Preterm birth remains a leading cause of neonatal morbidity and mortality throughout the world. Numerous risk factors for preterm birth have been identified, including non-Hispanic black race, a variety of social and behavioral factors, infections, and history of a prior preterm delivery. Of these, a history of prior spontaneous preterm birth is one of the strongest risk factors. Traditionally, women with a history of preterm birth or those deemed at high risk for preterm delivery have been placed on bed rest or a reduced activity regimen during their pregnancy. However, there is little evidence to support this recommendation. Recent research has suggested that regular physical activity and exercise during pregnancy is safe and does not increase the risk of preterm delivery. Therefore, physicians should encourage women with a history of preterm birth to exercise throughout pregnancy according to guidelines published by the American College of Obstetricians and Gynecologists as long as they are receiving regular prenatal care and their current health status permits exercise. However, there are no randomized controlled trials evaluating exercise prescription in women with a history of preterm birth, hence additional research is needed in this area.

Definition and Frequency
A preterm birth is defined as occurring after 20-0/7 weeks gestation and before 37-0/7 weeks of gestation (259 days from the first day of the mother’s last menstrual period), regardless of birth weight. Historically, birth weight was also included in the definition, with a premature infant defined as weighing less than 2,500 g at birth, delivered before 38 weeks gestation, or both. A report by the Expert Committee on Maternal and Child Health of the World Health Organization in the 1960s made a distinction between premature and low birth weight infants, which led to birth weight being removed from the definition of preterm birth. Another important distinction is whether or not a preterm birth occurs following spontaneous initiation of parturition, as some preterm deliveries are medically indicated due to maternal/fetal complications.

Worldwide, an estimated 15 million preterm births occur each year, with a global preterm birth rate of 11.1% (among 184 countries). While more than 60% of these preterm births occurred in sub-Saharan Africa and South Asia, this remains a significant problem in developed countries. Preterm birth rates remain as high as 9% and above for upper middle- and high-income countries. Preterm birth in the United States rose from 10.6% in 1990 to a peak rate of 12.8% in 2006. Since that time, the rate has declined to 11.39% in 2013. The initial rise in preterm birth rate resulted from a combination of factors, including increased use of assisted reproductive technologies, improved pregnancy dating by ultrasound, and increased willingness of providers to deliver preterm for maternal/fetal reasons.
indicators. The subsequent decline in preterm birth rate has been credited to improved fertility practices to reduce the incidence of multiple gestation pregnancies and improved strategies to prevent recurrent preterm birth, as well as quality improvement programs to limit provider-initiated preterm delivery to those with appropriate medical indications. Unfortunately, significant racial disparities remain, with a preterm birth rate of 16.27% among non-Hispanic black mothers compared to 10.17% among non-Hispanic white mothers.1

**Prediction and Prevention**

Women with a prior spontaneous preterm delivery have a 2.5-fold increased risk of having a subsequent preterm delivery, with an even higher risk in women with a prior preterm delivery at less than 28 weeks.11 Racial differences also exist, with recurrent preterm birth occurring in 26% of black women compared to 15%–20% of Caucasian women. Other disparities that exist include an increased risk of preterm birth among low socioeconomic status, low education levels, residence in disadvantaged areas, and lack of access/late access to prenatal care. Behavioral risk factors for recurrent preterm birth include low BMI (<19.8), significant interpregnancy weight loss (decrease in one BMI category or greater than 5 kg/m²), initiation of cigarette smoking, and short interpregnancy interval (less than 18 months). Additional risk factors include systemic and genital tract infections, periodontal disease, uterine anomalies including large fibroids, cervical dysplasia, and associated treatment, as well as previous cervical injury, shortened cervical length (less than 25 mm on transvaginal ultrasound), conception using assisted reproductive technologies, persistent vaginal bleeding, and multifetal gestation.4,15

Women carrying a singleton gestation with history of a prior spontaneous preterm birth should be offered progesterone supplementation (weekly intramuscular 17α-hydroxyprogesterone caproate) beginning at 16–24 weeks gestation to reduce the risk of recurrent spontaneous preterm birth.16–18 This therapy is continued until 36 weeks gestation. In women with a current singleton pregnancy, prior preterm birth at less than 34 weeks, and a short cervical length (less than 25 mm) before 24 weeks, cerclage placement should be considered, as placement in this population is associated with significant decreases in preterm birth and reductions in perinatal morbidity and mortality.19,20 In women without a history of preterm delivery who are diagnosed with a cervical length of less than 20 mm prior to 24 weeks, vaginal progesterone supplementation should be initiated for prevention of preterm birth.21

**Activity Reduction and Bed Rest**

Multiple interventions have been recommended to reduce the risk of recurrent preterm birth. Historically bed rest has been recommended to women at high risk for a preterm delivery, despite a lack of evidence in the literature to support its use. A Cochrane review by Sosa et al22 to evaluate the effect of bed rest for preventing preterm birth in pregnancy women at high risk found only one trial of 1,266 women for meta-analysis.23 In the study, 432 women were prescribed bed rest and 834 women received a placebo or no intervention. Preterm birth prior to 37 weeks was similar between groups (7.9% vs 8.5%; RR 0.92, 95% confidence interval [CI] 0.62–1.37).

A second study by Elliott et al24 was included in the Sosa et al review but not in the meta-analysis because data for singleton pregnancies were not available. In the study, 73 women being treated for preterm labor with a negative fetal fibronectin test were randomized to activity restriction (AR) (bed rest with bathroom and shower privileges while inpatient and modified on discharge to allow travel to prenatal visits) or no AR that included resuming home and work activities. No significant differences in preterm birth rate were found between groups (preterm delivery rate 44.4% patients with AR and 35.1% patients without AR, P = 0.478).

One randomized clinical trial studying 17α-hydroxyprogesterone caproate and omega-3 supplementation for the prevention of preterm birth also investigated the effects of activity restriction on the preterm birth rate among nulliparous women with a short cervix (less than 30 mm).25 In this study, activity restriction was defined as any of the following: pelvic rest, reduction of work activity, or reduction of nonwork activity. Of the 646 participants, 252 (39%) were prescribed some form of activity restriction (most commonly the combination of all three listed previously) at a mean gestational age of 23.9 weeks. Preterm birth prior to 37 weeks, and prior to 34 weeks, was significantly more common among women placed on activity restriction. This difference remained significant (adjusted odds ratio [OR] 2.37 for less than 37 weeks and 2.28 for less than 34 weeks) after controlling for confounding factors, including demographics and ultrasonography findings.

All these studies demonstrate that bed rest and AR do not significantly reduce the risk for preterm birth and may in fact have numerous adverse effects, including emotional distress, venous thromboembolism, deconditioning and increased weight gain, and financial consequences.26,27 Providers must consider these risks before prescribing bed rest and activity restriction (AR) to their patients.

**Exercise and Risk of Preterm Birth**

Many epidemiologic and observational studies have examined the effects of occupational activities such as prolonged standing, heavy lifting, and exertion, as well as regular exercise on preterm delivery rates and obstetric outcomes with mixed results. Mozurkewich et al28 performed a meta-analysis on 29 studies and concluded that physically demanding work, defined as heavy and/or repetitive lifting or load carrying, manual labor, or significant physical exertion, was associated with an increased risk for preterm delivery (pooled OR 1.22, 95% CI 1.16–1.29), as well as small for gestational age, hypertension, and preeclampsia. As stated by the authors, these results were modest and derived mainly from observational studies; therefore, the results need to be interpreted with
caution. A second review by Bonzini et al.29 included 49 studies and investigated the relationship between five occupational exposures (prolonged work hours, shift work, lifting, standing, and heavy physical work load) and three adverse obstetric outcomes (preterm birth, low birth weight, and preeclampsia/gestational hypertension). When evaluating risk for preterm birth, the findings ruled out a “more than moderate effect” (defined as a RR > 1.4) for each exposure and pooled estimates of risk pointed to only modest or null effects; therefore, no work activity restrictions could be justified.

A more recent prospective cohort study in the Netherlands,30 evaluating associations between physically demanding work and obstetric outcomes among 4,680 pregnant women, identified no significant effects from long periods of walking, standing, lifting greater than 25 kg, nightshifts, and long work hours on the occurrence of preterm birth. Many of these reviews make an important note: women that work physically demanding jobs tend to be healthier prior to conception and may therefore be at lower risk for adverse obstetric outcomes. Due to a lack of empirical evidence based on randomized controlled trials, recommendations for work activity during pregnancy remain a challenge for obstetricians.

Several studies have investigated the effects of exercise during pregnancy on preterm delivery and adverse obstetric outcomes. Clapp found that labor began 5 days earlier among the exercise group (277 ± 6 vs 282 ± 6 days) with no difference in the incidence of preterm delivery in a study of 131 recreational athletes who continued their exercise regimen in pregnancy compared to recreational athletes who discontinued exercise during pregnancy.6 A randomized controlled trial by Barakat et al.,7 which randomized 290 pregnant women to either exercise (55–60 minute general fitness classes three times per week, weeks 8–10 to 38–39) or not exercise, found no significant differences in gestational age at delivery between groups (EG = 39.7 ± 1.3 vs CG = 39.6 ± 1.1 weeks, P = 0.81). There were no significant differences in preterm deliveries and in fact fewer preterm deliveries among the exercise group (4.3%) relative to the control group (7.2%). Additionally, Jukic et al.8 reported lower incidence of preterm delivery among women who performed vigorous recreational activities during pregnancy.

Since the risk factors for preterm birth are exclusion criteria for many studies, the true risk for preterm birth due to performing short-term or chronic exercise greater than 85% of their maximum oxygen uptake (VO2 max) is not well studied. Human and animal studies demonstrate potential concerns when the athlete goes beyond the ventilator threshold or to the point of exhaustion.31–33 These concerns are transitory contractions and fetal heart rate deceleration. The woman at high risk for preterm birth may be at higher risk for complications with strenuous exercise taken to exhaustion.

Current Recommendations
The American College of Obstetricians and Gynecologists recently released a Committee Opinion on physical activity and exercise during pregnancy recommending women with uncomplicated pregnancies engage in at least 150 minutes of moderate intensity aerobic exercise per week.5 The American College of Sports Medicine (ACSM) defines moderate intensity as any activity equivalent to brisk walking.34 More specifically, the ACSM recommends that intensity should be 50%–85% of VO2 max with a target of 60%–70% VO2 max for women who were sedentary prior to pregnancy and above 70% VO2 max for pregnant women wanting to maintain fitness.34 Research has shown exercise during pregnancy helps control weight gain,35–37 reduces the risk of gestational diabetes and preeclampsia in obese women,38–42 and improves psychological well-being.43,44

Absolute contraindications to aerobic exercise in pregnancy include incompetent cervix or cerclage, multiple gestation at risk of premature labor, premature labor during the current pregnancy, and ruptured membranes.5 It is important to note that a history of preterm delivery is not listed among the absolute or relative contraindications.

Recommended activities include walking, swimming, stationary cycling, aerobics, modified yoga and Pilates, running or jogging, racquet sports, and strength training. Activities to avoid include contact sports, activities with high risk of falling or impact (downhill skiing, horseback riding, water skiing, etc.), scuba diving, sky diving, hot yoga, and hot Pilates.5 Additionally, women should avoid exercise in the supine position after 20 weeks gestation to prevent hypoten- sion.41 It is important that pregnant women stay well hydrated during exercise and rest when needed. There is no gestational age limit on exercise, and women may continue to exercise until they deliver.

Based on the literature available, women with a history of preterm delivery who are receiving regular prenatal care and indicated progesterone therapy should be encouraged to continue working with minimal restrictions and participate in 30 minutes of moderate intensity exercise most days of the week. This recommendation would not apply to women with a short cervix (less than 25 mm) who undergo cerclage placement, as exercise is contraindicated in that population. For patients who are hospitalized for preterm labor, regardless of whether they have a history of preterm birth, aerobic exercise is not recommended and work activity may need to be restricted depending on the patient’s occupation. Many obstetricians may recommend women in that situation stop working but should be cautioned against prescribing bed rest. Given the modest occupational risks on preterm labor, it is reasonable for women with a history of preterm birth to reduce their amount of time standing and heavy lifting at work. In women with history of a medically indicated preterm birth, exercise in the current pregnancy may help prevent a recurrent medically indicated preterm delivery in certain circumstances, particularly in the setting of poorly controlled hypertension and diabetes. Additional research is needed in this particular population, and physicians need to follow current guidelines.
while tailoring recommendations to each individual patient, considering their history and current health status.

**Conclusion**

In the United States, and worldwide, preterm birth remains a leading cause of neonatal morbidity and mortality. While a history of preterm birth is one of the strongest risk factors, significant racial disparities exist with a preterm birth rate of 16.27% among non-Hispanic black mothers compared to 10.17% among non-Hispanic white mothers. A variety of other disparities exist, including an increased risk of preterm birth among low socioeconomic status, low education levels, residence in disadvantaged areas, and lack of access/late access to prenatal care.

As continued research demonstrates the benefits of exercise during pregnancy, specific recommendations for high-risk populations need to be addressed. One such population is women with a history of preterm birth. Historically, these women were placed on bed rest or a reduced activity regimen during pregnancy, despite a lack of evidence supporting this practice. Recent studies have demonstrated regular physical activity and exercise during pregnancy is safe and does not increase the risk of preterm delivery. Women with a history of preterm delivery who are receiving regular prenatal care should be encouraged to continue working with minimal restrictions and participate in 30 minutes of moderate intensity exercise most days of the week.

**Author Contributions**

Wrote the first draft of the manuscript: NAS. Contributed to the writing of the manuscript: NAS, LEM, and ERN. Agree with manuscript results and conclusions: NAS, LEM, and ERN. Jointly developed the structure and arguments for the paper: NAS, LEM, and ERN. Made critical revisions and approved final version: NAS, LEM, and ERN. All authors reviewed and approved of the final manuscript.

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