The Association of Physical Activity with Preterm Delivery of Women Identified as Being at Risk for Preterm Delivery

by

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Chapter I

INTRODUCTION

Preterm birth remains the leading cause of neonatal morbidity and mortality. Approximately 5% of births end before the 37th week of gestation. These births account for 75 to 85% of all neonatal deaths (Rush et al., 1976). Cost of care for surviving preterm infants can be enormous with hospital expenditures averaging more than $40,000 for each survivor weighing less than 1,000 grams and ranging from $6,000-$13,000 for larger preterm infants (Phibbs, Williams & Phibbs, 1981; Pomerance et al., 1978). Emotional costs are high, as well, for families facing early separation from their preterm infants and dependence on an often overwhelming health care system. (Brown 1984; Holms, Reich & Pasternak, 1984; Werthmann, 1981).

Efforts to reduce the incidence of preterm birth have met with questionable success. Only moderate reductions have been achieved through treatment with tocolytic agents (Hemminki & Starfield, 1978). While the efficacy of these drugs appear to improve with early treatment, they are not without risk to the mother and infant (Fuchs & Fuchs, 1985). Further

advances in non-pharmacologic interventions for prevention of preterm delivery depend first of all upon identification of those factors associated with an increased risk for prematurity.

Several studies have examined possible risk factors for preterm birth. History of a previous preterm delivery and low socioeconomic status are two of the variables most closely linked to risk of subsequent preterm delivery. Other recognized risk factors include: primiparity, uterine or placental anomalies, multiple pregnancies, maternal or fetal illness (e.g., severe diabetes mellitus), urinary tract infections, vaginal infections, chorioamnionitis, history of spontaneous or induced abortions, DES exposure, history of antepartal bleeding, limited antenatal care, smoking, proteinuria, grand multiparity, single parenthood, high or low maternal age, low maternal weight gain and low prepregnant weight. Despite recognition of these many risk factors, the majority of preterm births cannot be attributed to any cause whatsoever (Berkowitz, 1985; Chenoweth, Esler, Chang, Keeping, & Morrison, 1983; Hoffman & Bakketeig, 1984; Johnson &

Dubin, 1980; Kaltreider & Schuyler, 1980; Papiernik-Berkhaur, 1969; Stillman, 1984).

Though activity restrictions are often prescribed routinely for patients at risk for preterm delivery, the contribution of physical activity to preterm birth remains unclear. Activity limitations may have the potential to provide protection against preterm birth. However, restrictions on activity can in turn have negative financial and emotional consequences for families. Further information on the role of physical activity in preterm delivery is necessary to protect families without subjecting them to unecessary hardships. This study examines the possible association between various levels of physical activity and preterm delivery in gravidas identified as being at risk for preterm delivery.

Review of the Literature

Interpretation of the literature surrounding physical activity and its impact on preterm birth is difficult for a variety of reasons. Primary among them is discrepancies in the definitions used to label preterm birth. While most recent studies define preterm birth as birth occurring between 20 and 37 weeks of gestation, the majority of studies prior to

1970 defined prematurity as birthweight less than 2500 grams. Interpretation of studies using the latter definition is particularly difficult as this definition fails to differentiate low birthweight due to shortened gestation from that attributable to intrauterine growth retardation (IUGR), two conditions which appear to have different incidences and origins (Kaltreider & Schuyler, 1980).

A second weakness of much of the literature involves inadequate control of potentially confounding variables. Lack of clear guidelines regarding factors critical to risk of preterm birth makes consistent control of confounding variables difficult. Lack of uniformity exists in control of even the most widely accepted risk factors. Certain variables, such as social class, are particularly hard to operationalize leading to questions about the reliability and validity of many commonly used methods of measurement. For instance, early studies examining preterm birth in the United Kingdom often determined social class by the most recent occupation of participants' husbands. However, Dublin (1957) found that in a Scottish population, social class of subjects' husbands had less correlation to chance of

prematurity than the social class of their fathers. Garn, Shaw and MacCabe (1976) found educational level, an infrequently used determinant of social class, to be the most stable variable across races for predicting preterm birth in New York. Generalization across national boundaries of findings relevant to social class is questionable even when seemingly adequate methods have been used to measure this concept. Western European countries, from which many of the studies on prematurity have originated, typically have some form of nationalized health care and a variety of methods of resource distribution. Social status may thus impact preterm birth to a greater or lesser degree in these countries than in the United States.

Confounding variables have complicated interpretation of studies on employment in pregnancy as well. It remains unclear whether many of the occupationally related perinatal outcomes reported in the literature are actually the result of employment per se or characteristics associated with employment. Beral, Grisso and Roman (1985) found that in their population, gravidas who worked in early pregnancy were three times as likely to be nulliparous and twice

as likely not to be living with the father of the baby than unemployed women. Thus, factors such as stress associated with being unpartnered or differences in parity may be responsible for the association between employment and preterm birth found by some studies. Conversely, factors such as race and the reduction in income, lack of access to health care and inadequate nutrition that often accompany unemployment may be intervening variables responsible for links between preterm birth and unemployment found by other researchers. Control of social variables, therefore, is critical to interpretation of studies surrounding preterm birth.

Comparison of studies examining the effect of employment on patients is further complicated by failure to specify methods used to categorize different occupations. Number of hours worked by participants and intensity of physical activity demanded by individual jobs are often neglected as well. For instance, one researcher might conceivably categorize all women who live on farms and perform minor duties related to farm maintenance as agricultural workers. Another might include only those women who perform heavy manual labor in this

category. In addition, the vast majority of studies examining the impact of employment on preterm birth, as do those examining risk for prematurity in general, have depended on retrospective examinations of occupational activity. Thus, they are likely to be subject to recall bias that can occur in association with traumatic life events.

The Impact of Employment

Literature examining the impact of employment on preterm birth has yielded contradictory results. Douglas (1950) analyzed data from one of the earliest and most comprehensive English studies on preterm birth. Consistent with other early researchers, he defined prematurity by birthweight. Douglas examined information gathered from interviews and birth records on 13,257 first singleton births occurring over a 1-week period. All births occurred to women defined as "working class" as determined by their husband's occupation. Women working during the last 5 months of pregnancy experienced a higher incidence of prematurity than unemployed gravidas or those who left work during the first 4 months of pregnancy. The lowest incidence was reported by women leaving work during their first 4 months. Douglas suggests that

this may be attributable to the greater degree of household assistance reportedly received by the latter group. Type and extent of employment or household assistance were not specified.

A second English study (Stewart, 1955) gathered data on 1,318 first singleton births occurring in Northhamtonshire in 1952. One hundred and forty-three unemployed women were compared to 152 women who ceased employment before the 28th week of gestation and 152 women employed beyond the 28th week. Subjects were matched for age, social class, occupation and marital status at the time of conception. Working mothers appeared to have a significantly increased risk of prematurity when measured by birthweight. However, only a trend for increase in risk was noted when prematurity was defined as birth 15 or more days prior to the estimated date of delivery.

Other early studies failed to find any significant association between prematurity and employment. Illsley, Billewicz, and Thompson (1953) compared birth records of 103 preganancies yielding infants less than 5 1/2 lb. with an equal number of pregnancies yielding infants greater than 8 1/2 lb. They found no association between employment and incidence of

prematurity. Subjects were matched for social class (husband's occupation), height, age and type of work during or before pregnancy. Number of hours worked was not addressed. It is possible that characteristics associated with birthweight greater than 8 1/2 lb., such as diabetes mellitus, may have confounded results.

Drillien (1957) also failed to find a consistent risk associated with employment during pregnancy. She studied pregnancy and employment histories of 314 mothers of premature infants and 390 mothers of term infants, all from Edinburough. No statistically significant difference in employment at any stage of pregnancy was found between term and preterm mothers. Differences remained insignificant when only pregnancies without complications were considered and mothers were matched for parity.

Accordingly, Terris and Gold (1969) failed to find any significant employment-related increase in the incidence of prematurity in infants of Black American mothers. Terris compared pregnancies of 197 mothers bearing low birthweight infants to controls matched for age, marital status, and parity. Although more mothers of low birthweight infants worked during

their last trimester of pregnancy, this difference did not reach significance.

Recent studies defining prematurity by length of gestation have yielded equally conflicting results. Nayae and Peters (1982) found no occupational risk for preterm birth. They analyzed records of 7,722 births gathered by the Collaborative Perinatal Project of the Institute of Neurological and Communications Disorder and Stroke between 1959 and 1966. Employment was categorized as requiring sitting most of the time (students, clerical workers) or requiring standing most of the time (retail sales workers, household help, laborers). Women whose employment could not be easily classified into the above categories (professional workers, technical workers, managers, machine operators, craft workers and babysitters) were excluded from analysis. Controlled variables included age, education, income, pregravid weight, pregnancy weight gain, blood pressure and presence of children at home. Number of hours worked was not recorded. No significant difference was noted in length of gestation for mothers working in either employment category during the third trimester or mothers listing no employment outside the home during this period.

Two other studies yielded similar results. Marbury et al. (1984) compared obstetric outcomes among 7,155 pregnancies. Women who were unemployed during pregnancy were compared to those who worked during the first 8 months of pregnancy and those who worked until term. A higher incidence of preterm birth was noted for unemployed women (7.4%) and women working between 1 and 8 months (10.6%) as compared to women employed throughout the 9 months of pregnancy (2.5%). Obviously women delivering before term are less likely to continue work up until their estimated date of delivery. Study results are further confounded by the fact that, although unemployed women were more likely to gain less than 20 pounds, they were also more likely to have had prior pregnancies and to have carried those pregnancies to term. Unemployed women were also almost four times as likely to be less than 20 years old and more than 10 times as likely to be on welfare.

Murphy, Dauncey, Neucome, Garcia and Ellbourne (1984), after analyzing birth records from 69,617 first singleton births occurring between 1965 and 1979, actually found a significant decrease in the incidence of preterm birth occurring to employed

gravidas. Again, characteristics of the employed population made it difficult to interpret results. Unemployed mothers were significantly more likely to have less than five antenatal visits, be at extremes of age and have a previous history of abortion. They were also more likely to have a prior history of medical problems. However, differences remained significant when history of previous medical complications were controlled. Risk was particularly high for unemployed women in the lower socioeconomic classes, perhaps indicating that variables associated with poverty may have been the important risk factors for these women.

Hoffman and Bakketeig (1984) found that certain occupations may be associated with a higher incidence of preterm birth. They used birth records and data from the Norwegian Central Bureau of Statistics to examine perinatal outcomes of 138,474 births. A higher incidence of preterm birth was found in women employed in sales and service jobs as opposed to those with no employment or those employed in agricultural, technical or professional occupations. No matching on social, economic, demographic or physical variables

was reported. It is unclear whether differences reached statistical significance.

Researchers examining pregnancy outcomes in active-duty military personnel and hospital employees have reported a higher incidence of preterm birth in both populations. Fox, Harris and Brekken (1977) found that the incidence of preterm birth for 195 active-duty Air Force personnel was five times that of a similar civilian population matched for parity and race. The Air Force population did, however, contain a larger proportion of single mothers.

The incidence of preterm birth in 204 Parisian hospital employees was 13% as opposed to an 8% incidence found in the general Parisian population (Estryn, Kaminski, Franc, Fermand & Gestle, 1978). Risk for employees increased when employment included a high number of patients per nursing staff, the carrying of heavy loads, work in a standing position, absence of breaks or long commutes.

In an attempt to determine those elements of occupational fatigue which might contribute to preterm birth, Mamelle, Laumon and Lazar (1984) interviewed 3,437 postpartum French women between 1977 and 1978. They identified five sources of occupational fatigue:

taxing posture, work on industrial machines, physical exertion, mental stress and environmental stress (see Appendix A). There was a significant relationship between prematurity and high fatigue scores as measured by the reported incidence of the above five sources of fatigue. When all medical, social, and occupational variables were analyzed only the fatigue index, history of previous premature birth and parity retained their significance for risk of preterm delivery. Social factors no longer made a significant contribution. Interestingly, there was a higher incidence of preterm birth for women who were not employed (7.2%) than for working women (5.8%), indicating that there may be fatigue factors for unemployed women that have not yet been identified.

Papiernik et al. (1985) utilized information from the above study to develop a preterm prevention program which included identification of women at risk for preterm birth, education of patients and staff regarding signs and possible triggers of preterm labor, and advice regarding reduction of physical activity for women identified as being at risk for preterm delivery. Implementation of this program at one hospital in eastern France resulted in a

significant reduction in the incidence of preterm birth over three successive 4-year periods (1971-82). Most impressive was the reduction by greater than half of the higher risk category of infants weighing between 1,000 and 1,500 grams. However, no significant difference was noted for those women defined to be at highest risk by history of previous preterm birth or antepartal bleeding.

In contrast to Mamelle et al. (1984), Berkowitz, Kelsey, Holford, & Berkowitz (1983) found no evidence that employment, housework, child care or leisure-time activity increased risk of preterm delivery. In fact, they found that in their sample of 488 mothers, women who participated in leisure-time sports or physical activity had a significantly decreased risk of preterm delivery. Like Mamelle et al., they broke down occupational activity into components such as time spent standing or carrying, weight lifted, frequency of lifting and hours worked in each trimester. They analyzed household activity according to number of hours performed, assistance available, daily use of stairs, weekly hours of child care preformed and baby sitting services utilized. The researchers caution that their results regarding leisure-time activity

might reflect the tendency of exercising subjects to exhibit other characteristics such as a good state of health and a higher standard of living. They did, however, attempt to control for socioeconomic status, gravidity, pregravid weight, obstetric complication, maternal illness and history of preterm delivery.

Leisure-Time Activity

Other studies investigating the impact of sports during pregnancy have failed to consistently document either adverse or beneficial effects on fetal outcome. The majority of research has been limited to studies examining moderate activity in small numbers of very low-risk subjects or strenuous activity in serious athletes such as Olympic participants.

Sibley, Ruhling, Cameron-Foster, Christensen and Bolen (1981) compared 7 women who participated in a 12-week swim conditioning program to 6 controls. All were 13 to 26 weeks gestation and determined to be low risk as defined by absence of evidence of several common complications of pregnancy such as toxemia or diabetes mellitus. None of the study participants delivered between 20 and 37 weeks gestation.

Collings, Curet and Mullin (1982) followed 12 women who participated in an aerobic exercise program

during the second and third trimesters. Subjects exercised three times a week for 25 minutes at 65-70% of their maximal heart rate. A comparison group of 8 women who did not perform any exercise served as a control. All women were determined to be low risk by their physicians. No significant difference was found in length of gestation between subjects and controls.

Zaharieva (1972) examined pregnancy outcome in 150 serious athletes, including Olympic participants. All participated in intensive training activities, presumably of varying amounts and lengths, during their pregnancies. All infants were reportedly healthy with an average birthweight of 7.4 pounds.

Clapp and Dickstein (1984) followed 167 women who performed no regular exercise of any type prior to or during pregnancy and 169 women who participated at or above minimum conditioning level through running, aerobic dance or cross-country skiing. Minimum conditioning level was defined as 1 hour of exercise three times a week at a heart rate greater than 50% of maximum. Though none of the study participants delivered preterm, women who participated in exercise at or above minimal conditioning level into the third trimester had gestations an average of 8 days shorter

than those exercising at less than minimum conditioning level or not at all. This relationship remained significant when subjects were matched for age, parity, socioeconomic status and preconceptual weight. The degree of endurance exercise performed before conception did not alter length of gestation.

Domestic Activity

By far the most neglected area of research has been that related to the quantity, quality and impact of domestic activities performed during pregnancy. A previously cited study (Douglas, 1950) reported a smaller incidence of preterm birth in women receiving assistance with household activities. Berkowitz et al. (1983), on the other hand, found no correlation between high levels of certain domestic activities and an increase in preterm birth. Conversely, a study by Papiernik and Kaminski (1973) indicated that childcare activities may pose some risk during pregnancy. Mothers of 149 premature infants were compared to 216 controls on 30 variables. Infants were classified according to weight and gestation (e.g., gestation less than or equal to 37 weeks weighing greater than 2,500 grams, greater than 37 weeks weighing greater than 2,500 grams, 35-37 weeks weighing 2,000-2,500

grams, less than or equal to 35 weeks weighing 2,000 grams and greater than 37 weeks weighing less than or equal to 2,500 grams). Having two preschool children without domestic help was significantly correlated to birth of an infant less than or equal to 37 weeks of gestation, weighing greater than 2,500 grams.

Physiologic Responses to Exercise

Among the physiologic changes which accompany pregnancy are an increase in cardiac output, resting oxygen consumption, resting heat production, maternal weight and venous capacity. These changes tend to intensify with advancing gestation (Artral et. al, 1981). Morton, Paul, Campos, Hart and Metcalfe (1985) found that in late gestation physical conditioning had little effect on hemodynamic response to rest and exercise. They attributed this to the larger role of physiologic factors influencing venous return in pregnancy.

One particularly pertinent response to exercise during pregnancy is a redistribution of blood flow from the uterus to working muscles, probably mediated by an accompanying release of catecholamines. Uterine blood flow can be further reduced by the upright position required for many physical activities

(Pernoll, Metcalfe & Paul, 1978). Lotgering, Gilbert and Longo (1984) demonstrated that, in pregnant ewes, uterine blood flow decreased with increases in intensification and duration of exercise. The impact of this reduction in uterine blood flow on the fetus appears to be tempered somewhat by two compensatory mechanisms. The first, hemoconcentration, results as plasma is filtered across the capillary beds to the exercising muscle (Greenleaf et al., 1977). In addition, uterine vasoconstriction is likely to occur in a fashion similar to that demonstrated in pregnant ewes. That is, placental bloodflow is probably spared somewhat at the expense of the myometrium (Hohimer, Bissonnette, Metcalfe, & McKean, 1984). While these compensatory mechanisms are typically sufficient for the maintenance of fetal well-being, in some instances they are absent or inadequate. Pomerance, Gluck and Lynch (1974) found that in five out of 54 apparently "normal" pregnancies, abnormal changes in fetal heart rate accompanied exercise. Four of the five infants subsequently exhibited signs of fetal distress. These researchers suggest that positive exercise tests might indicate the need for careful monitoring during labor and possibly activity restrictions during pregnancy.

Barden (1980) states that "generally, reduced blood flow is associated with increased uterine activity, whereas improvement of uterine blood flow promotes uterine relaxation" (p. 494). Little empirical evidence was found in the literature to support or refute this claim. Vielle, Hohimer, Burry and Speroff (1985) found no increase in the uterine irritability of women with uncomplicated pregnancies. Subjects were recruited by the researchers from a YMCA exercise program and were reported to have "unusually good health habits." Uterine contractions were monitored during the 30 minutes following exercise. Unfortunately, measurement of uterine irritability during exercise was not possible for technical reasons.

Errkola (1976) found that though physical work capacity was not a good predictor of preterm labor, women who had been treated for preterm birth demonstrated a significantly lower physical work capacity at 38 weeks gestation than those who had not experienced preterm labor. These researchers suggest that this result may have been due in part to the deconditioning effect of the larger number of sick days and hospitalizations reported by women

experiencing preterm labor. They add that it may also have been due to some mechanism associated with preterm birth.

Initiation of Labor

Although the mechanisms through which labor is initiated are not fully understood, it is generally felt that parturition occurs largely as a result of changes in the functional concentration of several hormones near term (Casey & MacDonald, 1984; Casey, Winkel, Porter & Macdonald, 1983). Among these changes is an increase in the functional ratio of estrogen to progesterone. Estrogen, as opposed to progesterone, exerts an excitatory effect on the uterine muscle both through its direct effect and through stimulation of gap junction formation. Gap junction formation in turn enhances electrical conduction and probably increases sensitivity and reactivity to oxytocic substances (Garfield, 1984).

In addition to their impact on uterine muscle, the steriod hormones may contribute to initiation of labor through regulation of prostaglandin and oxytocin synthesis (Alexandrova & Soloff, 1980; Challis & Mitcell, 1981; Garfield, 1984). Certain prostaglandins appear to play a particularly critical role in

parturition. Prostaglandins and their precursor, arachidonic acid, are capable of inducing abortion if injected into the amniotic fluid during the second trimester. Both increase dramatically in the amniotic fluid during labor (MacDonald et al., 1974). The primary tissues of origin for prostaglandins and arachidonic acid appear to be the fetal membranes and decidua vera where they have been isolated in large quantities (Keirse & Turnbull, 1976). Thus, in addition to possible regulation through estrogen and progesterone, certain mechanical factors may contribute to prostaglandin release as well. Stretching and contracting of the myometrium, as well as cervical manipulation and damage to the fetal membranes, have been demonstrated to increase amniotic and circulatory prostaglandin levels (Thorburn & Challis, 1979). In addition, substances in the fetal urine appear to be capable of initiating prostaglandin release, indicating that the fetus may play a role in the timing of parturition (Strickland, Saeed, Casey & Mitchell, 1982).

Oxytocin may also play a central role in progression of preterm labor, both through its potent stimulatory effect on the myometrium and as another

possible trigger of prostaglandins. Levels of both oxytocin and prostaglandins are elevated in women in preterm labor as opposed to their non-laboring counterparts. Oxytocin receptors multiply in the pregnant uterus with advancing gestation resulting in increased myometrial sensitivity to this hormone near term (Fuchs & Fuchs, 1984). Release of oxytocin occurs in response to mechanical stimulation of the cervix, the well-known Ferguson reflex. In addition, oxytocin is secreted in fetal urine. Release of fetal oxytocin into the amniotic fluid may be governed in part by stress. Seppala, Aho, and Tissar (1972) found that meconium stained fluid contained a higher concentration of oxytocin than clear fluid.

Stress may also serve as a trigger for vasopressin, a third oxytocic agent. Although vasopressin is generally thought to have only 1/10th to 1/15th the contractile effect of oxytocin on the pregnant uterus, it has been isolated in the umbilical artery of stressed infants in amounts 20 times higher than typical oxytocin levels (Pohjavuori & Fyhrquist, 1980). Hypoxia is a demonstrated trigger of vasopressin release in sheep fetus, and high levels of vasopressin have been measured in acidotic and

stressed human infants (Parboosingh, Lederis, & Singh, 1982; Stark et. al, 1982).

Finally, catecholamines, which have been demonstrated to stimulate prostaglandin release in rat uteri, may play a role in prostaglandin synthesis (Ishikawa & Fuchs, 1978). They further have the potential to exert a minor direct effect on the myometrium. Though epinephrine actually relaxes uterine muscle, norepinephrine has an opposing effect. While uterine norepinephrine receptors increase dramatically towards term, few are situated in the body of the uterus. Thus, norepinephrine is likely to have little direct effect on contractility. However, successful inhibition of early preterm labor can be effected through the use of beta-blockers (Fuchs & Fuchs, 1985).

Conceptual Framework

Physical activity induces major cardiovascular and respiratory changes in pregnant women. These changes, in turn, result in a reduction in uterine blood flow. In some pregnancies this reduction is sufficient to result in changes in the fetal heart rate consistent with symptoms that may occur with utero-placental insufficiency. In women at risk for

preterm birth, these events could hypothetically contribute to an endocrine-mediated initiation of labor through several pathways. The hypoxic insult to the decidual tissues may be sufficient to result in prostaglandin release. The suboptimal fetal environment created by these events might also be hostile enough to trigger a fetal messenger that catalyses prostaglandin synthesis. Certain types of physical activity have the potential to contribute to a mechanical release of oxytocin and prostaglandins through an increase in cervical pressure. Norepinehrine and vasopressin may exert some effect on myometrial contractility directly and through a stimulatory effect on prostaglandin synthesis. Additionally, physical exercise may initiate parturition through some as yet unknown direct effect on the hormones governing uterine quiescence. Figure 1 summarizes the possible pathways through which physical exertion may influence preterm birth. Further understanding of the association of physical activity and preterm birth is essential in order to adequately counsel pregnant women on appropriate levels of physical activity. This is particularly true for women believed to be at risk for preterm

delivery. The following study was designed to examine the association of various levels of physical activity with the incidence of preterm birth in women identified to be at high risk for preterm delivery.

Research Question

Is there a difference in the reported activity levels of women at risk for preterm delivery who deliver preterm and those who are at risk for preterm delivery but deliver at term?

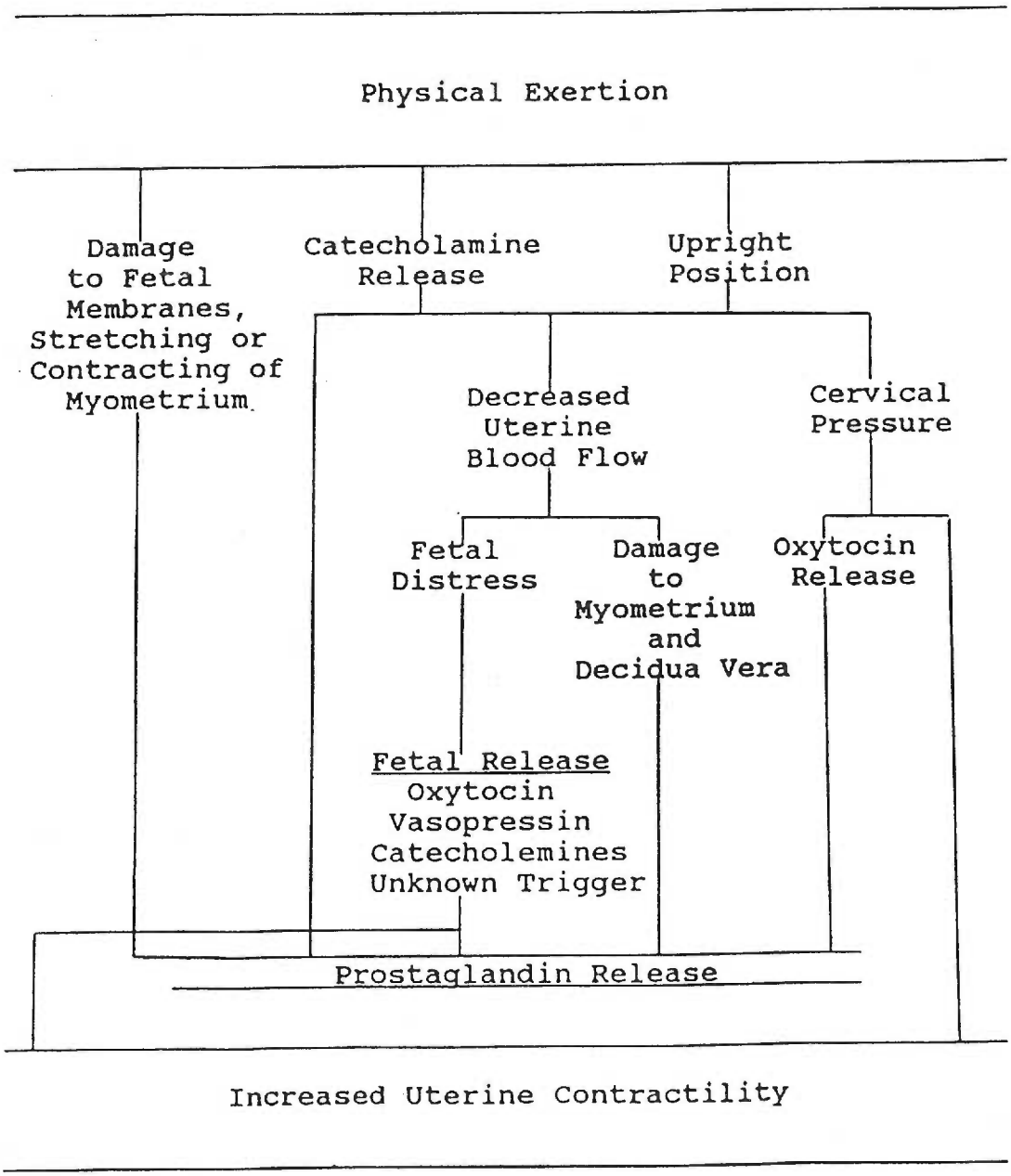

Figure 1. Pathways through which physical activity may influence preterm delivery.

Chapter II

METHODS

Design

A retrospective design was used to explore the association of physical activity with preterm birth in women determined to be at high risk for preterm delivery. The study involved measurement of levels of physical activity of women determined to be at high risk for preterm birth through the use of questionnaires. Physical activity scores of women experiencing spontaneous labor and delivery after 20 and before 37 weeks of gestation were compared to those experiencing spontaneous labor and delivery between 37 and 42 weeks of gestation.

Sample

The study sample was drawn from a tertiary obstetric unit in Portland, Oregon. All patients scoring 7 or greater on the the Risk For Preterm Delivery (RPD) tool (see Appendix B) were invited to participate if the following criteria were met: (a) English speaking, (b) labor initiated spontaneously, (c) absence of expressed concern by nursing staff over the impact of study participation on the patient's

psychological well-being, (d) delivery of a live singleton infant between 20 and 42 weeks of gestation as determined by last menstrual period or ultrasound between 14-20 weeks gestation, and (e) delivery no more than 72 hours prior to admission to study.

Subject Protection

Risk to subjects included potential anxiety or guilt related to participant belief that their level of physical activity contributed to the initiation of preterm labor. Potential benefits to participants included contribution to the body of knowledge that might in the future be used to help prevent preterm births. As history of previous preterm birth is one of the highest predictors of subsequent preterm delivery, those patients most likely to experience anxiety or guilt as a result of study participation were also the most likely to benefit from study results.

To reduce the potential for study-induced guilt or anxiety, the consent form was prepared such that it avoided implication of a causal link between physical activity and preterm birth. The purpose of the study was stated generally as "to study activities performed by women during pregnancy."

Potential study participants were given a written explanation of the study's general purpose, activities required of study participants (fill out questionnaire) and potential risks and benefits. Freedom to refuse participation without fear of reprisal was emphasized, confidentiality was assured, and subjects' names were known only to the researcher and hospital staff. All written materials were designed to be understood by those with an 8th grade education or lower. The nurse researcher's phone number was included in the study packet along with an invitation to call with any questions (see Appendix C).

Questionnaire

Risk for preterm delivery was determined by a score greater than or equal to 10 on the RPD scale. The RPD scale utilizes a variety of social, medical and physical variables to assign risk for preterm delivery (see Appendix B). In a recent clinical trial involving 966 subjects from New Zealand (Creasy, Gummer, & Liggins, 1980), a similar but earlier version of the tool (see Appendix D) was able to correctly predict 64 % of preterm births by labeling 13% of the population as high risk. Approximately 30%

of women labeled as high risk went on to deliver preterm. Like most obstetric risk-scoring tools, the RPD system relies heavily on obstetric history. As a result, the tool is much more accurate when applied to multigravidas than primigravidas. While sensitivity of the tool when used with primigravidas was only 31%, sensitivity was approximately 77% when tested on multigravid women. Approximately 44% of primiparous preterm births occurred to women labeled as low risk compared to 11.6% of multiparas. Thus, the tool has greater predictive value for multigravid women. Overall, it has the best balance between sensitivity and specificity of the tools commonly used to assess risk for preterm delivery (Holbrook & Creasy, 1984).

Physical activity was measured by a questionnaire (see Appendix E) exploring occupational, household and leisure-time activities requiring physical exertion. Questions concerning employment were based on occupational fatigue factors determined by Mamelle et al. (1984). Questions focused primarily on the five original occupational fatigue factors identified by these authors. Other work-related risks identified in their study, such as shift work and long hours, were incorporated into the questionnaire as well. A

question concerning commute time was included based on results of the previously cited study by Estryn et al. (1978). Leisure-time activity was determined by a question exploring the number of hours of aerobic activities performed each week.

No study has adequately identified those domestic activities that are physically exacting. Therefore, the questions contained within the domestic activity portion of the questionnaire were originally determined intuitively. The resulting portion of the final questionnaire (see Appendix F) was pretested on a group of 12 friends and colleagues to determine the adequacy of the content and possible units of measurement for several common domestic activities. Characteristics of the pilot population are represented in Table 1. Tables 2 and 3 display time spent by respondents on the household activities included in the pretest questionnaire. Activities are arranged in tables according to whether they were rated as lightly or moderately fatiguing by the majority of respondents. Only one activity, gardening, was rated as very fatiquing.

In addition, some information was elicited through the use of open-ended questions. Table 4

Table 1

Characteristics of Pilot Sample (N = 12)

Age Range	26-39 years
Caucasian	10
Asian	1
Black	1
Living with significant other	11
Children at home	9
Pregnant	1
Income above poverty line	12
Employed	10

Table 2

Results of Pilot Questionnaire: Light Activities

Light activities	Range of time performed	Average time performed
Cleaning kitchen	4 min./day-2 hrs./day	37 min./day
Preparing meals	9 min./day-3 hrs./day	1.1 hrs./day
Doing dishes	4 min./day-1 hr./day	31 min/day
Setting table	0 min./day-15 min./day	8 min/day
Pet care	0 min./day-1 hr./day	17 min./day
Dusting/windows	0 hrs./mo.-19.5 hrs./mo.	3.4 hrs./mo.
Changing sheets	0 min./wk.-1 hr./wk.	20 min./wk.
Shopping	1 hr./wk.- 4 hrs./wk.	1.7 hrs./wk.
Taking out trash	0 min./wk.-1.8 hrs./wk.	28 min./wk.
Putting away groceries	10 min./wk.-1 hr./wk.	27 min./wk.
Family healthcare	0 hrs./yr.-36 hrs./yr.	13.2 hrs./yr.
Driving car	0 hrs./mo.-56 hrs./mo.	21.6 hrs./mo.

Table 3

Results of Pilot Questionnaire: Moderate Activities

Moderate activities	Range of time performed	Average time performed
Cleaning bathroom	15 min./wk.-7 hrs./wk.	1.2 hrs./wk.
Cleaning other rooms	20 min./wk.-7 hrs./wk.	3.2 hrs./wk.
Care of children 4 yrs. old and Under	5 hrs./day-14 hrs./day	10 hrs./day
Care of children over 4 yrs. old	5 hrs./day-24 hrs./day	10.6 hrs./day
Care of other adults	0 min./day- 86 min./day	1 hr./day
Ironing	0 min./wk.-3 hrs./wk.	48 min./wk
Laundry	1 hr./wk.- 14 hrs./wk.	5 hrs./wk.
Vacuuming/mopping	10 min./wk.-3.5 hrs./wk.	1.2 hrs./wk.
Car maintenance	0 hrs./mo.-4.5 hrs./mo.	1.8 hrs./mo.
Household Maintenance	0 hrs./mo.-60 hrs./mo.	6.6 hrs./mo.

Table 4

Activities Listed as Particularly Fatiguing

Painting home
Moving
Major home improvements
Yard work
Gardening
Wallpapering
Removing windows

represents a list of those activities considered particularly fatiguing by some of the respondents.

Also explored through the use of open-ended questions were the ages (children's) at which childcare was considered to be most taxing. Ages ranged from infancy to preschool age, but all ages listed were 4 years old or younger. Therefore, questions exploring numbers of children and time spent on childcare were divided into two categories on the final questionnaire: information pertaining to children 4 years old and under, and information pertaining to children older than 4 years.

Additional domestic activities suggested by participants for inclusion in the final questionnaire were plant care and bookkeeping, both of which were rated as lightly fatiguing. General comments included the fact that living situation should be taken into account such as the size of houses or the need for climbing stairs. Two respondents mentioned that household activities were more fatiguing when they were boring or involved standing in one place. One pregnant respondent mentioned that anything that involved bending over was fatiguing. Another pilot participant mentioned that the constant need to lift

her infant son was particularly tiring. Housework with children present and the short-lived nature of the accomplishments obtained through housekeeping were also mentioned as very fatiguing.

Plant care, bookkeeping, stair climbing, lifting of heavy loads, bending and those activities listed as particularly fatiguing were all incorporated into the final questionnaire. Exploration of the psychologically fatiguing aspects of housework were incorporated into the final questionnaire through two open-ended questions dealing with the participants' reasons for performing housework and their feelings about such tasks. Additionally, final study participants were again asked to rate each activity as to degree of associated fatigue in order to compare perceptions between the two groups.

Procedure

Data collection occurred between October 24, 1986, and March 1, 1987. Obstetric charts of patients admitted to the postpartum unit were reviewed for documentation of risk factors contained within the RPD tool. In instances where specific gestational criteria did not accompany risk factors, risk factors were counted as present if they were present at the

visit closest to the 28th week of gestation (plus or minus 4 weeks). This is the gestation at which Creasy et al. (1980) suggest scores be reevaluated. All information other than educational attainment, length of commute and occupational activity used by the RPD scoring system are traditionally recorded in obstetric charts. Information on these three variables was gathered from responses to questionnaires. Heavy work was determined by the presence of three or more of the occupational risk factors identified by Mamelle et al. (1984). Long commute was defined as spending more than 1 1/2 hours traveling to and from work based on research by Estryn et al.(1978).

Questionnaires were offered to individuals scoring 7 or higher on the RPD tool. Information concerning educational attainment, occupational activity and commute time were taken from completed questionnaires and incorporated into scores. Patients with final scores of 10 or greater were considered high risk, and data from these participants was used in analysis.

Distribution and retrieval of questionnaires occurred during the patients' postpartum hospitalizations. Potential participants were

approached by the researcher, given a verbal description of the study and offered a consent form and questionnaire. Questionnaires and consent forms were retrieved later the same day or the following day depending on patient preference. Questionnaires were not read to participants unless this was specifically requested by potential subjects. This occurred in six cases (four term and two preterm). Reasons offered for this request were that participants wished to complete the questionnaire immediately but were breast-feeding, eating or tired. In each instance, care was taken to provide no further clarification of questions than was available through instructions to mothers completing the questionnaire themselves.

Analysis

Scores of participants delivering preterm were compared to those delivering at term. Two-tailed *t*-tests were used to compare the means of the two groups on the occupational and leisure-time portions of the questionnaire. Mean scores on the individual items of the domestic activity portion of the questionnaire were also compared through *t*-tests. Along with the 34 domestic activities contained within this section of the questionnaire, *t*-tests were also

performed on variables derived from the total number of hours spent performing domestic activities each day and the total number of hours spent performing domestic tasks excluding time spent caring for children. The latter variable, time spent at domestic activities minus childcare, was examined when it became apparent by the total domestic activity scores (often greater than 24 hours a day) that participants were documenting childcare, performed simultaneously with other tasks.

While each of the latter two variables evaluated the total amount of time spent on domestic activities, neither accounted for differences in the type of activities performed. To accommodate for these differences, domestic items were converted to *z*-scores. The *z*-scores were based upon the values derived from scores of participants delivering at term. The assumption was made that if real differences existed between the two groups, activity performed by those delivering at term should serve as the standard for normal. The average total *z*-score for the preterm population was then evaluated for significance.

Perceptions of fatigue were compared through two-tailed *t*-tests. Ratings of lightly, moderately and very fatiguing were assigned scores of 1 to 3 respectively. Means on individual items were then compared.

Fatigue factors and qualitative data obtained from answers to open-ended questions were used to add perspective to results obtained through other quantitative methods. For instance, responses to questions concerning attitudes toward and motivation for performing domestic/occupational activities were used to speculate on relationships between perceptions of these tasks to amount of activity reported and the possible impact of activity restrictions. Type and timing of activity limitations were explored to help determine the influence of these factors on study findings. Perceptions of fatigue were investigated to explore whether activities experienced as fatiguing corresponded to those associated with term or preterm delivery.

Missing values for leisure-time, occupational and domestic activities were counted as zero or no performance of the activity. If domestic activities were performed but not rated for fatigue, a score of 2

(moderate) was assigned to prevent skewing of results towards high or low extremes. On questionnaires where units were unspecified on four or fewer of the items, the item average of the respondents gestational group (term or preterm) was substituted for missing values in order to obtain a total score. Questionnaires were considered unusable if units of time were not specified on more than four (12%) of the 34 domestic activity items.

Chapter III

RESULTS

Sample

Though the initial intent was to collect data on 30 high-risk mothers delivering preterm and 30 high-risk mothers delivering at term, it became apparent as the study progressed that this would not be possible over the designated 4-month data collection period. Sixty-seven individuals were identified as high risk for preterm delivery. Forty-eight (72%) delivered at term and 19 (28%) delivered preterm. Of these, 51 (76%) completed questionnaires (34 term, 17 preterm). Reasons for not participating in the study were as follows: refusal due to fatigue, lack of time or lack of interest (4 term, 0 preterm); and discharge before completion of the questionnaire (10 term, 2 preterm). Of the 51 completed questionnaires, 44 (28 term, 16 preterm) were usable.

Table 5 displays demographic characteristics not incorporated into the RPD tool. No major differences were apparent between the two groups on gravidity or parity. Term mothers tended on the whole to be younger than preterm mothers and were composed of a

Table 5

Charctaristics of Final Sample

	Preterm			Term			
	Mean	Range	SD	Mean	Range	SD	p-value
Gestation	33	27-36	2.68	40	37-42	1.01	0.00
Gravidity	3.6	1-10	2.36	3.6	1-7	2.32	0.98
Parity	1.3	0-4	1.40	1.2	0-5	1.29	0.82
Age	25.6	18-37	6.49	21.9	15-33	5.25	0.05
Risk score	14.6	10-22	3.26	14.0	10-26	3.64	0.60
Number of children ≤ 4 years	0.63	0-2	0.72	0.43	0-2	0.69	0.38
Number of children > 4 years	0.63	0-4	1.03	0.54	0-5	1.14	0.80

	Preterm		Term	
	Number	Percent	Number	Percent
Race:				
Caucasian	14	88	21	75
Black	2	13	4	14
Other	0	0	3	11

higher percentage of "other" minorities. An average of approximately 7-weeks difference in gestation existed between the term and preterm groups.

In addition to the originally specified data, information was collected between January 5th and March 1st on preterm births not meeting study criteria. This was done to evaluate why such a large number of preterm births fell short of study qualifications. Of the 43 preterm births occurring during this period, only 9 (21%) met study criteria. Of those failing to qualify, reasons were as follows: low risk or lack of documentation to identify risk, 17 (50%); Cesarean birth for complications, 5 (15%); induction for complications, 8 (24%); non-English speaking, 3 (9%); and severe psychiatric disorder, 1 (3%).

Research Question

The purpose of this study was to answer the research question, is there a difference in the reported activity levels of women at risk for preterm delivery who deliver preterm and those who are at risk for preterm deliver but deliver at term?

No significant difference was found between the reported occupational or leisure-time activities of

term and preterm participants. Three of the 37 items derived from the domestic activity scale--cleaning rooms other than the kitchen and bathroom, changing sheets and bookkeeping--varied significantly ($p \leq 0.05$). Term mothers reported a higher incidence of these activities. Additionally, a trend was noted for term mothers to report more time spent moving ($p \leq 0.1$). Trends were also noted for preterm mothers to report higher levels of certain types of activities. Preterm mothers had higher domestic activity totals and reported spending more time caring for children under age 4 and driving the car during domestic errands ($p \leq 0.1$). The average total z-score for preterm participants was not statistically significant. Data from the above analysis are presented in Tables 6 through 10. Domestic activities are arranged according to whether they were expressed most often as daily, weekly or monthly activities.

Other Findings

Two of the 34 domestic variables rated for fatigue--ironing and shopping--were significant at the 0.05 level. Preterm mothers reported more fatigue with both of these activities (see Table 11).

Table 6

Occupational and Leisure-Time Activity

	Preterm			Term			T	p
	Mean	Range	S. D.	Mean	Range	S. D.	Value	Value
Occupational Score (# of occupational risk factors)	0.63	0-6	1.63	0.75	0-7	1.88	0.22	0.83
Liesure-Time (hrs/wk)	0.63	0-1	0.25	0.79	0-15	2.93	1.3	0.21

Table 7

Domestic Tasks: Daily Activities

	Preterm			Term			T	P
	Mean	Range	S. D.	Mean	Range	S. D.	Value	Value
Cleaning Kitchen (min/day)	37.01	0-180	48.38	36.80	0-120	30.23	-0.02	0.99
Doing Dishes (min/day)	21.07	0-90	20.73	31.06	0-180	39.28	1.10	0.28
Preparing Meals (hrs/day)	1.35	0-3	1.02	0.94	0-3	0.86	-1.42	0.16
Setting Table (min/day)	8.67	0-45	11.61	6.58	0-60	12.86	-0.54	0.59
Caring for Children ≤ 4 years (hrs/day)	8.28	0-24	10.86	3.22	0-15	5.02	-1.76	0.09**
Caring for Children > 4 years (hrs/day)	3.41	0-24	6.50	1.45	0-14	3.50	-1.12	0.28
Caring of Adults (hrs/day)	1.91	0-24	5.97	0.48	0-8	1.54	-0.94	0.36
Pet Care (min/day)	11.70	0-120	29.67	3.29	0-60	11.63	-1.09	0.29
Plant Care (min/day)	1.91	0-15	4.29	4.61	0-30	8.59	1.39	0.17
Climbing Stairs (X/day)	5.75	0-50	12.90	4.81	0-20	5.11	-0.28	0.78
Lifting ≥ 25 lbs. (X/day)	4.78	0-50	12.52	1.28	0-11	2.54	-1.11	0.29
Bending/squatting (X/day)	7.69	0-50	12.16	8.83	0-100	19.08	0.21	0.83

** $p \leq 0.1$

Table 8

Domestic Tasks: Weekly Activities

	Preterm			Term			T	P
	Mean	Range	S. D.	Mean	Range	S. D.	Value	Value
Cleaning Bathroom (hrs/wk)	1.40	0-7	1.79	1.22	0-7	1.80	-0.32	0.75
Cleaning Other Rms (hrs/wk)	2.18	0-7	2.27	4.24	0-17.5	3.86	2.23	0.03 *
Dusting (min/wk)	40.16	0-210	55.14	60.75	0-420	98.66	0.89	0.38
Changing Sheets (min/wk)	9.53	0-30	9.84	35.41	0-210	49.60	2.67	0.01 *
Vacuuming/mopping (hrs/wk)	0.98	0-3.5	1.38	1.15	0-7	1.76	0.33	0.74
Shopping (hrs/wk)	2.01	0-7	1.78	1.72	0-7	1.64	-0.56	0.58
Taking Out Trash (min/wk)	12.50	0-70	20.66	3.54	0-35	7.61	-1.67	0.11
Putting away Groceries (min/wk)	30.66	0-105	29.07	25.56	0-140	31.21	-0.53	0.60
Gardening (hrs/wk)	0.00	0	0.00	0.02	0-.58	0.11	0.75	0.46
Ironing (min/wk)	18.13	0-140	37.46	42.45	0-420	89.60	1.26	0.22
Laundry (hrs/wk)	4.28	0-14	4.84	2.14	0-10.5	2.51	-1.64	0.12
Driving (hrs/wk)	5.58	0-30	8.40	1.61	0-14	3.28	-1.82	0.09 **
Use of Public Transportation (hrs/wk)	5.78	0-86	21.42	3.72	0-42	10.62	-0.36	0.72
Bookkeeping (hrs/wk)	0.03	0-0.5	0.13	0.56	0-6	1.28	2.16	0.04 *

* $p \leq 0.05$

** $P \leq 0.1$

Table 9

Domestic Tasks: Monthly Activities

	Preterm			Term			T	P
	Mean	Range	S. D.	Mean	Range	S. D.	Value	Value
Cleaning Windows (hrs/mo)	0.17	0-2	0.52	0.48	0-8	1.67	0.91	0.37
Car Maintenance (hrs/mo)	0.13	0-2	0.50	0.09	0-2	0.39	-0.26	0.79
Household Repairs (hrs/mo)	0.25	0-4	1.0	0.89	0-12	2.51	1.20	0.24
Health Care (hrs/mo)	27.38	0-300	73.44	5.21	0-30	6.36	-1.21	0.25
Moving (hrs/mo)	0.13	0-2	0.50	15.14	0-180	40.98	1.94	0.06 **
Painting (hrs/mo)	0.00	0	0.00	3.55	0-96	18.13	0.78	0.44
Wallpapering (hrs/mo)	0.00	0	0.00	0.00	0	0.00	0.00	1.00
Other Major Home Improvements (hrs/mo)	0.13	0-2	0.50	0.25	0-7	1.32	0.45	0.66

** $p \leq 0.1$

Table 10

Domestic Activities: Total Scores

	Preterm			Term			T	P
	Mean	Range	S. D.	Mean	Range	S. D.	Value	Value
Household Total (hrs/day)	20.35	0.56-72.54	20.09	11.21	0.73-35.73	7.94	-1.74	0.10**
Total Minus Childcare (hrs/day)	8.66	0.56-30.16	8.60	6.54	0.73-17.35	3.94	-0.93	0.36
Total Z-score	0.26	-0.51-1.77	0.68	-	-	-	-	

** $p \leq 0.1$

Table 11

Fatigue Scores Associated With Domestic Activities

Activities Rated for Fatigue	Preterm N	Preterm Mean	Preterm S.D.	Term N	Term Mean	Term S.D.	T Value	P Value
Ironing	6	2.00	0.89	14	1.29	0.47	-2.37	0.03*
Shopping	14	2.29	0.83	25	1.80	0.65	-2.04	0.05*
Plant Care	6	1.00	0.00	12	1.33	0.49	1.63	0.12
Painting	0	0.00	0.00	3	1.67	1.16	2.5	0.13
Setting Table	9	1.00	0.00	13	1.23	0.44	1.57	0.13
Vacuuming/mopping	10	2.40	0.84	18	1.89	0.83	-1.55	0.13
Lifting > 25 lbs.	6	2.83	0.41	12	2.25	0.87	-1.55	0.14
Care of Children ≤ 4 years	7	2.86	0.38	10	2.50	0.53	-1.53	0.15
Doing Dishes	15	1.27	0.60	25	1.52	0.59	1.32	0.20
Healthcare	16	2.06	0.77	23	1.74	0.75	-1.31	0.20
Care of Children > 4 years	7	1.57	0.98	7	2.14	0.69	1.26	0.23
Care of Pets	7	1.00	0.00	5	1.20	0.45	1.21	0.26
Dusting	11	1.09	0.30	18	1.28	0.58	1.15	0.26
Driving	9	1.67	0.70	9	1.33	0.50	-1.15	0.27
Household Repairs	1	1.00	0.00	5	2.00	0.71	1.29	0.27
Washing Windows	2	2.50	0.71	3	2.00	0.00	-1 34	0.27
Laundry	11	2.36	0.81	24	2.04	0.81	- .10	0.28
Cleaning Other rooms	12	2.08	0.79	24	1.79	0.78	- .05	0.30
Cleaning Kitchen	13	1.54	0.66	27	1.74	0.59	).97	0.34
Use of Public Transportation	4	1.50	0.58	16	1.88	0.72	0.96	0.35
Bending/Squatting	11	2.00	0.63	19	2.21	0.63	0.88	0.39
Changing Sheets	10	1.80	0.92	24	1.63	0.65	-0.63	0.53
Preparing Meals	14	1.71	0.47	23	1.83	0.65	0.56	0.58
Climbing Stairs	8	2.25	0.71	20	2.40	0.68	0.52	0.61
Taking Out Trash	6	1.33	0.52	9	1.22	0.44	-0.45	0.66
Moving	1	3.00	0.00	10	2.70	0.68	-0.42	0.68
Cleaning Bathroom	12	1.83	0.72	23	1.74	0.69	-0.38	0.71
Putting Away Groceries	13	1.62	0.51	22	1.55	0.60	-0.35	0.73
Care of Other Adults	5	2.00	1.00	7	1.86	0.69	-0.29	0.77
Bookkeeping	2	1.50	0.71	8	1.63	0.52	0.29	0.78
Gardening	0	0.00	0.00	1	1.00	0.00	0.00	1.00
Car repairs	1	1.00	0.00	2	2.00	0.00	0.00	1.00
Wallpapering	0	0.00	0.00	0	0.00	0.00	0.00	1.00
Other Major Home Improvements	1	2.00	0.00	1	3.00	0.00	0.00	1.00

* ≤ 0.05

Risk factors for the two groups are presented in Table 12. Notable differences include the much higher incidence of uterine irritability (25% vs. 4%), previous preterm birth (44% vs. 18%) and two second trimester spontaneous or induced abortions (25% vs. 4%) experienced by the preterm mothers. Term mothers, on the other hand were much more likely to be single (75% vs. 44%), under 18 years old (21% vs. 0%), smoke more than 10 cigarettes per day (29% vs. 13%), and have had one or three first trimester abortions (21% and 21% vs. 6% and 6% respectively).

A large difference was reported in the number of and type of activity restrictions imposed on the two groups (see Table 13). Twice as many term mothers as preterm mothers reported having no activity restriction. Thirty-one percent of preterm mothers reported bedrest as their activity restriction as compared to 19% of term mothers. Twenty-five percent of preterm mothers were told not to participate in heavy activity while only 11.5 percent of term mothers reported these instructions. All but one of the reported activity restrictions were imposed for the majority of the time covered by the questionnaire. Similarly, in all but one case where uterine

Table 12

Risk Factors

	Preterm # (%)	Term # (%)
2 preschool children	1 (06)	1 (04)
Socioeco. status 1	2 (13)	5 (17)
Socioeco. status 2	8 (50)	12 (42)
Socioeco. status 3	3 (19)	9 (32)
Under 20 yrs	3 (19)	5 (18)
Under 18 yrs	0 (00)	6 (21)
Over 40 yrs	0 (00)	0 (00)
Single	7 (44)	21 (75)
Under 100 lbs	0 (00)	3 (11)
Under 5 ft	0 (00)	1 (04)
1 1st trimester abortion	1 (06)	6 (21)
2 1st trimester abortions	2 (13)	3 (11)
3 1st trimester abortions	1 (06)	6 (21)
1 2nd trimester abortion	2 (13)	6 (21)
2 2nd trimester abortions	3 (25)	1 (04)
< 1 yr since last birth	1 (06)	0 (00)
Hx of pylonephritis	2 (13)	4 (14)
Cone biopsy	0 (00)	0 (00)
Uterine anomaly	0 (00)	1 (04)
DES exposure	0 (00)	1 (04)
Previous preterm birth	7 (44)	5 (18)
Previous preterm labor	0 (00)	1 (04)
Work	3 (19)	9 (32)
> 10 cigarettes/day	2 (13)	8 (29)
Heavy work	2 (13)	4 (14)
Long commute	0 (00)	0 (00)
Wt gain < 10lbs by 26 wks	1 (06)	4 (14)
Albumuria	0 (00)	1 (04)
Hypertension	0 (00)	1 (04)
Bacturia	1 (06)	4 (14)
Fibroids	0 (00)	0 (00)
Breech at 32 wks	0 (00)	0 (00)
Wt loss of 5 lbs	2 (13)	3 (11)
Febrile illness	1 (06)	0 (00)
Engaged at 32-34 wks	0 (00)	0 (00)
Metrorrhagia	3 (19)	7 (25)
Effacement > 40%	0 (00)	0 (00)
Dilation	0 (00)	0 (00)
Uterine irritability	4 (25)	1 (04)
Placenta previa	0 (00)	0 (00)
Hydramnios	1 (06)	0 (00)

Table 13

Activity Restrictions

Type of Restriction	Preterm # (%)	Term # (%)
No restriction	4 (25.0)	13 (50.0)
Bedrest	5 (31.3)	5 (19.2)
No heavy activity	4 (25.0)	3 (11.5)
No work	1 (00.6)	1 (03.8)
Take it easy	2 (12.5)	4 (15.4)

irritability was present, restrictions were not imposed until after irritability had been diagnosed.

Perceptions of and reasons for performing housework differed as well (see Tables 14 and 15). Over 31% of preterm mothers reported the benefits of housework as providing motivation for performance of domestic tasks. This was true for only 14.3% of term mothers. Only 10.7% of term mothers reported enjoying housework as compared to 31.3% of the preterm mothers.

Differences also existed between perceptions of the two groups on work (see Tables 16 and 17). Only 3.8% of employed term mothers cited positive benefits derived from working as the motivation for employment versus 18.8% of employed preterm mothers. Nearly 19% of preterm mothers reported liking work as compared to 7.2% of term mothers. Because of the small number of employed participants (n=10), percentages were based on very small numbers.

Table 14

Motivation for Housework

Responses	Preterm # (%)	Term # (%)
To keep house clean	6 (37.5)	12 (44.4)
Necessary	1 (07.7)	6 (22.4)
For the benefits derived from it	5 (38.5)	4 (14.8)
Other	1 (07.7)	5 (18.5)
Missing	3 (18.8)	0

Table 15

Attitudes Toward Housework

Responses	Preterm # (%)	Term # (%)
Dislike it	5 (31.3)	11 (39.3)
Like it	5 (31.3)	3 (10.7)
Neutral	5 (31.3)	14 (50.0)
Missing	1 (06.3)	0

Table 16

Motivation for Work

	Preterm # (%)	Term # (%)
Necessary	1 (06.3)	4 (15.4)
For the benefits derived from it	3 (18.8)	1 (03.8)
Other	0	1 (03.8)
Not applicable	12 (75.0)	20 (79.6)
Missing	0	2 (07.2)

Table 17

Attitudes Toward Work

	Preterm # (%)	Term # (%)
Dislike it	0	2 (07.7)
Like it	3 (18.8)	2 (07.7)
Neutral	1 (06.3)	2 (07.7)
Not applicable	11 (68.8)	20 (76.9)
Missing	1 (06.3)	0

Chapter IV

DISCUSSION

Because of the very limited size of the sample available for this study, it should be viewed primarily as a pilot project. Therefore, it would be unwise to draw anything but very tentative conclusions from the results. However, some speculation as to possible reasons for findings will be presented below.

No significant difference was found between the reported leisure-time and occupational activities of mothers delivering at term and preterm. The lack of significant difference related to occupational activity conflicts with the findings of Mamelle et al. (1984), but is consistent with results cited by Berkowitz et al. (1983). The latter study also found a significant increase in the sports-related activity performed by women delivering at term. The lack of significance for either form of activity in this study may have several explanations. There may truly have been no difference between the occupational and leisure-time activities of the two groups. Alternatively, the questionnaire may have failed to capture significant aspects of their physical activity.

Significant differences were found on three of the domestic variables, and a trend was noted for four others. Given that 37 domestic variables were tested, some would be expected to be significant by chance. It is unlikely, however, that this would be true for all seven variables. Two of the variables in which a trend towards significance was noted were related to childcare. This is consistent with the findings of Papiernik and Kaminski (1973) who suggested that care of more than two preschool children without domestic help was a risk factor for preterm delivery. Care of children under 4 years of age may be a taxing activity which is not optional for some young mothers. That is, women may be obligated to perform childcare even in the face of prescribed activity restrictions. The trend noted for a greater number of total hours spent on housework by preterm mothers appears to be linked to childcare as well. Total domestic activity did not demonstrate a trend when childcare was excluded. This finding may be incidental. However, it is possible that some aspect of caring for children increases risk for preterm delivery in vulnerable populations. Whether the finding related to driving time is attributable to something inherent in the

activity itself, to a related factor, or to chance is hard to assess without further information.

Term mothers were found to report a significantly greater amount of time spent performing 4 activities. While it is possible that some aspect of these activities might be protective against preterm delivery, this finding is more likely due to the greater number of activity restrictions imposed on the preterm mothers. It is, in fact, somewhat surprising in light of these restrictions that term mothers did not report significantly higher levels of activity on several other domestic variables as well. It may be that some of the domestic items were not viewed as physical activity (i.e., caring for plants) and so may not have been limited by preterm mothers. Other activities might not have been optional and so limited to a lesser extent (i.e., cleaning other rooms in the house might be optional while the bathroom or kitchen may not be so easily left unattended). It is also possible that there was enough difference in the gestations of the two groups so that term mothers were naturally curtailing some of their own physical activity. Finally, the mothers who delivered preterm may have belonged to a group that typically spent a

very large quantity of time performing domestic activities, and thus the activity restrictions served only to make them comparable to term mothers.

The latter possibility may be supported by the finding that preterm mothers reported liking housework and employment much more often than term mothers. However, this may reflect a more positive attitude developed after these activities had been denied them through restrictions. Whatever the reason, if domestic activity is a source of pleasure for some mothers, one must wonder about the impact of limiting it or any other activity.

Of interest in and of itself is the difference in activity restrictions prescribed for the two groups, given that both were presumably high risk for preterm delivery. This difference may have been a reflection of the higher number of very serious risk factors such as uterine irritability, history of preterm birth and history of second trimester abortions experienced by the group that ultimately delivered preterm. It may be that activity restrictions provide little protection against preterm delivery in this group. Alternatively these activity restrictions may have

needed to occur earlier (such as before uterine irritability was present) to be beneficial.

Preterm mothers reported finding two activities--ironing and shopping--significantly more fatiguing than term mothers. Both activities frequently require extensive periods of standing and as a result, have the potential to reduce blood flow to the uterus. However, neither of these tasks corresponded to activities which were reportedly performed more often by preterm mothers. Therefore, though these activities may or may not have contributed to the preterm deliveries of study participants, any impact on length of gestation from ironing and shopping probably was not the result of a greater number of hours spent by preterm mothers at these activities.

The ratio of women identified as high risk who delivered preterm in this study (28%) was similiar to the approximately 30% predicted by Creasy et al. (1980) using the RPD tool. The best predictor variables for determining preterm delivery in this sample were uterine irritability, previous preterm delivery and history of two or more second trimester abortions. Two of these variables are useful in that

they can be identified pre-conceptionally or early in pregnancy. They are, however, of no use in predicting risk for preterm delivery for women experiencing their first pregnancies.

The least helpful indicators of preterm delivery in this sample were single marital status, age less than 18 years, history of one or three first trimester abortions and history of smoking more than 10 cigarettes per day. All these variables corresponded more closely to term rather than preterm delivery.

Limitations

Certainly the greatest limitation of this study was the sample size. In light of the small sample, it must be viewed as a pilot study.

A second limitation involves possible weaknesses of the tools used to measure risk and physical activity. In particular, the tool measuring physical activity suffered from several weaknesses. The limited nature of the qualitative and quantitative information on physical activity during pregnancy, particularly that associated with household activities, necessitated the use of an intuitively derived, lightly tested questionnaire. A number of compromises were necessary in the development of this

questionnaire. Because there was little empirical basis for specifying the common units of time spent performing domestic activities, these units were left out to avoid biasing responses. It is evident that this was confusing for respondents by the large number (14%) of participants who failed to specify units. In an effort to minimize this confusion, items had been grouped into categories that the pilot questionnaire indicated were performed over similar intervals (i.e., daily, weekly and monthly activities). This contributed to groupings that may have made less sense along other parameters. For instance, vacuuming and mopping was placed after cleaning rooms other than the kitchen or bathroom. Some individuals answering the latter question may have included time spent vacuuming or mopping in their response. Presumably, this would occur equally among the term and preterm groups. In any event, a less confusing questionnaire drawing from a larger empirical base might be able to eliminate some of these problems.

Also in need of some refinement is the tool used to identify patients at risk for preterm birth (RPD). Sixty-six percent of women identified as high risk for preterm delivery by this scale subsequently delivered

at term (Holbrook & Creasy, 1984). It may be that these women are truly at risk but fail to interact with environmental stimuli, such as high levels of physical activity, that ultimately trigger preterm labor. Alternatively, these women may be falsely labeled as high risk. Additionally, the tool used for this study, though similar, is a modified version of the tool tested in the cited clinical trial. The results of this study should be viewed, therefore, as pertaining to the impact of physical activity on patients labeled as high risk for preterm birth by one version of the RPD tool rather than on all patients necessarily at risk for preterm birth.

A further limitation was the study's retrospective design. Because of this design, it was subject to the biases that can occur when individuals are asked to recall detailed events. Limiting recall to the month prior to delivery was deemed necessary to minimize errors in memory. However, this presented special problems in that the average gestation at the time questionnaires were completed was obviously less for preterm than term mothers. Further difficulties were encountered in determining risk for preterm birth retrospectively through chart review. Many of the

individuals who did not meet study criteria may have done so if adequate documentation of risk factors had been available.

Summary

Literature surrounding the impact of physical activity on length of gestation has been conflicting. Though several studies have examined the impact of employment and sports-related activity, these studies have yielded contradictory results. Very little effort has been expended to determine the quality and impact of domestic activity performed during pregnancy. Several physiological changes that result from the performance of physical activity during pregnancy have the potential to contribute to preterm labor. No study was found that specifically examined the impact of physical activity on individuals at risk for preterm delivery.

The study presented in this thesis examined the reported differences in physical activity of women at risk for preterm delivery as measured by the RPD tool. Leisure-time, occupational and domestic activity during the month prior to delivery were compared for 16 high-risk women delivering preterm and 28 high-risk women delivering at term. Perceptions of

fatigue related to 34 domestic activities were also measured.

No significant difference was found between the two groups on occupational or leisure-time activity. Term mothers were found to report significantly greater amounts of time spent keeping books, changing sheets and cleaning rooms other than the kitchen or bathroom. A trend was also noted for term mothers to report more time spent moving. These findings were probably due to the greater incidence of activity restrictions imposed on the mothers who eventually delivered preterm. Trends were noted for preterm mothers to spend a greater amount of time caring for children and driving. This implies that there may be some activities, such as caring for children, that mothers cannot restrict in spite of activity limitations. These activities may or may not be a threat to term delivery.

Shopping and ironing were reported to be significantly more fatiguing by preterm mothers. Neither of these activities was performed significantly more often by preterm mothers. Therefore, if these tasks impacted risk for preterm delivery in this sample, it was probably not through

increased performance of these activities by preterm mothers.

Preterm mothers were much more likely to have a history of a prior preterm birth, a second trimester abortion or uterine irritability. The fact that this group delivered preterm in spite of a higher incidence of activity restrictions may indicate that activity limitation provides little protection. Alternatively, it may imply that activity restrictions need to be initiated before the onset of symptoms such as uterine irritability .

Preterm mothers were also much more likely to report liking housework and their jobs. Whether this is a function of an inherent difference in the two groups or a reflection of the fact that these individuals had been denied these activities is difficult to assess.

Nursing Implications

Due to the size and limitations of this study it would be premature to use study findings to speculate on appropriate levels of physical activity for women at risk for preterm delivery. The study did, however, accentuate the complexity of factors influencing the impact of activity restrictions on these women. For

instance, the fact that preterm mothers delivered prematurely in spite of a higher incidence of activity restrictions indicates that, if these restrictions are beneficial at all, they may need to be implemented before complications such as uterine irritability occur. Early identification of risk factors is essential to this process so that individuals in need of special care and education can be targeted early in pregnancy or pre-conceptionally. Since activities that may contribute to preterm delivery have not been identified specifically, education programs which emphasize awareness of situations that trigger almost imperceptible contractions, such as the program recommenced by Herron and Dulock (1983), may be the most appropriate model for health care providers at this point in time.

It is also apparent that prescribing activity restrictions does not necessarily ensure that individuals will be able to comply. Activities such as childcare may not be optional without the provision of further support or intervention. Consequently nurses need to be aware of potential social, political, financial and emotional barriers to activity limitations. Clients can then be assisted in

problem-solving solutions to these barriers and locating supportive services in the community. Nurses need to impact broader social and political policies so that community support will be available to needy clients.

Wide variations in individual understanding of what constitutes high and low physical activity also appear to exist. As with any educational intervention, nursing care needs to begin with an accurate understanding of the clients' perceptions of these terms. Plans for limiting activity need to be discussed in specific terms so that both client and health care provider are clear on the intervention to be implemented. The value of particular activities to clients needs to be explored. Recommendations can then be tailored so that stressors resulting from interventions do not outweigh potential benefits. Whatever general limitations in activity eventually prove to be most appropriate for women at risk for preterm delivery, it is clear that there will need to be some specific variations to meet individual needs.

Implications for Nursing Research

This study has highlighted the need for further research on several aspects of physical activity as it

relates to preterm birth. The first of these needs relates to the development of an empirically based yet practical tool for the measurement of physical activity, particularly domestic activity during pregnancy. The second is the need for further refinement of tools designed to determine risk during pregnancy.

Additional areas in need of exploration include the impact of activity restrictions at various gestations on pregnancy outcomes and early warning signs of and risk factors for preterm labor, particularly in primigravidas. Methods for minimizing the many barriers to activity restrictions need to be investigated as well.

Ideally, further studies on physical activity in pregnancy should be performed prospectively. This would eliminate a number of the limitations encountered in this study such as memory bias, differences in gestation and dependence on records for risk identification. Normally the enormous cost in time and resources demanded by prospective studies so outweigh the benefits that they become impractical. In this case, the number of potential subjects lost to study participation because of lack of documentation

may be high enough to balance some of the costs of a prospective study, thus making it a more attractive option.

Whatever direction future research takes, further investigation of the impact of physical activity during pregnancy is warranted. Despite the fact that preterm birth is one of the greatest problems faced by obstetric practitioners, there is currently little empirical basis for recommendations regarding physical activity in women identified as at risk for preterm delivery. Irresponsible recommendations regarding activity limitations during pregnancy could create unnecessary financial and emotional burdens for high-risk families, and could potentially be used to limit women's access to the work force. Such recommendations should not be made lightly. Alternatively, should high levels of physical activity prove to pose a risk for certain infants, health care providers have an obligation to provide parents with the information and support necessary to make and carry out informed decisions. This study has attempted to contribute to available information and to catalyze further research on the impact of physical activity on preterm birth.

REFERENCES

Alexandrova, M., & Soloff, M. S. (1980). Oxytocin receptors and parturition I: Control of oxytocin receptor concentration in rat myometrium at term. Endocrinology, 106(3), 730-735.

Artal, R., Platt, L. D., Sperling, M., Kammula, R. K., Nakamura, R., & Jilek, J. (1981). Exercise in pregnancy: Maternal cardiovascular and metabolic responses in normal pregnancy. American Journal of Obstetrics and Gynecology 140, 123-127.

Barden, T. P. (1980). Premature labor. In J. T. Queenan (Ed.), Management of high risk pregnancy, Oradell, N.J.: Medical Economics Co.

Beral, V., Grisso, J. A., Roman, E. (1985). Is paid employment during pregnancy detrimental to offspring? Progress in Clinical and Biological Research, 163B, 261-264.

Berkowitz, G. S. (1985). Clinical and obstetric risk factors for preterm delivery. The Mount Sinai Journal of Medicine 52(4), 239-247.

Berkowitz, G. S., Kelsey, J. L., Holford, T. R., & Berkowitz, R. L. (1983). Physical activity and the risk of spontaneous preterm delivery. The Journal of Reproductive Medicine 28(9), 581-589.

Brown, E. (1984). Long term sequelae of preterm birth. In F. Fuchs and P. G. Phillips (Eds.), Preterm birth: Causes, prevention and management. (pp. 39-63) New York: Macmillin Publishing Co.

Casey, M. L., & MacDonald, P. C. (1984). Endocrinology of preterm birth. Clinical Obstetrics and Gynecology 27(3), 562-571.

Casey, M. L., Winkel, C. A., Porter, J. C., & MacDonald, P. C. (1983). Endocrine regulation of the initiation and maintenance of parturition. Clinics in Perinatology 10(3), 709-721.

Challis, J. R. G., & Mitchell, B. F. (1981). Hormonal control of preterm and term parturition, Seminars in Perinatology, 5(3), 192-202.

Chenoweth, J. N., Esler E. J., Chang A., Keeping J. D., & Morrison, J. (1983). Understanding preterm labour: The use of path analysis. Australia, New Zealand Journal of Obstetrics and Gynecology, 23(4), 199-203.

Clapp, J. F., & Dickstein, S. (1984). Endurance exercise and pregnancy. Medicine and Science in Sports, 16(6), 556-562.

Collings, C. A., Curet, L. B., & Mullin J. P. (1982). Maternal and fetal responses to a maternal aerobic exercise program. American Journal of Obstetrics and Gynecology, 145, 702-707.

Creasy, R. K., Gummer, B. A., & Liggins, G. C. (1980). System for predicting spontaneous preterm birth. Obstetrics and Gynecology, 55(6), 692-695.

Douglas, J. W. B. (1950). Some factors associated with prematurity: The results of a national survey. Journal of Obstetrics and Gynecology of the British Empire, 57(2), 143-170.

Drillien, C. M. (1957). The social and economic factors affecting the incidence of premature birth. Journal of Obstetrics and Gynecology of the British Empire, 64(2), 161-184.

Errkola, R. (1976). The physical work capacity of the expectant mother and its effect on pregnancy, labor and the newborn. International Journal of Gynecology and Obstetrics, 14(2), 153-159.

Estryn, M., Kaminski, M., Franc, M., Fermand, S., & Gerstle, F. (1978). Grossesse et conditions de travail en milieu hospitalier. Revue Francaise Gynecologie et Obstertrique, 73(10), 625-631.

Fox, M. E., Harris, R. E., & Brekken, A. L. (1977). The active-duty military pregnancy: A new high risk category. American Journal of Obstetrics and Gynecology, 129, 705-707.

Fuchs, A., & Fuchs, F. (1984). Endocrinology of term and preterm labor. In F. Fuchs and P. G. Stubblefield (Eds.), Preterm birth: Causes, prevention and management (pp39-63). New York: Macmillan Publishing Co.

Fuchs, A., & Fuchs, F. (1985). Mechanisms and prevention of preterm birth. Progress in Clinical and Bioligical Research, 163B, 223-230.

Garfield, R. E. (1984). Control of myometrial function in preterm versus term labor. Clinical Obstetrics and Gynecology, 27(3), 572-591.

Garn, S. M., Shaw, H. A., & McCabe, K. (1976). Effects of socioeconomic status and race on weight defined and gestational prematurity in the United States. In D. M. Reed & F. J. Stanley (Eds.), The epidemiology of prematurity (pp.127-143). Baltimore, MD: Urban and Schwazenberg, Inc.

Greenleaf, J. E., Convertino, V. A., Shemel, R. W., Bernaur, E. M., Adams, W. C., Vignau, S. R., and Brock, P. J. (1977). Plasma Na+, Ca+ and saline shifts and thermoregulation during exercise in man. Journal of Applied Physiology, 43(6), 1026-1032.

Hemminki, E., & Starfield, B. (1978). Prevention of low birthweight and preterm birth: Literature review and suggestions for research policy. Milbank Memorial Fund Quarterly, 56(3), 339-361.

Herron, M. A., & Dulock, H. L. (1983). Preterm labor: A staff development program in perinatal nursing care. New York: March of Dimes Birth Defect Foundation.

Hoffman, H. J., & Bakketeig, L. S. (1984). Risk factors associated with the occurrence of preterm birth. Clinical Obstetrics and Gynecology, 27(3), 539-553.

Hohimer, A. R., Bissonette, J. M., Metcalfe, J., & Mckean, T. A. (1984). Effect of exercise on uterine blood flow in the pregnant pigmy goat. American Journal of Physiology, 256(2), H207-H212.

Holbrook, R. H., & Creasy, R. K. (1984). Prevention of preterm delivery: The important role of early recognition. Postgraduate Medicine, 75(8), 177-185.

Holms, D. L., Reich, J. N., & Pasternak, J. F. (1984). The development of infants at risk. London: Lawrence Earlbaum Association.

Illsley, R., Billewicz, W. Z., and Thompson, A. M. (1953). Prematurity and paid work during pregnancy. British Journal of Preventive and Social Medicine, 8(4), 153-156.

Ishikawa, M., & Fuchs, A. (1978). Effects of epinephrine and oxytocin on the release of prostaglandin F from rat uterus in vitro. Prostaglandins, 15(1), 89-101.

Johnson J. W. C., & Dubin, N. H. (1980). Prevention of preterm labor. Clinical Obstetrics and Gynecology, 23(1), 51-73.

Kaltrider, D. F., & Schuyler, K. (1980). Epidemiology of preterm delivery. Clinical Obstetrics and Gynecology, 23(1), 17-31.

Keirse, M. J. N. C., & Turnbull, A. C. (1976). The fetal membranes as a possible source of amniotic fluid prostaglandins. British Journal of Obstetrics and Gynecology, 83(2), 146-151.

Lotgering, F. K., Gilbert, R. D., and Longo, L. D. (1984). Exercise responses in pregnant sheep: Oxygen consumption, uterine blood flow, and blood volume. Journal of Applied Physiology, 55(3), 834-841.

MacDonald, P. C., Schultz, F. M., Duenhoelter, J. H., Gant, N. F., Jimenez, J. M., Pritchard, J. A., Porter, J. C., & Johnston, J. M. (1974). Initiation of human parturition: 1. Mechanism of action of arachidonic acid. Obstetrics and Gynecology, 44(5), 629-636.

Mamelle, N., Laumon, B., & Laszar, P. (1984). Prematurity and occupational activity during pregnancy. American Journal of Epidemiology, 119(3), 309-20.

Marbury, M. C., Linn, S., Monson, R. R., Wegman, D., H., Schoenbaum, S. C., Stubblefield, P. G., & Ryan, K. J. (1984). Work and pregnancy. Journal of Occupational Medicine, 26(6), 415-421.

Morton, M. J., Paul, M. S., Campos, G. R., Hart, M., & Metcalfe, J. (1985). Exercise dynamics in late gestation: Effects of physical training. American Journal of Obstetrics and Gynecology, 152, 91-97.

Murphy, J. F., Dauncey, M., & Neucombe, R., Garcia, J., & Elbourne, D. (1984). Employment in pregnancy: Prevalence, maternal charactaristics, perinatal outcomes. The Lancet, 1, 1163-1166.

Naeye, R. L., & Peters, E. C. (1982). Working during pregnancy: Effects on the fetus. Pediatrics, 69(6), 724-727.

Papiernik, E. (1984). Proposals for a programmed prevention policy of preterm birth. Clinical Obstetrics & Gynecology, 27(3), 614-635.

Papiernik, E., Bouyer, J. Dreyfus, J. Collin, D., Winisdorffer, G., Guegin, S., Lecompte, M. and Lazar, P. (1985). Prevention of preterm births: A perinatal study in Haguenau, France. Pediatrics, 76(2), 154-158.

Papiernik,E., &. Kaminski, M. (1973). Multifactorial study of risk of prematurity at 32 weeks of gestation: A study of 30 predictive characteristics. Journal of Perinatology, 2, 30-36.

Parboosingh, J., Lederis, K. and Singh, N. (1982). Vasopressin concentration in cord blood: Correlation with method of delivery and cord pH. Obstetrics and Gynecology, 60(2), 179-183.

Pernoll, M. L., Metcalfe, J., & Paul, M. (1978). Fetal cardiac response to maternal exercise. In L. D. Longo, & D. D. Reneau (Eds.), Fetal and newborn cardiovascular physiology: Vol. 2. (pp. 389-98). New York: Garland Press.

Phibbs, C. S., Williams, R. L., & Phibbs, R. H. (1981). Newborn risk factors and costs of neonatal intensive care. Pediatrics, 68(3), 313-321.

Pohjavuori, M., & Fyhrquist, F. (1980). Hemodynamic significance of vasopressin in the newborn infant. Journal of Pediatrics, 97(3), 462-465.

Pomerance, J. J., Gluck, L., & Lynch, V. A. (1974). Maternal exercise as a screening test for uteroplacental insufficiency. Obstetrics and Gynecology, 44(3), 383-387.

Pomerance, J. J., Ukrainski, C. T., Ukra, T., Henderson D. H., Nash, A. H., & Meredith, J. L. (1978). Cost of living for infants weighing 1,000 grams or less at birth. Pediatrics, 61(6), 908-910.

Rush, R. W., Keirse, M. J. N. C., Howat, P., Baum, J. D., Anderson, A. B. M., & Turnbull, A. C. (1976). Contribution of preterm delivery to perinatal mortality. British Medical Journal, 2, 965-968.

Seppala, M., Aho, I., & Tissar, A. (1972). Radioimmunoassy of oxytocin in amniotic fluid, fetal urine, and meconium during late pregnancy and delivery. American Journal of Obstetrics and Gynecology, 114, 788-795.

Sibley, L., Ruhling, R. O., Cameron-Foster, J., Christensen, C. and Bolen, T. (1981). Swimming and physical fitness during pregnancy. Journal of Nurse-Midwifery, 26(6), 3-12.

Stark, R. I., Wardlaw, S. L., Daniel, S. S., Husain, M. K., Sanocka, U. M., James, L. S., & Vande Wiele R. L. (1982). Vasopressin secretion induced by hypoxia in sheep: Developmental changes and relationship to B-endorphin release. American Journal of Obstetrics and Gynecology, 143(2), 204-215.

Stewart, A. (1955). A note on the obstetric effects of work during pregnancy. British Journal of Preventive and Social Medicine, 9, 159-161.

Stillman, R. G. (1984). Pregnancy prospects of DES daughters. Contemporary Obstetrics and Gynecology, 24(4), 47-53.

Strickland, D. M., Saeed, S. A., Casey, L. M.,& Mitchell, M. D. (1982). Stimulation of prostaglandin biosynthesis by urine of the human fetus may serve as a trigger for parturition. Science, 220(4596), 521-522.

Terris, M., and Gold, E. (1969). An epidemiologic study of prematurity: Relation to smoking, heart volume, employment and physique. American Journal of Obstetrics and Gynecology, 103(3), 358-370.

Thornburn, G. D., & Challis, J. R. G. (1979). Endocrine control of parturition. Physiology Review, 59(4), 863-918.

Vielle, J., Hohimer, R. A., Burry, K., and Speroff, (1985). The effect of exercise on uterine activity in the last eight weeks of pregancy. American Journal of Obstetrics and Gynecology, 151(6) 727-730.

Werthmann, M. W. (1981). Medical constraints to optimal psychological development of the preterm infant. In S. L. Friedman, & M. Sigman (Eds.),

Preterm birth and psychological development. New York: Acedemic Press Inc.

Zaharieva, E. (1972). Olympic participation by women: Effects on pregnancy and chilbirth. Journal of the American Medical Association, 221(9), 992-995.

APPENDIX A

OCCUPATIONAL FATIGUE FACTORS

Occupational Fatigue Factors

Occupational fatigue index defined by five sources of fatigue: each score is "high" if three or more occupational elements listed below are present.

Occupational Fatigue Source	
Posture	Posture in standing position more than three hours each day
Work on Industrial Machines	Work on industrial conveyer belt Independent work on machines with strenuous effort or vibrations
Physical Exertion	Continuous or periodical effort Loads of more than 10 kg.
Mental Stress	Routine work Varied tasks requiring little attention without stimulation
Environment	Manipulation of chemical substances Any two of the following three elements: -Significant noise level -Cold temperatures -Very wet atmosphere

Note. From "Prematurity and Occupational Activity" by N. Mamelle, B. Laumon and P. Lazar, 1984, American Journal of Epidemiology, 119(3), p. 311.

APPENDIX B

RISK FOR PRETERM DELIVERY TOOL

Risk for Preterm Delivery Tool

Points	Socioeconomic Status	History	Life Style	Current Pregnancy
1	2 children at home Low socioeconomic status[b]	1 first-trimester abortion Less than 1 year since last birth	Work outside home	
2	Younger than 20 years Older than 40 years Single parent Low socioeconomic status[b]	2 first-trimester abortions	More than 10 cigarettes per day	Less than 10 lbs gain by 26 weeks' gestation Albuminuria Hypertension Bacteriuria
3	Low socioeconomic status[b] Shorter than 5 ft Lighter than 100 lbs	3 or more first-trimester abortions	Heavy work Long tiring commute	Fibroids Breech at 32 weeks Weight loss of 5 lbs Febrile illness Head engaged at 32-34 weeks
4	Younger than 18 years	Pyelonephritis		Metrorrhagia after 12 weeks' gestation Effacement > 40% Dilation Uterine irritability
5		Cone biopsy Uterine anomaly 1 second-trimester abortion DES exposure		Placenta previa Hydramnios
10		Preterm delivery 2 or more second-trimester abortions Preterm labor		Twins Abdominal surgery

Score 1: Items A or C.
Score 2: Items B or D, or A + C.
Score 3: Items A + D, or B + C, or B + D.

Expectant Father's Occupation	Pregnant Woman's Educational Background
A: semiskilled laborer laborer student	C: grades 10-12
B: farm laborer unemployed	D: less than 10 years

Note. From "Preterm Labor- A staff development tool." by M. A. Herrron and H. L. Dulock, 1982, March of Dimes Series 2B, module 5, p.14.

APPENDIX C

CONSENT FORM

Consent Form

Oregon Health Sciences University
School of Nursing

CONSENT FORM

Investigator: Deborah Warren R.N., B.S.N.
Supervisor: Carol Howe, C.N.M., DNSc.

I, Deborah Warren, am currently studying the types of physical activity performed by pregnant women. To help provide information about physical activity and pregnancy, I would like you to fill out a questionnaire describing the activities you typically performed while you were pregnant. The questionnaire should take you approximately 20 minutes to complete. If you decide to fill out the questionnaire, I will pick it up from you later today or tomorrow.

Your willingness or refusal to participate in this study will not affect in any way the care you receive from staff in this hospital. If you decide to participate, all information will be confidential. Your name or identity will not be revealed in any publication. Information from the questionnaires will be referred to only by number.

Your participation in this study will not benefit you directly. However, future mothers may benefit from learning more about physical activity in pregnancy. Thus, you may benefit if you have another child. I will be happy to answer any questions or concerns you may have. My telephone number is 503-246-3626.

It is not the policy of the Department of Health, Education and Welfare, or any other agency funding the research project in which you are participating, to compensate or provide medical treatment for human subjects in the event the research causes in physical injury. The Oregon Health Sciences University, as an agency of the state, is covered by the State Liability Fund. If you suffer injury from the research project, compensation would be available to you only if you establish that the injury occurred through the fault of the Center, it's officers or employees. If you have further questions, please call Dr. Michael Baird (503) 225-8014.

I understand that I may refuse to participate or withdraw from this study at any time without affecting my relationship with, or treatment at the Oregon Health Sciences University.

I have read the foregoing and agree to participate in this study.

Signature_____

APPENDIX D

RISK FOR PRETERM DELIVERY TOOL:

EARLY VERSION

Risk for Preterm Delivery Tool: Early Version

Table 1. Risk of Preterm Delivery*

Points	Socioeconomic status	Past history	Daily habits	Current pregnancy
1	2 children at home Low socioeconomic status	1 abortion Less than 1 year since last birth	Work outside home	Unusual fatigue
2	Younger than 20 years Older than 40 years Single parent	2 abortions	More than 10 cigarettes per day	Less than 13 kg gain by 32 weeks' gestation Albuminuria Hypertension Bacteriuria
3	Very low socioeconomic status Shorter than 150 cm Lighter than 45 kg	3 abortions	Heavy work Long tiring trip	Breech at 32 weeks Weight loss of 2 kg Head engaged Febrile illness
4	Younger than 18 years	Pyelonephritis		Metrorrhagia after 12 weeks' gestation Effacement Dilatation Uterine irritability
5		Uterine anomaly Second-trimester abortion DES exposure		Placenta previa Hydramnios
10		Premature delivery Repeated second-trimester abortion		Twins Abdominal surgery

* Score is computed by addition of the number of points given any item. 0-5 = low risk; 6-9 = medium risk; ≥ 10 = high risk

Note: From "System for predicting spontaneous preterm birth" by R. K. Creasy, B. A. Gummer and G. C. Liggins, 1980, Obstetrics and Gynecology 55(6), p. 693.

APPENDIX E

PHYSICAL ACTIVITY QUESTIONNAIRE

Physical Activity Questionnaire

Physical Activity Questionnaire

ID_____ PT- 0 1 Gest_____ G____ P_____ Age_____

Section 1- Sports

1. During the month before your delivery, how many hours each week did you usually participate in aerobic sports? Examples might include running, swimming, aerobic dance and raquette sports. Answer zero if you did not typically participate in any aerobic activities._____

Section 2- Occupational Activity

Instruction-If you did not work during the month before your delivery skip to section 3. If you did work during the month before your baby was born, circle Y(yes) for conditions that applied to your work situation. Circle N(no) if the conditions did not apply to your work situation.

2. Did you work on an industrial conveyor belt?	Y	N
3. Did you work on machines that required strenuous work or vibrated?	Y	N
4. Did you have to spend more than three hours a day standing?	Y	N
5. Did you regularly lift more than 25 pounds?	Y	N
6. Did your job require strenuous physical effort?	Y	N
7. Did you work with chemical substances?	Y	N
8. Did you work in cold temperatures?	Y	N
9. Did you work around loud noises?	Y	N
10. Did you work more than 40 hours a week?	Y	N
11. Did you work more than five days a week?	Y	N
12. Did you work more than eight hours a day?	Y	N
13. Did you work night shift?	Y	N
14. Did you work different shifts?	Y	N
15. Did you spend more than one and a half hours each day going to and from work?	Y	N

Section 3- Household Activity

Instructions- Please fill in the blanks telling how much time you usually spent doing the following housekeeping activities during the month before your baby was born . Be sure to specify units of time (ie mins./hrs. each day/week/month). Answer zero if you typically did not perform the activity. Also indicate how physically tiring you considered each activity by circling the correct letter (L=lightly fatiguing, M=moderately fatiguing, H= highly fatiguing).

example
picking flowers 10 min. each day L (M) H

(L=lightly fatiguing, M=moderately fatiguing, H=highly fatiguig)

16. cleaning the kitchen	_____each_____	L M H
17. washing or loading dishes	_____each_____	L M H
18. cooking or preparing meals	_____each_____	L M H
19. setting the table	_____each_____	L M H
20. care of children four and under	_____each_____	L M H
21. care of children over four	_____each_____	L M H
22. care of other adults	_____each_____	L M H
23. pet care	_____each_____	L M H
24. plant care	_____each_____	L M H
25. cleaning the bathroom	_____each_____	L M H
26. cleaning rooms other than kitchen or bathroom	_____each_____	L M H
27. dusting	_____each_____	L M H
28. changing sheets	_____each_____	L M H
29. vacuuming or mopping	_____each_____	L M H
30. shopping	_____each_____	L M H
31. taking out trash	_____each_____	L M H
32. putting groceries away	_____each_____	L M H
33. gardening	_____each_____	L M H
34. ironing	_____each_____	L M H
35. doing laundry	_____each_____	L M H
36. washing windows	_____each_____	L M H
37. car maintenance	_____each_____	L M H
38. household repair	_____each_____	L M H
39. family healthcare (include doctors visits for yourself and others)	_____each_____	L M H
40. driving car (don't include time spent going to and from work)	_____each_____	L M H
41. using public transportation (ie. buses)	_____each_____	L M H
42. moving	_____each_____	L M H
43. painting your home	_____each_____	L M H
44. wallpapering	_____each_____	L M H
45. Other major home improvements	_____each_____	L M H
46. bookkeeping	_____each_____	L M H

On the average, how many times did you do the following each day during the month before your baby was born ? Please indicate how fatiquing you considered each of the following by circling the correct letter (L=lightly, M=moderately, H=highly).

47. climb a flight of stairs _____times each day L M H
48. lift more than 25 pounds (examples might include groceries or children) _____times each day L M H
49. do activities that required bending or squatting _____times each day L M H

50. How many children four and under do you have?

51. How many children over four do you have?

52. Why do you do housework?

53. How do you feel about housework?

54. Why do you work?

55. How do you feel about your job?

56. Did your doctor or midwife instruct you to limit your activity during your pregnancy? If so, at what point in your pregnancy were you told to limit your activity?

57. What type of activity restriction did your doctor prescribe? (ie bedrest, take it easy etc.)

58. What is your husband's or partner's occupation?

59. What was the highest grade you completed?

APPENDIX F

DOMESTIC ACTIVITY QUESTIONNAIRE

Domestic Activity Questionnaire

On the average, how much time do you spend doing the following housekeeping activities (specify minutes or hours). Indicate how physically fatiguing you consider each activity by placing an X in the correct column (little, moderate, very).

	hours, minutes	per	day, week month	L	M	V
cleaning the kitchen	_____	per	_____	( )	( )	( )
cleaning the bathroom	_____	per	_____	( )	( )	( )
cleaning other rooms in the house	_____	per	_____	( )	( )	( )
cooking or preparing meals	_____	per	_____	( )	( )	( )
setting the table	_____	per	_____	( )	( )	( )
washing or loading dishes	_____	per	_____	( )	( )	( )
care of children four and under	_____	per	_____	( )	( )	( )
care of children over four	_____	per	_____	( )	( )	( )
pet care	_____	per	_____	( )	( )	( )
caring for other adult members				( )	( )	( )
of the family	_____	per	_____	( )	( )	( )
dusting or washing windows	_____	per	_____	( )	( )	( )
changing sheets	_____	per	_____	( )	( )	( )
vacuuming or mopping	_____	per	_____	( )	( )	( )
shopping	_____	per	_____	( )	( )	( )
taking out trash	_____	per	_____	( )	( )	( )
putting groceries away	_____	per	_____	( )	( )	( )
gardening	_____	per	_____	( )	( )	( )
ironing	_____	per	_____	( )	( )	( )
doing laundry	_____	per	_____	( )	( )	( )

		L M V
maintenance of car	_____per_____	( )( )( )
household repair	_____per_____	( )( )( )
family healthcare (include doctors visits for yourself and others)	_____per_____	( )( )( )
driving car (don't include time spent commuting to and from work)	_____per_____	( )( )( )
using public transportation	_____per_____	( )( )( )

1. How many children do you have? What are their ages?

2. How old were your children when you felt their care was the most fatiguing?

3. Consider the amount of care involved in caring for one child. How much did your workload increase when you had your second child? (10%,20% etc.)

How much did your workload increase after you had your third child?

4. What other household activities do you typically perform that are not listed above. Please list time per day or week and how physically fatiguing you consider these activities)?

5. Have you recently participated in any major household projects that you consider particularly fatiguing (ie moving, painting)?

6. Other comments on household activity and fatigue.

AN ABSTRACT OF THE THESIS OF

DEBORAH C. WARREN

For the DEGREE OF MASTERS OF NURSING

Date of Receiving this Degree: July 31, 1987

Title: THE ASSOCIATION OF PHYSICAL ACTIVITY WITH PRETERM DELIVERY OF WOMEN AT RISK FOR PRETERM DELIVERY

APPROVED [redacted]

Carol Howe, C.N.M., D.N.Sc.

Abstract

The purpose of this study was to explore the possible relationship of varying levels of physical activity to length of gestation of pregnancies determined to be high risk for preterm delivery. Questionnaires examining occupational, domestic and recreational physical activities were completed by 16 preterm mothers and 28 term mothers during their postpartum hospitalizations. Questions referred to activities performed by participants during the month prior to their delivery. All participants had been retrospectively determined to be high risk for preterm delivery using the Risk For Preterm Delivery Tool.

No significant differences were found between the two groups for reported levels of occupational or recreational activity. Term mothers reported significantly ($p \leq 0.05$) more time spent cleaning rooms other than the bathroom or kitchen, changing sheets, and bookkeeping. A trend was noted for term mothers to report more time spent moving ($p \leq 0.1$). It was proposed by the researcher that these differences may have been due to the greater number of activity restrictions reported by the preterm mothers.

Trends were also noted for preterm mothers to report more time spent caring for children under four, driving and performing domestic activities as a whole ($p \leq 0.1$). Domestic activity totals reported by preterm mothers did not show a trend towards significance when childcare activities were not included in totals, indicating that childcare played a role in two of the three activities for which a trend was noted. It was felt that some activities, such as childcare may not be optional in spite of prescribed activity restrictions and may or may not contribute to risk for preterm delivery. Preterm mothers also reported experiencing significantly more fatigue with two activities that generally require standing,

ironing and shopping ($p \leq 0.05$). Neither task corresponded to activities performed significantly more often by one group or the other.

The most predictive risk factors for preterm delivery in this sample were history of a previous preterm birth, history of two or more second trimester abortions and presence of uterine irritability. The least useful predictors were single marital status, age less than 18 years, smoking more than 10 cigarettes per day and having a history of one or three first trimester abortions.

Term mothers were less likely to report liking work and housework or to report the benefits of these two activities as a source of motivation for performing them. This may have reflected actual differences between the groups or a new found appreciation of these activities by preterm mothers after activity restrictions had been imposed.

Limitations of the study included the small sample size, the retrospective design and need for refinement of the tools used. Suggestions for further research included follow-up studies that avoid these limitations and further exploration of risk factors that can be identified early in pregnancy.

Suggestions were also offered for incorporation of findings into practice and included targeting high-risk individuals early in pregnancy for follow-up and education, and tailoring activity restrictions to meet individual needs.