




# Benefits of Resistance Training During Pregnancy for Maternal and Fetal Health: A Brief Overview

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**Abstract:** Research demonstrates resistance training is not only safe but also beneficial for pregnant women. However, exercise recommendations for pregnant women still minimize the importance of resistance exercise and provide minimal guidance. With a large increase in strength-focused sports among women, it is critical to re-evaluate the risk/benefit ratio of these exercises and ensure the latest recommendations reflect the latest clinical research. The purpose of this review is to highlight the safety and benefits of resistance training for both maternal and fetal health, particularly focusing on recent work. Relevant research involving resistance training during pregnancy was accessed and analyzed via a quasi-systematic search. Results demonstrate that appropriate prenatal resistance training can help alleviate some of the common symptoms of pregnancy, such as fatigue, back pain, and poor mental health. Resistance exercise can assist with glucose control in gestational diabetes mellitus, as well as decrease the risk of infant macrosomia and childhood metabolic dysfunction associated with uncontrolled gestational diabetes. Resistance training can also increase the likelihood of a vaginal delivery, which is beneficial for both mother and baby. Concerning fetal health, resistance training increases uterine blood flow, decreases the risk of neonatal macrosomia, and improves cognitive function and metabolic health in childhood. As with all forms of exercise, pregnant women should avoid resistance exercises that involve the supine position for extended bouts of time, trauma (or risk of trauma) to the abdomen, ballistic movements, movements that rely heavily on balance, and conditions that prohibit appropriate temperature control. With these considerations in mind, resistance training's benefits far surpass the lack of risk to the fetus. Resistance training is a safe and effective way to improve and maintain physical fitness during pregnancy and represents no risk to fetal health and development. Thus, healthcare providers should recommend resistance training for pregnant women.

**Keywords:** strength training, macrosomia, gestational diabetes, labor & delivery

## Introduction

Pregnancy is often referred to as a “teachable moment” because it is a time when women are highly motivated to modify their behavior, either for their health or the health of their developing fetus.<sup>1</sup> Regular physical activity during pregnancy can lower the risk of pregnancy-related conditions such as gestational weight gain, gestational dyslipidemia, preeclampsia, gestational diabetes, and gestational hypertension, and improve labor and delivery outcomes.<sup>2–5</sup> Although the benefits and safety of exercise during pregnancy are well-known, only 23% of pregnant women in the United States participate in at least 150 minutes per week of moderate physical activity,<sup>6</sup> the minimum amount recommended by the American College of Obstetricians and Gynecologists (ACOG) and the World Health Organization (WHO).<sup>7,8</sup> On the other hand, nearly 60% of pregnant women do not engage in any leisure-time physical activity.<sup>6</sup>

ACOG has mostly emphasized aerobic physical activity in their past guidelines due to lack of conclusive evidence on resistance training during pregnancy.<sup>9,10</sup> However, current research shows resistance training is not only safe, but also beneficial during pregnancy.<sup>11</sup> The benefits of resistance training in non-gravid populations are widespread, from weight management to bone and mental health.<sup>12</sup> The specific mechanisms by which gains from resistance training occur are similar during pregnancy.<sup>13</sup> In fact, pregnancy is a time when things such as weight status, back pain, fatigue, and mental

health are all extremely important to maintain, and resistance training offers these benefits.<sup>14</sup> Taken together, ACOG included resistance training recommendations for pregnant women in their latest committee opinions.<sup>7,15</sup> To our knowledge, even though some reviews on resistance training during pregnancy have been published,<sup>16,17</sup> only a few comprehensively outweighed its maternal and fetal health benefits over perceived risks. Further, no such review has been published since ACOG updated their committee opinion on maternal physical activity in 2020,<sup>15</sup> paying more attention to resistance training and lifting recommendations. As a result, few pregnant women (11% in the United States) practice resistance training during pregnancy, and likewise, few healthcare providers advise pregnant women to do resistance training.<sup>18,19</sup> Thus, it is timely and beneficial to comprehensively discuss the benefits and safety of resistance training during pregnancy in compliance with the latest ACOG committee opinion. Given the large increase in strength-focused sports (CrossFit™, weightlifting, and powerlifting) among women over the past 10 years, and some even continuing their sport during pregnancy,<sup>20–22</sup> it is critical to re-evaluate the risk/benefit ratio of these exercises and ensure the latest recommendations reflect the latest clinical research. Such attempts are likely to facilitate obstetricians recommending to start or at least to continue resistance training or strength-focus exercise routines to pregnant patients. The purpose of this overview is to analyze current research and elucidate the benefits and safety of resistance training for pregnant women and their fetuses, and how such benefits and safety concerns comply with ACOG's latest committee opinion.

## Resistance Exercise for Maternal Health

While the health benefits of aerobic exercise during pregnancy are well known, the benefits of resistance exercise during pregnancy have not been clearly defined until recently. Emerging evidence suggests that resistance exercise is equally important for each of these aspects of health during pregnancy, among many others. Pregnancy is associated with a decrease in functional status, but exercise before, during, and after pregnancy can improve health status throughout pregnancy and the postpartum period.<sup>23</sup> Resistance exercise, in particular, can help control gestational diabetes mellitus, obesity, and loss of physical function, as well as improve labor, delivery outcomes, and the quality of life during pregnancy.<sup>16,17</sup> The effects of resistance training on maternal and fetal outcomes are tabulated in [Table 1](#).

**Table 1** Effect of Resistance Training on Different Maternal and Fetal Outcomes

Author (Year)	Sample	Intervention	Outcomes
Ramírez-Vélez et al (2017) <sup>4</sup> Randomized controlled trial	Nulliparous Latina Women (16–20 weeks)	Aerobic + Resistance (moderate-vigorous) 60 min * 3 times/week (12 weeks)	Intervention regulated low density lipoprotein and triglycerides gain, reduced postpartum hemorrhage, attenuate newborns' complications.
O'Connor et al (2011) <sup>13</sup>	Pregnant women with backpain. (21–25 weeks)	Strength training (low-moderate) 45 min * 2 times/week (12 weeks)	Strength training was positively related to improved lumbar extensor endurance without increasing the risk of injury.
Ward-Ritacco et al (2016) <sup>14</sup> Randomized control trial - Secondary analysis	Pregnant women with backpain. (21–25 weeks)	Resistance training (low-moderate) 45 min * 2 times/week (12 weeks)	Resistance training improved mental and physical energy and reduced mental and physical fatigue.
O'Connor et al (2018) <sup>24</sup> Randomized control trial	Pregnant women with backpain. (21–25 weeks)	Resistance training (low-moderate) 17 min * 2 times/week (12 weeks)	Resistance training improved vitality and reduced fatigue.
Barakat et al (2013) <sup>25</sup> Randomized control trial	Sedentary singleton pregnant women (10–12 weeks)	Aerobic + Resistance (moderate) 55 min * 3 times/week (10–39 gestation weeks)	Intervention reduced gestational diabetes related complications such as risk of macrosomia, caesarean delivery, and maternal weight gain.

(Continued)

Table 1 (Continued).

Author (Year)	Sample	Intervention	Outcomes
Kokic et al (2018) <sup>26</sup> Randomized control trial - Secondary analysis	Patients with gestational diabetes mellitus	Aerobic + Resistance (moderate) 45 min * 2 times/week (diagnosis - 36 week gestation)	Intervention reduced blood glucose levels without causing harmful acute responses.
Kokic et al (2018) <sup>27</sup> Randomized control trial	Patients with gestational diabetes mellitus	Aerobic + Resistance (moderate) 50 min * 2 times/week Brisk walking (30 min) (diagnosis - delivery)	Intervention reduced postprandial glucose levels.
De Barros et al (2010) <sup>28</sup> Randomized control trial	Sedentary patients with gestational diabetes mellitus (24–34 weeks)	Resistance exercise – elastic band (somewhat heavy) 40 min * 3 times/week (24–34 weeks - delivery)	Resistance training reduced insulin requirement and enhanced capillary glycemic control.
Huifen et al (2022) <sup>29</sup> Randomized control trial	Patients with gestational diabetes mellitus (24–31 weeks)	Resistance exercise (moderate) 60 min * 3 times/week (at least 6 weeks)	Intervention reduced fasting and postprandial blood glucose, insulin requirement, gestational weight gain and blood pressure.
Brankston et al (2004) <sup>30</sup> Randomized control trial	Patients with gestational diabetes mellitus (26–32 weeks)	Resistance exercise (somewhat hard) 3 times/week (26–32 weeks - delivery)	Resistance exercise delayed requirement of insulin therapy and reduced usage and prescription of insulin.
Barakat et al (2009) <sup>31</sup> Randomized control trial	Sedentary pregnant women (12–13 weeks)	Resistance + Toning (light-moderate) 40 min * 3 times/week (26 weeks)	Resistance training does not affect adversely on newborn's body size and attenuates risk of macrosomia in overweight and patients with gestational diabetes.
Petrov Fieril et al (2015) <sup>32</sup> Randomized control trial	Healthy pregnant women (14–25 weeks)	Resistance exercise (moderate-vigorous) 60 min * 2 times/week (12 weeks)	Resistance training does not affect adversely on maternal or fetal health.
Barakat et al (2009) <sup>33</sup> Randomized control trial	Sedentary pregnant women (12–13 weeks)	Resistance + Toning (light) 36 min * 3 times/week (26 weeks)	Resistance exercise does not impact the method and time of delivery during childbirth.
Barakat et al (2008) <sup>34</sup> Randomized control trial	Sedentary pregnant women (12–13 weeks)	Resistance + Toning (light) 35 min * 3 times/week (12–13 to 38–39 weeks)	Resistance training does not affect the gestational age or cause preterm deliveries.
Garnæs et al (2017) <sup>35</sup> Randomized control trial - Secondary analysis	Overweight/obese pregnant women (11–14 weeks)	Walking + Resistance (moderate) 60 min * 3 times/week (early pregnancy- delivery)	Resistance training does not affect birth weight or neonatal and maternal outcomes.
White et al (2019) <sup>36</sup> Randomized control pilot trial	Singleton pregnant women (12–25 weeks)	Resistance band (somewhat hard) 55 min * 3 times/week (15 weeks)	Resistance band workouts can increase vaginal deliveries without negative effects on mother or newborn.
Barakat et al (2016) <sup>37</sup> Randomized control trial	Singleton pregnant women (9–11 weeks)	Aerobic + Resistance (somewhat hard) 55 min * 3 times/week (9–11 – 38–39 weeks)	Exercise reduced risk of hypertension, excessive gestational weight gain and macrosomia.

(Continued)

**Table 1** (Continued).

Author (Year)	Sample	Intervention	Outcomes
Bgeginski et al (2015) <sup>38</sup> A pilot study	Pregnant women (22–24 weeks)	1-RM + Resistance (4 times in 22–24, 28–32 & 34–36 gestational weeks)	Resistance exercise during pregnancy is safe for the fetus- fetal heart rate.
Petrov Fieril et al (2016) <sup>39</sup> A cross-over design	Healthy pregnant women (21 week)	Aerobic + Resistance (light-moderate) 30 min + 30 min (single session)	Response of maternal hemodynamics to aerobic and resistance exercise is alike.

## Pregnancy Symptoms

One of the most commonly reported symptoms of pregnancy is fatigue.<sup>40</sup> Excess fatigue during pregnancy is positively associated with preterm births, increases the risk of operative deliveries, and reduces the overall quality of life.<sup>41</sup> Resistance exercise prevents deterioration of energy and vitality during pregnancy and attenuates fatigue.<sup>14,24</sup> In several studies, women who did not practice resistance training experienced decreased energy and vitality and increased fatigue throughout pregnancy, while women who performed resistance training during pregnancy did not experience these changes in energy and fatigue.<sup>14,24</sup> Although there were no significant improvements from the start of their training to the end, the women performing resistance training during pregnancy appeared to maintain their levels of energy and vitality.<sup>24</sup> Also, some women noted resistance training to improve other symptoms associated with pregnancy, such as nausea and headaches.<sup>42</sup> Proper resistance training has been shown to improve these pregnancy-related symptoms, with both immediate and lasting effects.<sup>42</sup> When combined with regular aerobic exercise, resistance training can relieve pregnancy symptoms.

## Back Pain

Along with the dramatic shift in the center of gravity, pregnancy is also accompanied by an increase in joint laxity, which can increase the risk of injury to muscles, joints, and ligaments.<sup>43,44</sup> These changes contribute to back pain, which approximately 76% of pregnant women experience.<sup>44,45</sup> Back pain during pregnancy causes many discomforts, which can impair activities of daily living (eg, lifting and grocery shopping), and lead to sleep disturbances due to unbearable pain.<sup>44</sup> Although the perception is that resistance training provokes back pain, without causing any further injury,<sup>44</sup> it actually improves symptoms of back pain by strengthening core muscle strength. Resistance training improves posture and lordosis of the lumbar spine and alleviates some of the joint discomforts associated with weight gain in ways not seen with regular practice of aerobic exercise.<sup>17,44,46</sup>

## Mental Health

The rapid changes in both hormones and weight during pregnancy contribute to a wide variety of mental health issues. Resistance training can improve self-esteem, self-image, self-confidence, and sense of control during pregnancy by increasing physical strength and the ability to independently perform activities of daily living.<sup>16,42,47</sup> The improvements in self-esteem and self-confidence are then associated with a reduced incidence of anxiety and depression and an increased feeling of control over the physical changes of pregnancy, which is also associated with an improvement in overall mental health.<sup>42</sup> In fact, resistance training in combination with regular physical activity has been shown to decrease both the incidence and severity of depression during pregnancy.<sup>44</sup> All of these improvements are related to an improved quality of life, which has significant implications for both physical and mental health during pregnancy.<sup>24,42</sup> Given the increasing prevalence of mental health concerns during and after pregnancy,<sup>48</sup> the implications for strength training to help new and expectant mothers are substantial.

## Gestational Diabetes Mellitus

One major health concern for many pregnant women is the development of gestational diabetes mellitus. The prevalence of gestational diabetes in the United States has rapidly increased in the last decade (from 4.6% in 2006 to

8.4% in 2017 per 100 people).<sup>49</sup> The development of gestational diabetes during pregnancy increases pregnancy complications such as pre-eclampsia, cesarean birth, and preterm delivery.<sup>50</sup> Regular exercise can decrease the risk of developing gestational diabetes by 57%.<sup>51</sup> In particular, pregnant women involved in regular resistance and aerobic training tend to have lower incidence of gestational diabetes than women who do only aerobic training or no exercise.<sup>52</sup> According to another study, although an aerobic and resistance training intervention in combination couldn't reduce the risk of developing gestational diabetes considerably, it reduced the incidences of diabetes-related complications such as macrosomia and operative deliveries.<sup>25</sup> Additionally, several studies have shown the impact of aerobic and resistance training on improving glycemic control in pregnant women, thus mediating the adverse effects of gestational diabetes mellitus.<sup>25–28</sup> Another recent study demonstrated that not only did moderate-intensity resistance exercise improve glucose control and decrease reliance on insulin but it also assisted women with gestational diabetes with pregnancy-related weight gain and blood pressure.<sup>29</sup> Women with gestational diabetes who performed resistance training during their pregnancy need less insulin to attain optimal glycemic control and maintain it for longer periods than women who did not perform any strength training.<sup>28,30</sup> Resistance training is especially beneficial for women who struggle to control their glucose levels with diet and insulin alone.<sup>30</sup> Although all women should implement resistance training during pregnancy, women with gestational diabetes stand to benefit greatly from a regular resistance training program, which may improve maternal health in both the short- and long term.

## Obesity

Obesity during pregnancy can also have serious consequences for maternal health. Obesity is associated with higher levels of maternal inflammation, which is, in turn, associated with the development of gestational diabetes and other chronic metabolic conditions.<sup>53,54</sup> In several studies, women who practiced strength training, either alone or in combination with aerobic training, gained less weight than women who did not exercise at all.<sup>25,31</sup> Either alone or in combination with aerobic exercise, resistance training has been shown to limit excessive weight gain and mediate the negative effects of weight gain on maternal health.<sup>11,32,43</sup> Along with controlling gestational weight gain, resistance training can also increase muscle mass, making it easier for women to handle the weight of the fetus and the demands of childcare.<sup>16</sup> A combination of resistance and aerobic exercise can help control weight gain and improve muscle mass during pregnancy.

## Labor & Delivery

Although current evidence regarding the effects of resistance training on the course of labor and delivery is inconclusive, it is known that strength training does not negatively affect labor, gestational age, and delivery.<sup>4,33,34</sup> In these cases, resistance training does not negatively influence the length of hospital stay,<sup>35</sup> mode of delivery,<sup>4,32,33,35</sup> or total labor time.<sup>33,47</sup> While several studies have not found any differences in labor and delivery among women who performed resistance training and women who did not, they also did not find any increased risk of adverse outcomes for women who were resistance trained throughout their pregnancy.<sup>32,33</sup> For these women, strength training did not increase the likelihood of natural birth or decrease time spent in active labor, but it also did not increase the likelihood of cesarean birth or increase time spent in labor,<sup>33</sup> which supports the claim of the lack of risks associated with resistance training during pregnancy. Among women assigned to an intervention or control group, women who took part in supervised resistance training had a shorter first stage of labor,<sup>17,44,55</sup> lower incidences of operative delivery,<sup>36,47,52,55</sup> and fewer complications during delivery.<sup>4,17</sup> Resistance training during pregnancy was also associated with a decreased risk of preterm labor.<sup>4,52,55</sup> While the results are mixed, research supports both the benefits and lack of risks of resistance training on labor and delivery outcomes, and these are promising clinical outcomes.

## Resistance Exercise for Fetal Health

Although many women fear exercise during pregnancy because of the potential harm to the fetus, research indicates that resistance training poses no risk to the developing child. In fact, resistance training has both acute and chronic benefits for the fetus. While cultural myths lead some women to fear a harmful loss of blood flow to the fetus during exercise, this

change in blood flow has not been substantiated in research.<sup>16,38,56,57</sup> In fact, slight changes in blood flow to the uterus might improve fetal health.<sup>44</sup> Rather than inducing fetal hypoxia and putting fetal well-being at risk, the physiological changes during exercise have a protective effect on the fetus.<sup>43,44</sup> Post-exercise, there is an increase in blood flow to the umbilical cord and a decrease in fetal resistance.<sup>43</sup> This increase in blood flow then increases placental vascularity and growth and reduces oxidative stress, which promotes fetal growth and well-being.<sup>44</sup> These changes can improve fetal stress tolerance, which has positive implications for fetal development and neonatal birth outcomes.<sup>43</sup> Similarly, changes in fetal heart rate during resistance training are indicative of increased fetal wakefulness and activity, rather than acute risk.<sup>17,26,57</sup> Although some studies have found no changes in fetal heart rate during resistance training,<sup>38,57</sup> other studies have found that changes in maternal and fetal heart rate are not associated with any risk of hypoxia or hyperthermia.<sup>26,44,58</sup> Resistance training has not caused any unsafe changes in maternal or fetal heart rate,<sup>47</sup> and the changes seen are similar to aerobic exercise, which many women feel comfortable performing during pregnancy.<sup>58</sup> Overall, a substantial amount of evidence supports that resistance training is not harmful to the fetus, and can even be beneficial for fetal growth and development.<sup>11,17,26,27,36,38,39,44,52,57</sup>

## Growth and Development

Resistance training has no association with adverse growth and developmental outcomes. In previous studies, higher amounts of training volumes were not associated with decreased Apgar scores,<sup>55</sup> which assess heart rate, respiration, muscle tone, color, and reflexes at birth. By decreasing the risk of cesarean delivery,<sup>31,54,59,60</sup> preterm birth,<sup>32</sup> delivery complications such as birth canal lacerations,<sup>31,59</sup> shoulder dystocia,<sup>31,60</sup> and death,<sup>4,31,59,60</sup> resistance training during pregnancy can positively influence neonatal health well past childhood and into adulthood. Studies have shown that infants born to women who combined aerobic and resistance training during pregnancy are more alert, better at self-quieting, and less agitated.<sup>17</sup> In childhood, children born to women who practiced weight-bearing exercise had better attentiveness and discipline and were also more cognitively advanced at five years old than children born to control subjects.<sup>44,61</sup>

## Macrosomia

High birth weight, or macrosomia, is associated with increased risk of birth injuries to both mother and baby, cesarean birth, and numerous postnatal complications.<sup>59,60,62</sup> At birth, macrosomic infants are more likely to need neonatal intensive care and more likely to experience mortality and morbidity.<sup>59,60,62</sup> Exercise regimens that include resistance training have been shown to decrease the risk of having macrosomic infants.<sup>37</sup> In several studies, infants born to women performing resistance training were less likely to be macrosomic than infants born to control groups of non-exercising women.<sup>25,33,35</sup> As children, macrosomic infants are more likely to be obese, develop type 2 diabetes, have hypertension, and develop cardiometabolic diseases, such as metabolic syndrome or cardiovascular disease.<sup>25,27,35,54,62</sup> These conditions are also likely to extend into adulthood, leading to an increased risk of adult morbidity and mortality.<sup>31,35,54</sup> Neonatal macrosomia might also be associated with some types of cancer in adulthood.<sup>31</sup> In multiple studies of women with gestational diabetes mellitus, the resistance training intervention was associated with lower incidences of macrosomia, while the control groups were associated with normal or increased incidences of macrosomia.<sup>25,31,44</sup> While some research has found that resistance training does not affect the incidence of macrosomia,<sup>4</sup> all of the current research is conclusive that resistance training is not harmful to fetal growth and development.<sup>4,17,27,32</sup> The incidence of neonatal macrosomia at birth has significant implications for lifelong health, and maternal resistance training can effectively mediate the risk of these adverse outcomes, particularly in macrosomia related to gestational diabetes.

## Safety of Resistance Training During Pregnancy

One of the reasons that resistance training has not been emphasized in previous prenatal training guidelines was lack of consensus regarding the safety of resistance training during pregnancy. While several considerations must be accounted for, resistance training is safe for both mother and fetus.<sup>11</sup> Rather than increasing the risk of injury, resistance training decreases the risk of musculoskeletal injury during pregnancy when performed safely.<sup>24,44</sup> Studies have shown that there

are no potentially dangerous changes in blood pressure, heart rate, or temperature during resistance training.<sup>39</sup> Specialists have cautioned against participating in Olympic lifting due to the adverse effects of the Valsalva maneuver in pregnancy; however, these recommendations lack experimental evidence.<sup>63</sup> One recent study recruited nearly 700 pregnant women who participated in heavy weightlifting and found that individuals who engaged in heavy prenatal resistance training had typical perinatal and pelvic floor health outcomes.<sup>63</sup> These data further support the notion that resistance training is safe and does not contribute to worse outcomes for pregnant women.

The purpose of resistance training initiated during pregnancy should not be to maximize hypertrophy, especially for women who did not engage in regular resistance training before their pregnancy. Rather, the resistance training program should focus on achieving the highest level of physical fitness possible, especially focusing on the strength of muscles involved in labor and weight-bearing,<sup>16</sup> and to prevent significant losses in function while maximizing safety.<sup>17,43,44</sup> This can be achieved through exercises using light weights, resistance bands, or water activities.<sup>16,36,62</sup> When performed safely and with appropriate progression, resistance training does not increase the risk of adverse events for either the mother or the fetus.<sup>11,17,36,39</sup>

## Considerations to Maximize Safety

Resistance training is beneficial for the health of both the mother and fetus, but certain considerations must be taken to maximize the safety of both. One of the primary concerns for any woman performing resistance training during pregnancy should be to avoid any supine positions, particularly later in pregnancy.<sup>16</sup> Lying supine can decrease venous return,<sup>17,44,46</sup> especially as the fetus grows larger and compresses the inferior vena cava to a greater extent.<sup>43,64</sup> The compression of the vena cava prevents blood from returning to the heart and also compromises blood flow to the fetus, which can have negative effects on both a healthy fetus and an at-risk fetus.<sup>64,65</sup> Any exercises that require a supine position should be modified, such as with an inclined bench,<sup>64</sup> or avoided. The Valsalva maneuver should also be avoided due to the potential decrease in fetal blood flow.<sup>43,44</sup> The increase in intra-abdominal pressure caused by holding the breath during a movement might impair uterine perfusion and should be avoided by pregnant women performing resistance training.<sup>43,44,64</sup> While being overly cautious and following these guidelines is still appropriate, recent research suggested that both the supine position and the Valsalva maneuver during heavy resistance training did not contribute to poorer outcomes.<sup>63</sup> More research on these techniques is needed, and it is still advisable to abide by these cautions until more is known.

Pregnant women should also avoid exercises that rely on balance, unless they are specifically training balance. The change in center of gravity can promote a lordotic spine in the lower back, which can impair posture and balance.<sup>17</sup> Exercises such as lunges and squats, which are dynamic movements requiring balance, might not be safe for pregnant women, especially later in pregnancy as changes in center of gravity become more dramatic.<sup>16,17,43,64</sup> During pregnancy, an increase in levels of the hormone relaxin prepares the body for delivery, but can also increase the risk of injury to the joints and connective tissues.<sup>44</sup> Ballistic movements can exacerbate these injuries, and should be avoided, particularly later in the pregnancy when joint laxity and center of gravity are changing more dramatically than at the start of pregnancy.<sup>43,64</sup> The risk of trauma to the abdomen should also be avoided at every stage of the pregnancy.<sup>17</sup> Resistance bands can be used to replace free weights in exercises that might involve trauma to the abdomen in the case of movement failure.<sup>16,36,64</sup>

Another concern during pregnancy is maternal thermoregulation and maintenance of a safe temperature. While the ACOG guidelines for exercise during pregnancy advise against overheating,<sup>46</sup> dangerous levels of hyperthermia have not been seen in studies involving resistance training.<sup>26,39</sup> Although vigorous-intensity exercise does increase maternal temperature, there have been no reports of any adverse effects on fetal health and safety.<sup>39,44</sup> During resistance training sessions, pregnant women can prevent hyperthermic episodes by wearing loose-fitting clothing, adequate water consumption, and being mindful of environmental conditions during the workout.<sup>17,43</sup> Resistance training exercises should be individually tailored to each pregnant woman through discussion with the obstetric team while maximizing safety.

## A Call for Action

Following the ACOG’s latest guidelines,<sup>15</sup> and considering the benefits and safety of resistance training, obstetric care providers, exercise physiologists, personal trainers, and strength coaches should encourage healthy pregnant women to include at least some resistance training in their exercise regimen rather than completely avoiding it. Highlighting the advantages is valuable because when the benefits surpass the associated risks, it encourages positive behavioral changes.<sup>66</sup> This, in turn, holds the potential to significantly enhance outcomes in maternal and neonatal health. Many women do not exercise during pregnancy because they do not enjoy typical aerobic activity; it is plausible that more women may engage in appropriate activity if they feel safe and also receive guidance through proper resistance training. This not only applies to pregnant women but also to non-pregnant women, especially in societies where muscle building is not culturally seen as feminine.<sup>67</sup>

As a call to action, more resources are needed to help pregnant women know safe, effective, and appropriate resistance training for each stage of pregnancy. One such resource, BumptUp<sup>®</sup>, is an evidence-based physical activity application that contains weekly prenatal exercise programming, over 250 individual exercises, and educational information all complete with suggestions for modification, videos, and written descriptions to coach women through safe resistance training during pregnancy.<sup>68</sup>

Table 2 is an example block of a workout for pregnant women, designed for weeks 13–15 of pregnancy. During weeks 14 and 15, the movements remain the same, but the exerciser is encouraged to incrementally increase difficulty via an increased number of repetitions, resistance/weight, or time spent in the movement. A holistic program would be divided into several blocks/phases that correspond well with changes by trimester in an effort to incorporate progressive overload while also accounting for the physiological changes of pregnancy. The below workout is also designed to not include much/if any resistance training equipment (ie, can be done anywhere, any time). For more details on each movement and how to do them, as well as a program that includes all of pregnancy, please visit <https://bumptupapp.com>. An example of the details provided on the app can be found here: <https://info.bumtup.org/2023/06/01/scissor-hops/>.

While more women engage in strength training now than ever before, and research supports the many benefits of this mode of training, more robust research is clearly needed aiming at the effects of strength training on maternal and fetal health. The dose-response relationships of strength training volumes and outcomes are unclear and warrant further study (ie what amount is needed to solicit specific benefits?). Further, studies should carefully explore the benefits of strength training on specific outcomes of interest with high-quality objective assessment techniques in the form of clinical trials to determine cause and effect. As an example, there is very limited research on the impact of resistance training on blood pressure and/or preeclampsia during pregnancy. Because it is clear that in non-gravid populations, resistance training supports improvements in arterial blood pressure,<sup>69</sup> stronger evidence to show a similar effect during pregnancy is

**Table 2** Example Week of Workouts for Pregnant Women

Day 1			Day 2			Day 3		
Movement	Sets	Reps	Movement	Sets	Reps	Movement	Sets	Reps
Wall Sit	2	30 s	Split Squat	3	8	Stair Step Ups	3	10 e
Glute Bridge	2	15	Tall Plank Scap Pushup	2	10	Seated Strict Press	3	8
Scissor Hops	2	20 e	Tricep Dip	2	15	Sumo Squat to Chair/ Box	3	8
Beginner Pushup	3	5	Supported SL RDL	2	10 e	Good morning	3	8
Bear Crawl Isometric Hold	3	25 s	Lateral Monster Walks	3	10	Milk Jug Row (all fours)	3	10 e
Calf Raise	3	20 s	Seated Upper Back Squeeze	3	12	Hip Flexor March	3	25 s
Prone Straight Leg Toe Touches	3	20 s	Penguin Heel Taps	3	10 e	Side Lying Hip Abduction	3	10 e
Paused Incline Mtn Climbers	3	20 s	Jog/ Walk Intervals	5	20 s	Bear Crawl Lateral Steps	3	10 e

**Abbreviations:** s, seconds; e, each side.



needed.<sup>70</sup> In addition, not all strength training is created equal. For example, CrossFit™ contains more cardiovascular involvement (complete a number of exercises as fast as possible) than traditional weightlifting (full recovery between sets), and different types of strength training should be studied individually in order to determine which yields the most benefit for pregnant women. All of these data collectively should be focused on developing specific recommendations for resistance training prescriptions for pregnant women.

## Conclusion

In conclusion, resistance training is a safe, beneficial, and effective form of exercise for pregnant women to increase their physical fitness and improve pregnancy outcomes, and these effects may be further increased when resistance training is combined with aerobic exercise.<sup>26,52,54</sup> Resistance training, alone or together with aerobic exercise, can improve maternal symptoms of pregnancy, mediate the effects of gestational diabetes and obesity on maternal and fetal health, and improve labor and delivery outcomes for both mother and fetus. Resistance training during pregnancy can also improve fetal development and infant health from childhood well into adulthood. When performed safely, resistance training does not increase the risk of injury or harm to either the mother or the fetus. Research indicates that moderate-intensity resistance exercises up to 80% of maternal maximal heart rate are safe during pregnancy,<sup>4,13,14,26,31–33,47</sup> but frequency should be based on functional status pre-pregnancy and the goals of an exercise program. All women who are not contraindicated to exercise should be encouraged to participate in regular resistance training throughout their pregnancy.

## Disclosure

Dr. Tinius holds equity in BumpUp Labs Inc, which holds the exclusive rights to the mobile app, BumpUp®. The authors have no other conflicts of interest to disclose for this work.

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