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Maternal Activity Restriction in Pregnancy and the Prevention of Preterm Birth: An Evidence-based Review

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Abstract: Activity restriction is one of the most common practices used for the prevention of preterm birth. Despite the lack of evidence to support the efficacy of activity restriction, and newer data that highlight potential harms to the mother, the intervention is still prescribed. This review of the literature describes the potential benefits, harms, and efficacy of activity restriction in the prevention of preterm birth.
Key words: premature birth, bed rest, obstetrics

Preterm Birth

The preterm birth rate in the United States has risen over the last 2 decades. In 2007, preterm births increased 20% since 1990, to 12.7% of all live births. Estimates indicate that in 2005, the costs in terms of medical and lost productivity associated with preterm birth were > $26.2 billion (US dollars).

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Preterm birth refers to a birth before 37 weeks gestational age as confirmed by the first day of the last menstrual period or ultrasonography. Preterm birth can be divided into 2 broad categories: spontaneous preterm birth and clinically indicated preterm birth. The former, spontaneous preterm birth consists of birth initiated by the parturition processes including membrane rupture, decidua activation, and uterine contractions. The latter, clinically indicated preterm birth consists of birth induced by a physician secondary to maternal or fetal reasons. Intervention strategies differ on the basis of the pathophysiology identified in individual cases of preterm birth.

Although there have been many interventions to help prevent preterm birth in

those at risk, activity restriction is likely the most common intervention prescribed in the world. Activity restriction in pregnancy ranges from refraining from exercise, cessation of employment and housework, to bed rest, which in its strictest form can mean confinement to bed. Bed rest in pregnancy is prescribed by >90% of obstetricians to reduce the risk of spontaneous abortion, preterm labor, preterm premature rupture of membranes, and other pregnancy complications.[1] Using the 1988 National Infant Mortality Survey, >18.2% of the pregnant women each year reported that they had been advised by their physician to rest in bed for at least 1 week during their pregnancies and 12.9% of all women stated that they reduced or stopped work.[2] In a survey by the American College of Obstetricians and Gynecologists 34%, 37%, and 39% of obstetricians prescribed bed rest for a shortened cervical length (<2.5 cm), cervical funneling, and a positive fetal fibronectin test, respectively.[3] A Canadian survey of obstetricians, family practitioners, and midwives selected from 6 regions across the country found that 72.3%, 77.2%, and 67.1% used activity restriction in their practices, despite approximately two thirds of participants answering that the data for effectiveness were in the fair-to-poor range.[4] In addition, obstetricians and family practitioners were more likely to prescribe bed rest at home or in the hospital compared with midwives. A few providers clarified their response by commenting that, although evidence is lacking for routine use of bed rest in pregnancy, it is "the only thing we have" or that it made the woman "feel better." Further, in a 2007 survey of members of the Society of Maternal Fetal Medicine, 71% and 87% recommended bed rest in the setting of arrested preterm labor and preterm premature rupture of membranes, respectively, despite 72% and 56% of respondents indicating that there was minimal or no benefit associated with bed rest.[5]

Evolution of Bed Rest

Activity restriction as medical therapy can be traced back to the ancient Greek physician Hippocrates: "Rest as soon as there is pain, it is a great restorative in all disturbances of the body."[6]

Since the 1900s, bed rest in the postpartum period was common. The term "confinement" (estimated date of confinement) was used to describe the period of time when the woman would not be seen in society, but confined to the home. Postpartum care comprised "lying in," which lasted approximately 3 weeks or more. The first use of bed rest in the antenatal period is unclear; however, Churchill described bed rest as a therapy for pregnancy complications in the mid-1800s:

"If the patient has previously miscarried, as she approaches again the same period, she must take more rest [...]. Rest [] is one of the most powerful prophylactic means we possess. (1958)"

Unfortunately, like many practices in medicine, the prescription of activity restriction in the pregnant woman has become ingrained in medical and social culture without demonstrating a benefit in a scientific study. The perception of a lack of harm along with patients' and practitioners' desperate need for an intervention in these women has likely fueled its continued use in obstetrics.

Efficacy of Activity Restriction in Preventing Preterm Birth

Papiernik was one of the first to examine risk factors for preterm birth. In a descriptive study by Papiernik in France, he identified 30 predictive characteristics that increase the occurrence of preterm delivery, including "factors of fatigue": work outside the home, strenuous work, apartment above the third floor, and long daily commuting time >90 minutes.[7]

In 1983, Berkowitz et al[8] performed a retrospective case-control trial examining 175 mothers who delivered singleton preterm infants compared with 313 mothers who delivered singletons at term. There were no significant differences between the 2 groups in the hours of employment, housework, childcare and physical activity. The authors concluded that hours of employment, housework, childcare, and exercise did not increase the risk for preterm birth.

In a randomized trial, Hobel et al[9] sought to evaluate a preterm prevention program including education, increased clinic visits, and selected prophylactic interventions to reduce preterm birth. The authors randomized 8 West Los Angeles prenatal clinics. Five prenatal clinics were placed in the experimental clinics grouping and 3 were used as controls (N = 1774). Women in the 5 experimental clinics received increased frequency in prenatal visits, preterm birth prevention education, psychosocial and nutritional screening, and crisis intervention. The experimental clinics were randomized again to one of the following interventions: bed rest, defined as resting for 3 times a day for an hour; psychosocial support and an oral progestin group in which they were randomized again to either 20 mg of medroxyprogesterone acetate (Provera; Pfizer, New York, NY) or to placebo. The rate of preterm birth in the experimental clinics was 7.4% versus 9.1% in the control clinics [odds ratio (OR), 0.78; 95% confidence interval (CI), 0.58-1.04; $P = 0.045$]. Power was limited in this trial, with a 77% chance of detecting a 30% difference in preterm birth with an α error of 0.05, leading the authors to conclude that there was insufficient sample size for definitive conclusions to be made based on the trial's results.

The Europop study was a large population-based study of deliveries occurring in 17 European countries.[10] They compared work conditions in >5000 women who had a preterm birth versus nearly 8000 women who had a term birth. Manual workers, including industrial, agricultural, and unskilled workers had a greater number of preterm births compared with professionals. In addition, women who reported more than a 42-hour work week, prolonged standing for >6 hours a day, or poor job satisfaction had significantly higher rates of preterm birth. However, these findings were not universal, with some population-based studies finding no difference in work-related conditions and preterm birth.

A Cochrane Systematic Review conducted in 2007 sought to evaluate the effect of bed rest for the prevention of preterm birth in a home or hospital setting. Selection criteria included randomized and quasi-randomized controlled trials that assessed clinical outcomes. Blinding and completeness of follow-up were assessed for each outcome.[11] Four articles were identified for review irrespective of methodological quality. Only 1 study[9] met criteria for inclusion; however, it is recognized that details about the method of randomization, allocation concealment, and completeness of follow-up are not clear. In the Cochrane analysis, the results of 432 women prescribed bed rest were compared with 834 women assigned to placebo and no intervention (control group). The rates of preterm birth before 37 weeks were similar between both groups, 7.9% in the intervention group versus 8.5% in the control group (relative risk 0.92; 95% CI, 0.62-1.37). Authors concluded that routine advice of bed rest for preventing preterm birth should not be given to pregnant women.

More recently, 2 randomized control trials have attempted to evaluate the incidence of activity restriction in women with known risk factors or symptoms of preterm birth and the impact of such interventions. In 1 prospective trial by

Elliot et al,[12] women with symptoms of preterm labor, a negative vaginal fetal fibronectin, and < 3 cm cervical dilation were tocolyzed with magnesium sulfate and randomized to either activity restriction or no restriction. Mean gestational age at presentation was 30.8 weeks and there were no differences between groups in terms of uterine contractions per hour. Activity restriction was defined as bed confinement except for use of the bathroom and physician visits. Thirty-eight women were randomized to the activity restriction group and 41 to the non–activity restriction group. There was no difference in the rate of preterm delivery between the 2 groups.

In contrast to preterm uterine contractions, identification of a short cervix < 30 mm or less than the 10th percentile has proven to be a beneficial target for intervention using vaginal progesterone. Two randomized trials have demonstrated reduced rates of preterm birth with the administration of vaginal progesterone to women found to have a short cervix on transvaginal ultrasound.[13,14] A secondary analysis of data from the Short Cervix and Nulliparity trial examined the responses of study participants when questioned as to whether their health care provider had recommended activity restriction.[15] *Pelvic Rest* was defined as prohibition from sexual activity. Participants were also questioned on the reduction of *work activity* or *non–work activity*, and the frequencies of such recommendations, partial or complete, were analyzed. Six hundred and forty-six women were included in the trial, and nearly 40% of women with a short cervix were prescribed some form of activity restriction. Various combinations of restriction were used; however, all 3 forms were prescribed simultaneously in 68% of cases. Women who were recommended activity restriction were older ($P < 0.001$), more likely to have private insurance ($P = 0.01$), and cervical funneling ($P = 0.004$) or intra-amniotic debris ($P = 0.005$) found on transvaginal ultrasonography. Preterm birth at < 37 weeks gestation was significantly more common among women placed on activity restriction (37% vs. 17%, $P < 0.001$; OR 2.91; 95% CI, 2.0-4.21). The results remained significant after controlling for demographic and ultrasound differences as well as the treatment group (adjusted OR 2.37; 95% CI, 1.60-3.53). (Treatment groups: (1) 17-α-hydroxyprogesterone caproate and activity restriction; (2) cervical length < 15 mm and activity restriction; or (3) gestation age at screening < 20 wk and activity restriction). A limitation to this study includes the lack of monitoring of patient compliance to selected recommendations on activity restriction. Interestingly, the trial found that activity restriction was not a standard prescription for women with risk factors most commonly associated with preterm birth. For example, women with private insurance and non-Hispanic whites were more likely to have been recommended activity restriction. These findings suggest that the recommendation of activity restriction is not only based on perceptions of risk, but also social and financial determinants.

Physiology of Activity Restriction

As humans, we spend majority of our lives awake and in motion. Activity restriction is a naturally occurring phenomenon in all human beings in the form of circadian sleep. In fact, the lack of prolonged periods of daily rest is implicated in the growing diagnoses of sleep disorders. However, even during times of resting in bed, the average healthy adult changes position or turns every 11.6 minutes.[16] The advent of space exploration in the 1960s unearthed research on the effect of no gravitational forces on a human being. Expeditions to the International Space Station typically last long durations of time, at least 6 months. All body systems

must therefore adapt to prolonged periods of activity restriction.

Studies on nonpregnant adults placed on strict activity restriction have shown that diuresis begins within the first day with an extracellular fluid loss of 600 mL by the second day. Significant fluid shifts and redistribution of plasma volume occur almost immediately. Eleven percent of the blood volume is diverted away from the lower extremities with 78%, 20%, and 2% redistributed to the thorax, head and neck, and abdominal organs, respectively. Increased blood flow to the head and neck results in increased nasal congestion, headaches, gastroesophogeal reflux, and elevated blood pressure in the brachial arteries. Electrolyte losses are also immediately evident, most prominently with sodium and chloride and less so with potassium.[17]

Alterations of the endocrine system have also been documented.[18–23] Glucose, insulin, and growth hormone peak twice daily instead of every 24 hours. Insulin resistance develops within 3 days of strict activity restriction.[18] After 4 days, there is increased calcium excretion and bone resorption with a decrease in osteoblast bone formation. Calcium loss of 0.5% per month of bed rest is noted without any reduction in calcium excretion with limited exercise while sitting or lying each day.

With strict activity restriction, the abdominal contents press against the diaphragm and all lung volumes except for tidal volume decrease. After 3 weeks, there is marked increase work of inspiratory muscles and 26% less oxygen inspired leading to impaired gas exchange.[17]

After weeks of strict activity restriction, there is also a significant decrease in metabolism and appetite leading to constipation, increased susceptibility to skin breakdown and nerve compression, and shifts in the cycles of cortisol, thyroid hormones, and aldosterone.[18,24] Epinephrine peaks in the afternoon rather than the morning and its secretion is directly related to inefficient sleep and alterations in the circadian sleep-wake cycle. An increased risk for infection likely stems from decreased efficacy of leukocyte function resulting from a 2-fold increase in immunoglobulin G catabolism.[25]

Cardiovascular deconditioning and *Physical deconditioning* were terms coined by the aerospace industry to describe major changes after strict activity restriction. Muscle atrophy occurs rapidly and begins within 6 hours of diminished activity.[26] After 5 weeks of strict activity restriction, absolute losses of muscle mass reach 25% to 30%. Strength is severely diminished and any attempt at remobilization incurs fatigue. In nonpregnant adults, there is significantly decreased stroke volume and cardiac output. After decreased plasma volume and venous return to the heart as a result of a supine position, maximal cardiac output decreases 26% and stroke volume decreases from 103 mL before bed rest to 83 mL after bed rest.[27] After a period of strict activity restriction, the ability of the cardiovascular and muscular systems to adapt again to the upright posture is profoundly diminished.

The Untoward Physiological Effects of Activity Restriction

Despite the failure of comprehensive reviews and few prospective trials to find any efficacy in the routine use of activity restriction in pregnancy, the practice continues. Many providers endorse their recommendation of activity restriction by stating no maleficence to the fetus or mother. This antiquated philosophy has been recently debated with the advent of research highlighting potential harms (Table 1).

Venous thromboembolism is one of the leading causes of maternal mortality and severe morbidity in the United States. Venous thromboembolism, including

TABLE 1. Physiological and Psychological Effects of Bed Rest in Pregnancy

Effects of Bed Rest in Pregnancy
Loss of muscle mass
Decreased lung volume
Nasal congestion
Constipation
Increased risk of thromboembolism
Increased risk of infection
Insulin resistance
Muscle soreness
Dizziness
Insomnia, fatigue
Increased bone resorption
Shortness of breath
Boredom
Difficulty in concentrating
Increased family stress
Depression
Loss of income

pulmonary embolism, accounts for 19.6% of maternal deaths or 2.3 deaths per 100,000 live births. Although a rare complication, recent studies have found a nearly 10-fold increased risk for thromboembolism compared with nonpregnant women.[28] In a retrospective study by Kovacevich,[29] >6000 patient charts were reviewed and 192 women were placed on activity restriction for preterm labor or premature rupture of membranes. The risk for thromboembolic events in women on activity restriction was significantly higher than in women not on activity restriction, with a prevalence of 15.6 cases of thromboembolism per 1000 women in patients who were prescribed extended bed rest for ≥ 3 days duration, compared with controls (0.8 cases per 1000 women). Thromboembolic events in pregnant women are a feared complication of strict activity restriction among obstetricians and family physicians.[4] In a study published by Carr,[30] the rate of deep venous thromboembolism in pregnant women on strict activity restriction did not warrant the routine use of heparin prophylaxis. To combat the increased risk for thromboembolism, many obstetricians recommend bilateral lower extremity pneumatic compression boots for women placed on strict activity restriction. The compliance of this intervention and its efficacy in the prevention of deep venous thromboembolism in this patient population has not been studied.

Similar to nonpregnant adults, strict activity restriction used in pregnancy greatly affects the physical conditioning of a majority of subjects. Loss of muscle mass and protein catabolism peaks between 3 and 7 days. Maloni and Schneider[31] studied the effects of strict activity restriction on gastrocnemius muscle metabolism and postpartum muscle deconditioning in 65 pregnant women. Muscle metabolism was assessed using a noninvasive dual wavelength hemoglobin/myoglobin spectrophotometer (Runman). The use of Runman to assess deoxygenation and reoxygenation of tissue has been validated in studies of the adult brain after circulatory arrest, the fetal brain, and the quadriceps and gastrocnemius muscle of nonpregnant subjects. The study found that antepartum activity restriction significantly increased the length of time needed for muscle reoxygenation after exercise, which followed a positive linear pattern from the first antepartum test to the last antepartum test ($P < 0.05$). In contrast, the length of time for muscle reoxygenation after exercise in the postpartum period significantly decreased after resolution of activity restriction ($P < 0.05$).

Symptoms of postpartum deconditioning included back soreness, difficulty walking, ascending and descending stairs, dizziness, shortness of breath, and fatigue. Difficulty in mobility persisted up to 6 weeks postpartum with the postural muscles of the legs and back mostly affected. Seventy-one percent of women who were placed on activity restriction had difficulty ascending and descending stairs, 14% needed help walking, 71% needed help sitting, 14% reported their knees buckling, and 9% experienced falls.

Pregnant women placed on bed rest also have a significant decrease in weekly weight gain likely secondary to a loss of muscle mass. In the first week of strict activity restriction, > 75% of women will either lose weight or maintain weight. Women placed on activity restriction have lower birth weights across all gestational ages when compared with non–activity restricted pregnant women.[32]

Strict activity restriction in pregnancy reflects a period of prolonged immobilization. As a result, these women will experience a significant decrease in weight bearing and skeletal load. Promislow et al[33] performed a prospective study of 181 women from 1992 to 1995. Bone mineral density was measured at 16 and 36 weeks gestational age. Bone metabolism in pregnancy is complicated by an increased calcium demand for mineralization of the fetal skeleton and expansion of plasma volume. The study found a universal increased rate of trabecular bone loss during pregnancy (1.9%, CI, 1.2-2.5). Women prescribed bed rest had a significant increase in bone loss with an adjusted mean loss of 4.6% compared with 1.5% for women not prescribed bed rest ($P = 0.001$). In addition, women who were placed on bed rest were found to have increased odds of bone loss at a higher rate. After adjustment for age, race, parity, lactation history, weight gain, calcium intake (< 2000 mg/d), and exercise, women prescribed bed rest lost an additional 3.1% of bone mineral density.

In a prospective, longitudinal study, Kaji et al[34] investigated markers of bone turnover in women placed on bed rest compared with those who were not on bed rest. The study found that markers for bone resorption are significantly increased in women placed on bed rest ($P < 0.001$). One specific marker of bone turnover continuously increased during bed rest and remained significantly increased 4 weeks postpartum ($P = 0.005$).

The Negative Psychosocial Effects of Activity Restriction

The psychological suffering endured by women placed on antenatal activity restriction has largely been explored in the nursing literature.[35–42] Women interviewed after their experience of bed rest describe feelings of profound fear and anxiety: "The idea of moving around is a very scary thought."[35] All women believed that activity increased uterine irritability. Guilt and self-blame were pervasive feelings if women were unable to comply with the recommendation of strict activity restriction. Additional researchers have shown higher levels of anxiety, depression, increased somatic complaints, emotional, and intellectual liability among women on activity restriction.[36,38,41] Negative feelings about the pregnancy and sleep disturbances have also been cited in the literature.[35,42] Furthermore, women perceived personal choice and the ability to accept or refuse treatments as minimal. Restricted movement and supine positioning contribute to feelings of passivity and vulnerability, which negatively affects patient autonomy and the physician-patient relationship. Control of the pregnancy is thought to rest firmly in the hands of the obstetrician leading toward a more paternalistic relationship rather than a more ethically accepted shared decision-making model.

The adverse effects of activity restriction are not limited to the woman, but extended to the family unit. With loss of the maternal figure at home, family members are forced to assume greater responsibilities. In a survey of 89 women who were prescribed activity restriction, the most common family difficulty cited was "doing it all."[40] Mercer and Ferketich published data on the experience of antenatal activity restriction from the partner's perspective.[43] They found that partners experienced increased negative emotions including depression and anxiety. Thirty-

one percent of partners with a spouse diagnosed with a high-risk pregnancy were clinically depressed versus 18% of partners with a spouse carrying a low-risk pregnancy. Partners described few sources of social support, feelings of isolation, and being overwhelmed by increased responsibility.

In addition, children of mothers who are on activity restriction experience profound emotional difficulty. Children are often confused or frightened by the application of activity restriction.[40] Coping skills in children are immature and the stress of a new routine may manifest as increased feelings of sadness, anger, or somatic complaints. Childcare is also a major stress for families. Many women expressed concern over caregiver quality and the impact of their own lack of involvement.

In the modern era, a majority of pregnant women in the United States work and represent a significant contribution to household income. The expectation that women would leave work upon becoming pregnant began to change in the 1970s. More American families depended on a 2-income household for financial stability and in 1978 "the Pregnancy Discrimination Act" was passed, which prohibited employment discrimination on the basis of pregnancy or childbirth. According to the most recent US census report, women are more likely to work before and during their pregnancy. From 2000 to 2003, 67% of first-time mothers worked while pregnant compared with 39% in 1976 to 1980 and 17% in 1961 to 1965. Women who were 30 years or older and had a bachelor's degree or higher were more likely to work during pregnancy. Among all women who worked during their first pregnancy, 57% worked full-time jobs (at least 35 h a week), 87% worked into the last trimester, and 64% worked into their last month of pregnancy.[44]

It is not a surprise that lost wages incurred as a result of activity restriction is cited as one of the most prominent stressors. In a recent survey, 71% of women placed on activity restriction experienced financial difficulties.[37]

Conclusions

There is no evidence supporting the efficacy of activity restriction to decrease preterm birth. With growing evidence of established maternal harms and detrimental effects to the family unit, McCall et al[45] asserted, "its continued use is inconsistent with the ethical principles that govern medical practice." First, inadequate informed consent and lack of shared decision-making among physicians and women on activity restriction tramples a patient's right to autonomy. Secondly, evidence of negative physiological, psychological, and financial effects of activity restriction prove that the intervention is not consistent with the medical principles of beneficence and nonmaleficence. Lastly, the fact that multiple recent surveys have shown that the use of activity restriction to prevent preterm birth is still common among obstetricians, family physicians, midwives, and maternal-fetal medicine specialists despite perceptions of minimal benefit is unjust. Women are

TABLE 2. Type of Activity Restriction

Type of Activity Restriction	Definition
Light	One hour or less of continuous rest in bed or in the sitting position during waking hours, and no lifting > 10 lbs
Moderate	> 1 h but < 8 h of continuous rest during waking hours with no household chores and no lifting. Health-related visits are allowed.
Strict	Confinement to their dwelling except for health-related visits. Rest in the sitting or supine position the entire day. No household chores or lifting.

Adapted from Sciscione.[3]

TABLE 3. Review of Articles—Bed Rest in Pregnancy

References	Type of Study	Objective	Number	Findings
Berkowitz et al[8]	Retrospective case-control	To examine the effects of employment, housework, and leisure physical activity in pregnancy	175 mothers of singleton preterm infants 313 controls	No significant difference in hours of employment, housework, childcare, and physical activity
Elliot et al[12]	Prospective randomized control	To examine the impact of AR on PTB rate among women experiencing PTL with negative FFN	36 women randomized to AR 37 women randomized to NAR	No statistical difference in the incidence of PTB between the 2 groups. 44.4% of the AR group delivered preterm and 35.1% of the NAR group delivered preterm.
Hobel et al[9]	Prospective randomized control	To evaluate a preterm prevention project including education, increased prenatal visits, and selected prophylactic interventions to reduce PTB (bed rest, N = 432, psychosocial support, N = 407, 20 mg Provera, N = 411)	5 clinics (1774 patients) in the intervention group; 3 clinics (880 patients) served as controls	No evidence to suggest any added benefit of prophylactic interventions.
Sosa et al[11]	Cochrane review	To evaluate the effect of bed rest using RCTs with clinical outcomes	1 study met inclusion criteria (Hobel et al[9])	PTB < 37 wk similar between groups (7.9% in the intervention group vs. 8.5% in the control group; RR 0.92; CI, 0.62-1.37)
Saurel-Cubizolles et al[10]	Retrospective case-control	To analyze the relation between PTB and employment conditions in Europe	5145 women who delivered preterm 7911 women who delivered at term	No evidence to suggest increased risk of PTB among employed women
Grobman et al[15]	Secondary analysis of randomized control trial	To evaluate outcomes associated with AR and women with short cervix	252 women on AR with short cervix 394 women NAR with short cervix	PTB < 37 wk significantly more common among women on AR (37% vs. 17%, $P < 0.001$)
Kovacevich et al[29]	Retrospective case-control	To determine prevalence of thromboembolic events among women on AR for PTL or PPROM	192 women with PTL or PPROM on AR 6164 women with PTL or PPROM NAR	Increased risk of thromboembolic events among women on AR (15.6 cases/1000 vs. 0.8 cases/1000)
Carr et al[30]	Retrospective case-control	To determine whether the risk of DVT in women on AR warrants prophylactic heparin	266 women on AR 48259 women NAR	Risk of DVT in women on AR is < 1.0% and does not warrant heparin therapy (assuming a 1% risk warrants heparin therapy with a power of 80%, α of 0.05)

TABLE 3. (Continued)

References	Type of Study	Objective	Number	Findings
Maloni and Schneider[31]	Longitudinal study	To assess gastrocnemius muscle metabolism and recovery during antepartum AR and 6 wk postpartum	65 women on AR	Time for gastrocnemius muscle reoxygentation after exercise significantly increased during AR ($t = -2.1$, $P < 0.05$) and significantly decreased postpartum ($t = 1.83$, $P < 0.05$)
Maloni et al[32]	Longitudinal study	To assess maternal weight change and infant birth weight among women on AR	141 women on AR	Weekly rate of weight change significantly lower than IOM recommendations ($t = -4.21$, $P < 0.001$) Birth weights significantly lower than matched US sample ($t = -6.81$, $P < 0.001$)
Kaji et al[34]	Longitudinal study	To evaluate changes in bone turnover markers during pregnancy	15 women on AR for PTL 22 women NAR without PTL	Markers of bone turnover in women on AR were significantly higher than controls ($P < 0.001$)
Promislow et al[33]	Prospective cohort study (1992-1995)	To evaluate patterns of bone loss in pregnancy	181 women randomized from a parallel study (Lead in Pregnancy)	Increased bone loss among women on AR compared with women NAR (4.6% vs. 1.5%, $P = 0.001$)

AR indicates activity restriction; DVT, deep venous thromboembolism; FFN, fetal fibronectin; NAR, no activity restriction; IOM, Institute of Medicine; PTB, preterm birth; PTL, preerm labor; PPROM, preterm premature rupture of membranes.

equal contributors to society and by ignoring the economic impact of millions of women out of work each year due to activity restriction in pregnancy is irresponsible. Furthermore, in an era of increasing health care costs and unequal distribution of resources, the practice of activity restriction was found to have an annual cost of $1.03 billion in 1993.[2] The societal cost, adjusted to 2013 dollars, ranges from $2 billion to $7 billion per year.[46] The public deserves evidence-based beneficial interventions and every dollar we continue to spend on the ineffective, harmful practice of activity restriction is a violation of public trust and impedance to proven public health programs. At this time, the use of activity restriction in pregnancy cannot be supported outside of a trial.

Recommendations for the Future

Bed rest is the most commonly used term when a woman is placed on activity restriction, yet there is no standard definition. Varying definitions listed in studies that have examined the effectiveness of bed rest in pregnancy include pelvic rest, rest 3 times a day for an hour,[9] no more than 1 to 2 hours a day out of bed,[5] bed confinement with the exception of bathroom use and physician visits,[12] work restriction or non–work restriction, and a combination of all forms.[15]

Inconsistency in the definition of activity restriction in the literature undermines the ability to study the efficacy of activity restriction to decrease preterm birth. To conduct meaningful research in this area

and to provide consistent patient care and unambiguous provider communication, it is important to develop standard terms and definitions. In a contemporary review, Sciscione recommended the sole use of activity restriction and the abandonment of all other terms. Table 2 divides activity restriction into 3 increasing levels, which will aid in standardization for future research.[3] A comprehensive review of the literature is provided in Table 3.

Large randomized trials are needed, and until then, the application of activity restriction in pregnancy should be confined to clinical trials. The intervention necessitates a standard protocol, approval by an institutional review board, and appropriate informed consent outlining the unknown benefit and known detrimental effects.

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