE Mean
Control	38	-6.79	9.63	1.5
Exercise	45	0.23	7.74	1.2
95% CI for mu (2) - mu (1): (3.2, 10.9)				
T-Test mu (2) = mu (1) (vs not =): T= 3.63 ***P=0.0005*** DF= 69				

Variable L-E	N	Mean	StDev	SE Mean	95.0 % CI
Control	38	-6.79	9.63	1.54	*(-9.91, -3.67)*
Exercise	45	0.23	7.74	1.17	*(-2.12, 2.58)*

Two Sample T-Test and Confidence Intervals for Perceptions of coping assets (post pregnancy minus early pregnancy)

Two sample T for P-E (Time 2)	N	Mean	StDev	SE Mean
Control	38	-4.8	10.5	1.7
Exercise	44	2.07	7.67	1.1
95% CI for mu (2) - mu (1): (2.7, 10.9)				
T-Test mu (2) = mu (1) (vs not =): T= 3.32 ***P=0.0014*** DF= 66				

Variable P-E	N	Mean	StDev	SE Mean	95.0 % CI
Control	38	-4.76	10.52	1.71	(-8.22, -1.30)
Exercise	44	2.07	7.67	1.14	(-0.24, 4.37)

Two sample T-Test and Confidence Intervals for Perceptions of coping assets (post pregnancy minus late pregnancy)

Two sample T for P-L (Time 3)	N	Mean	StDev	SE Mean
Control	38	1.55	9.84	1.6
Exercise	45	1.59	7.41	1.1
95% CI for mu (2) - mu (1): (-3.8, 3.9)				
T-Test mu (2) = mu (1) (vs not =): T= 0.02 **P=0.99** DF= 69				

Variable P-L	N	Mean	StDev	SE Mean	95.0 % CI
Control	38	1.55	9.84	1.60	(-1.68, 4.79)
Exercise	45	1.59	7.41	1.09	(-0.61, 3.79)

Appendix 18. Results for Perceptions of Coping Deficits

Analysis of Variance for CopDef

Source		DF	Seq SS	Adj SS	Adj MS	F	P
ExerGrou	1	105.90	250.17	250.17	11.72	0.001	
Time		2	248.85	332.21	166.11	7.78	0.001
ExerGrou*Time		2	453.54	447.17	223.59	10.48	***0.000***
Subject		93	7196.29	7196.29	77.38	3.63	0.000
Error		164	3500.29	3500.29	21.38		
Total		262	11504.87				

Two sample T-Test and Confidence Intervals for Perceptions of Coping Deficits (late pregnancy minus early pregnancy)

Two sample T for L-E (Time 1)	N	Mean	StDev	SE Mean
Control	39	5.23	6.52	1.0
Exercise	46	0.28	5.11	0.75

95% CI for mu (2) - mu (1): (-7.51, -2.4)

T-Test mu (2) = mu (1) (vs not =): T= -3.84 ***P=0.0003*** DF= 71

Variable L-E	N	Mean	StDev	SE Mean	95.0 % CI
Control	39	5.23	6.52	1.04	(3.12, 7.34)
Exercise	46	0.283	5.106	0.753	(-1.234, 1.799)

Two Sample T-Test and Confidence Intervals for Perceptions of Coping Deficits (post pregnancy minus early pregnancy)

Two sample T for P-E (Time 2)	N	Mean	StDev	SE Mean
Control	39	4.41	7.92	1.3
Exercise	46	-1.09	6.39	0.94

95% CI for mu (2) - mu (1): (-8.65, -2.3)

T-Test mu (2) = mu (1) (vs not =): T= -3.48 ***P=0.0009*** DF= 72

Variable P-E	N	Mean	StDev	SE Mean	95.0 % CI
Control	39	4.41	7.92	1.27	(1.84, 6.98)
Exercise	46	-1.087	6.387	0.942	(-2.984, 0.810)

Two Sample T-Test and Confidence Intervals for Perceptions of Coping Deficits (post pregnancy minus late pregnancy)

Two sample T for P-L (Time 3)	N	Mean	StDev	SE Mean
Control	39	-0.82	8.78	1.4
Exercise	46	-1.31	5.60	0.81

95% CI for mu (2) - mu (1): (-3.73, 2.7)

T-Test mu (2) = mu (1) (vs not =): T= -0.30 **P=0.76** DF= 69

Variable P-L	N	Mean	StDev	SE Mean	95.0 % CI
Control	39	-0.82	8.78	1.41	(-3.67, 2.02)
Exercise	46	-1.312	5.597	0.808	(-2.938, 0.313)

Appendix 19. Results for Perceptions of Physical Well-being

Analysis of Variance for PhyWellB

Source	DF	Seq SS	Adj SS	Adj MS	F	P
ExerGrou	1	435.20	129.27	129.27	11.20	0.001
Time	2	155.87	173.15	86.57	7.50	0.001
ExerGrou*Time	2	173.80	193.66	96.83	8.39	***0.000***
Subject	93	2954.59	2954.59	31.77	2.75	0.000
Error	162	1869.44	1869.44	11.54		
Total	260	5588.90				

Two Sample T-Test and Confidence Intervals for Perceptions of Physical Well-Being (post pregnancy minus early pregnancy)

Two sample T for P-E (Time 1)	N	Mean	StDev	SE Mean
Control	39	-3.77	4.93	0.79
Exercise	45	-0.11	4.69	0.70
95% CI for mu (2) - mu (1): (1.56, 5.76)				
T-Test mu (2) = mu (1) (vs not =): T= 3.47 ***P=0.0008*** DF= 79				

Variable P-E	N	Mean	StDev	SE Mean	95.0 % CI
Control	39	-3.769	4.928	0.789	(-5.367, -2.172)
Exercise	45	-0.111	4.691	0.699	(-1.521, 1.298)

Two Sample T-Test Confidence Intervals for Perceptions of Physical Well-Being (post pregnancy minus early pregnancy)

Two sample T for P-E (Time 2)	N	Mean	StDev	SE Mean
Control	39	-2.90	5.64	0.90
Exercise	44	0.63	4.90	0.72
95% CI for mu (2) - mu (1): (1.22, 5.83)				
T-Test mu (2) = mu (1) (vs not =): T= 3.05 ***P=0.0032*** DF= 73				

Variable P-E	N	Mean	StDev	SE Mean	95.0 % CI
Control	39	-2.897	5.642	0.903	(-4.726, -1.069)
Exercise	44	0.630	4.901	0.723	(-0.825, 2.086)

Two Sample T-Test for Perceptions of Physical Well-Being (post pregnancy minus late pregnancy)

Two sample T for P-L (Time 3)	N	Mean	StDev	SE Mean
Control	39	0.87	4.62	0.74
Exercise	45	0.87	4.80	0.71
95% CI for mu (2) - mu (1): (-2.04, 2.04)				
T-Test mu (2) = mu (1) (vs not =): T= -0.00 **P=1.0** DF= 79				

Variable P-L	N	Mean	StDev	SE Mean	95.0 % CI
Control	39	0.872	4.624	0.740	(-0.627, 2.371)
Exercise	45	0.870	4.801	0.708	(-0.556, 2.295)

Appendix 20. Results for Perceptions of Body Image

Analysis of Variance for CorBodyI

Source	DF	Seq SS	Adj SS	Adj MS	F	P
ExerGrou	1	156.44	1.07	1.07	0.05	0.818
Time	2	782.35	921.79	460.89	22.94	0.000
ExerGrou*Time	2	712.47	721.22	360.61	17.95	***0.000***
Subject	93	3534.18	3534.18	38.00	1.89	0.000
Error	155	3114.54	3114.54	20.09		
Total	253	8299.98				

Two Sample T-Test and Confidence Intervals for Perceptions of Body Image (late pregnancy minus early pregnancy)

Two sample T for L-E (Time 1)	N	Mean	StDev	SE Mean
Control	34	-6.21	7.41	1.3
Exercise	45	-0.49	4.83	0.72
95% CI for mu (2) - mu (1): (2.79, 8.6)				
T-Test mu (2) = mu (1) (vs not =): T= 3.92 ***P=0.0003*** DF= 53				

Variable L-E	N	Mean	StDev	SE Mean	95.0 % CI
Control	34	-6.21	7.41	1.27	(-8.79, -3.62)
Exercise	45	-0.489	4.832	0.720	(-1.941, 0.963)

Two Sample T-Test and Confidence Intervals for Perceptions of Body Image (post pregnancy minus early pregnancy)

Two sample T for P-E (Time 2)	N	Mean	StDev	SE Mean
Control	34	-8.54	8.61	1.5
Exercise	45	-0.54	5.60	0.83
95% CI for mu (2) - mu (1): (4.65, 11.4)				
T-Test mu (2) = mu (1) (vs not =): T= 4.78 ***P=0.0000*** DF= 55				

Variable P-E	N	Mean	StDev	SE Mean	95.0 % CI
Control	34	-8.54	8.61	1.46	(-11.50, -5.59)
Exercise	45	-0.543	5.600	0.826	(-2.207, 1.120)

Two Sample T-Test and Confidence Intervals for Perceptions of Body Image (post pregnancy minus late pregnancy)

Two sample T for P-L (Time 3)	N	Mean	StDev	SE Mean
Control	34	-2.20	5.33	0.90
Exercise	45	-0.43	5.80	0.86
95% CI for mu (2) - mu (1): (-0.71, 4.24)				
T-Test mu (2) = mu (1) (vs not =): T= 1.42 **P=0.16** DF= 61				

Variable P-L	N	Mean	StDev	SE Mean	95.0 % CI
Control	34	-2.200	5.335	0.902	(-4.033, -0.367)
Exercise	45	-0.435	5.803	0.856	(-2.158, 1.288)

Appendix 21. Results for Perceptions of Somatic Symptoms

Analysis of Variance for CorSomaC

Source	DF	Seq SS	Adj SS	Adj MS	F	P
ExerGrou	1	134.48	19.64	19.64	1.08	0.299
Time	2	638.92	662.32	331.16	18.24	0.000
ExerGrou*Time	2	281.35	302.48	151.24	8.33	***0.000***
Subject	93	2847.65	2847.65	30.62	1.69	0.000
Error	152	2759.52	2759.52	18.15		
Total	250	6661.92				

Two Sample T-Test and Confidence Intervals for Perceptions of Somatic Symptoms (late pregnancy minus early pregnancy)

Two sample T for L-E (Time 1)	N	Mean	StDev	SE Mean
Control	37	-5.32	7.11	1.2
Exercise	44	-0.05	5.66	0.86

95% CI for mu (2) - mu (1): (2.38, 8.2)

T-Test mu (2) = mu (1) (vs not =): T= 3.63 ***P=0.0005*** DF= 69

Variable L-E	N	Mean	StDev	SE Mean	95.0 % CI
Control	37	-5.32	7.11	1.17	(-7.70, -2.95)
Exercise	44	-0.047	5.661	0.863	(-1.789, 1.696)

Two Sample T-Test and Confidence Intervals for Perceptions of Somatic Symptoms (post pregnancy minus early pregnancy)

Two sample T for P-E (Time 2)	N	Mean	StDev	SE Mean
Control	37	-0.62	7.18	1.2
Exercise	44	3.39	5.37	0.81

95% CI for mu (2) - mu (1): (1.20, 6.8)

T-Test mu (2) = mu (1) (vs not =): T= 2.84 ***P=0.0058*** DF= 69

Variable P-E	N	Mean	StDev	SE Mean	95.0 % CI
Control	37	-0.62	7.18	1.15	(-2.94, 1.71)
Exercise	44	3.386	5.371	0.810	(1.753, 5.019)

Two Sample T-Test and Confidence Intervals for Perceptions of Somatic Symptoms (post pregnancy minus late pregnancy)

Two sample T for P-L (Time 3)	N	Mean	StDev	SE Mean
Control	37	4.65	5.42	0.89
Exercise	44	3.57	4.73	0.71

95% CI for mu (2) - mu (1): (-3.35, 1.19)

T-Test mu (2) = mu (1) (vs not =): T= -0.95 **P=0.35** DF= 71

Variable P-L	N	Mean	StDev	SE Mean	95.0 % CI
Control	37	4.649	5.417	0.891	(2.842, 6.455)
Exercise	44	3.568	4.727	0.713	(2.131, 5.005)

Appendix 22. Results for Attitudes to Marital Relationships

Analysis of Variance for CorMarit

Source	DF	Seq SS	Adj SS	Adj MS	F	P
ExerGrou	1	21.72	0.36	0.36	0.03	0.871
Time	2	632.25	700.05	350.03	25.52	0.000
ExerGrou*Time	2	271.26	222.89	111.44	8.12	***0.000***
Subject	92	5232.93	5232.93	56.38	4.15	0.000
Error	151	2071.25	2071.25	13.72		
Total	248	8229.41				

Two Sample T-Test and Confidence Intervals for Attitudes to Marital Relationships (late pregnancy minus early pregnancy)

Two sample T for L-E (Time 1)	N	Mean	StDev	SE Mean
Control	37	-2.11	5.78	0.95
Exercise	44	-1.16	4.13	0.62
95% CI for mu (2) - mu (1): (-1.32, 3.22)				
T-Test mu (2) = mu (1) (vs not =): T= 0.84 **P=0.41** DF= 63				

Variable L-E	N	Mean	StDev	SE Mean	95.0 % CI
Control	37	-2.108	5.782	0.951	(-4.036, -0.180)
Exercise	44	-1.159	4.126	0.622	(-2.413, 0.095)

Two Sample T-Test and Confidence Intervals for Attitudes to Marital Relationships (post pregnancy minus early pregnancy)

Two sample T for P-E (Time 2)	N	Mean	StDev	SE Mean
Control	37	-5.92	4.70	0.75
Exercise	44	-1.84	4.92	0.75
95% CI for mu (2) - mu (1): (1.97, 6.20)				
T-Test mu (2) = mu (1) (vs not =): T= 3.84 ***P=0.0002*** DF= 71				

Variable P-E	N	Mean	StDev	SE Mean	95.0 % CI
Control	37	-5.923	4.704	0.753	(-7.448, -4.398)
Exercise	44	-1.837	4.918	0.750	(-3.351, -0.324)

Two Sample T-Test and Confidence Intervals for Attitudes to Marital Relationships (post pregnancy minus late pregnancy)

Two sample T for P-L (Time 3)	N	Mean	StDev	SE Mean
Control	37	-4.03	6.45	1.1
Exercise	44	-0.98	4.80	0.72
95% CI for mu (2) - mu (1): (0.49, 5.6)				
T-Test mu (2) = mu (1) (vs not =): T= 2.38 ***P=0.020*** DF= 65				

Variable P-L	N	Mean	StDev	SE Mean	95.0 % CI
Control	37	-4.03	6.45	1.06	(-6.18, -1.88)
Exercise	44	-0.978	4.798	0.715	(-2.419, 0.464)

Appendix 23. Results for Attitudes to Sex

Analysis of Variance for CorAttSe

Source	DF	Seq SS	Adj SS	Adj MS	F	P
ExerGrou	1	80.86	49.90	49.90	2.23	0.138
Time	2	640.01	750.34	375.17	16.76	0.000
ExerGrou*Time	2	620.02	557.99	279.00	12.47	***0.000***
Subject	91	5084.72	5084.72	55.88	2.50	0.000
Error	140	3133.10	3133.10	22.38		
Total	236	9558.72				

Two Sample T-Test and Confidence Intervals for Attitudes to Sex (late pregnancy minus early pregnancy)

Two sample T for L-E (Time 1)	N	Mean	StDev	SE Mean
Control	34	-4.67	6.92	1.2
Exercise	42	-0.64	4.15	0.64
95% CI for mu (2) - mu (1): (1.38, 6.7)				
T-Test mu (2) = mu (1) (vs not =): T= 3.05 ***P=0.0035*** DF= 55				

Variable L-E	N	Mean	StDev	SE Mean	95.0 % CI
Control	34	-4.67	6.92	1.15	(-7.01, -2.33)
Exercise	42	-0.643	4.154	0.641	(-1.937, 0.652)

Two Sample T-Test and Confidence Intervals for Attitudes to Sex (post pregnancy minus early pregnancy)

Two sample T for P-E (Time2)	N	Mean	StDev	SE Mean
Control	34	-7.86	9.43	1.6
Exercise	42	-0.25	5.41	0.82
95% CI for mu (2) - mu (1): (4.01, 11.2)				
T-Test mu (2) = mu (1) (vs not =): T= 4.25 ***P=0.0001*** DF= 51				

Variable P-E	N	Mean	StDev	SE Mean	95.0 % CI
Control	34	-7.86	9.43	1.59	(-11.09, -4.62)
Exercise	42	-0.250	5.414	0.816	(-1.896, 1.396)

Two Sample T-Test for Attitudes to Sex (post pregnancy minus late pregnancy)

Two sample T for P-L (Time 3)	N	Mean	StDev	SE Mean
Control	34	-3.03	6.74	1.2
Exercise	42	-0.02	6.19	0.92
95% CI for mu (2) - mu (1): (0.05, 6.0)				
T-Test mu (2) = mu (1) (vs not =): T= 2.03 ***P=0.046*** DF= 59				

Variable P-L	N	Mean	StDev	SE Mean	95.0 % CI
Control	34	-3.03	6.74	1.16	(-5.38, -0.68)
Exercise	42	-0.022	6.192	0.923	(-1.882, 1.838)

Appendix 24. Results for Attitudes to Pregnancy / Baby

Analysis of Variance for CorAttPr

Source	DF	Seq SS	Adj SS	Adj MS	F	P
ExerGrou	1	264.45	48.05	48.05	3.77	0.054
Time	2	489.37	448.70	224.35	17.62	0.000
ExerGrou*Time	2	373.79	408.47	204.24	16.04	***0.000***
Subject	93	2989.87	2989.87	32.15	2.53	0.000
Error	156	1985.91	1985.91	12.73		
Total	254	6103.40				

Two Sample T-Test for Attitudes to Pregnancy / Baby (late pregnancy minus early pregnancy)

Two sample T for L-E (Time 1)	N	Mean	StDev	SE Mean
Control	38	-5.08	5.57	0.90
Exercise	44	-0.43	4.59	0.69
95% CI for mu (2) - mu (1): (2.38, 6.92)				
T-Test mu (2) = mu (1) (vs not =): T= 4.08 ***P=0.0001*** DF= 69				

Variable L-E	N	Mean	StDev	SE Mean	95.0 % CI
Control	38	-5.079	5.572	0.904	(-6.910, -3.247)
Exercise	44	-0.432	4.587	0.692	(-1.826, 0.963)

Two Sample T-Test for Attitudes to Pregnancy / Baby (post pregnancy minus early pregnancy)

Two sample T for P-E (Time 2)	N	Mean	StDev	SE Mean
Control	38	-2.24	6.70	1.1
Exercise	44	3.28	4.70	0.69
95% CI for mu (2) - mu (1): (2.94, 8.1)				
T-Test mu (2) = mu (1) (vs not =): T= 4.28 ***P=0.0001*** DF= 67				

Variable P-E	N	Mean	StDev	SE Mean	95.0 % CI
Control	38	-2.24	6.70	1.09	(-4.44, -0.03)
Exercise	44	3.283	4.703	0.693	(1.886, 4.679)

Two Sample T-Test for Attitudes to Pregnancy / Baby (post pregnancy minus late pregnancy)

Two sample T for P-L (Time 3)	N	Mean	StDev	SE Mean
Control	38	2.68	5.26	0.86
Exercise	44	3.74	4.15	0.61
95% CI for mu (2) - mu (1): (-1.05, 3.18)				
T-Test mu (2) = mu (1) (vs not =): T= 1.00 ***P=0.32*** DF= 65				

Variable P-L	N	Mean	StDev	SE Mean	95.0 % CI
Control	38	2.676	5.260	0.865	(0.922, 4.430)
Exercise	44	3.739	4.155	0.613	(2.505, 4.973)