

Role of antenatal physiotherapy in high-risk pregnancy: A comprehensive review

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Abstract:

High-risk pregnancy represents a significant challenge in maternal healthcare due to its association with increased maternal and fetal morbidity and mortality. Conditions such as gestational diabetes mellitus, hypertensive disorders of pregnancy, obesity, multiple gestation, advanced maternal age, and previous obstetric complications necessitate specialized antenatal management. In recent years, antenatal physiotherapy has emerged as a crucial non-pharmacological intervention that contributes to improved maternal health, optimized fetal outcomes, and enhanced quality of life during pregnancy. Physiotherapy interventions including aerobic exercise, resistance training, pelvic floor muscle training, breathing exercises, postural correction, relaxation techniques, and hydrotherapy have demonstrated substantial benefits in managing pregnancy-related complications. Contemporary evidence indicates that appropriately prescribed physical activity may reduce the risk of gestational diabetes, excessive gestational weight gain, cesarean delivery, musculoskeletal pain, and psychological distress while promoting cardiovascular fitness and functional independence. This comprehensive review examines the role of antenatal physiotherapy in high-risk pregnancies, discusses physiological adaptations during pregnancy, outlines assessment and intervention strategies, evaluates maternal and fetal outcomes, and highlights emerging technological advances in antenatal rehabilitation. The review emphasizes evidence-based physiotherapy approaches and their integration into multidisciplinary obstetric care to improve pregnancy outcomes and maternal well-being.

Keywords:

High-Risk Pregnancy, Antenatal Physiotherapy, Exercise Therapy, Gestational Diabetes Mellitus, Preeclampsia, Maternal Health, Prenatal Rehabilitation, Pelvic Floor Training.

1. Introduction:

Pregnancy is a unique physiological condition characterized by extensive adaptations in nearly every body system to support fetal growth and development. During pregnancy, significant anatomical, hormonal, biomechanical, cardiovascular, respiratory, metabolic, and psychological changes occur that enable successful maternal-fetal functioning and preparation for childbirth (ACOG, 2020). Although pregnancy is generally considered a normal biological process, a substantial proportion of pregnancies are categorized as high-risk because of pre-existing maternal diseases, pregnancy-related complications, adverse obstetric history, or fetal abnormalities that increase the likelihood of maternal and neonatal morbidity and mortality (Mottola et al., 2018). Globally, approximately 15–20% of pregnancies are considered high-risk and contribute significantly to healthcare burden, maternal hospitalization, preterm birth, and perinatal complications (Davenport et al., 2019). Common high-risk conditions include gestational diabetes mellitus, pregnancy-induced hypertension, preeclampsia, obesity, cardiovascular disorders, thyroid dysfunction, multiple gestation, advanced maternal age, and recurrent pregnancy loss (Nascimento et al., 2017). Traditionally, women experiencing high-risk

pregnancies were often advised to restrict physical activity and prioritize bed rest because of concerns regarding fetal safety and pregnancy complications. However, growing scientific evidence has demonstrated that prolonged inactivity may contribute to muscle weakness, excessive gestational weight gain, poor cardiovascular fitness, insulin resistance, thromboembolic events, psychological distress, and reduced functional capacity (Di Mascio et al., 2016). Consequently, modern obstetric care has shifted toward encouraging safe and supervised physical activity as part of comprehensive prenatal management (Meah et al., 2020). Contemporary clinical guidelines from international organizations recognize exercise and physiotherapy as important non-pharmacological interventions capable of improving maternal health and reducing the risk of adverse pregnancy outcomes when appropriately prescribed and monitored (Dipietro et al., 2019). Antenatal physiotherapy has evolved substantially over recent decades and now represents an essential component of multidisciplinary prenatal care aimed at optimizing maternal and fetal well-being throughout pregnancy (Santos-Rocha, 2022). Physiotherapists play a critical role in assessing physical function, identifying movement limitations, prescribing individualized exercise programs, managing musculoskeletal pain, enhancing cardiopulmonary fitness, and educating women regarding safe physical activity during pregnancy (Barakat et al., 2021). Figure 1 illustrates the overall framework of antenatal physiotherapy in high-risk pregnancy, demonstrating the relationship between maternal risk factors, physiotherapeutic interventions, and improved pregnancy outcomes.

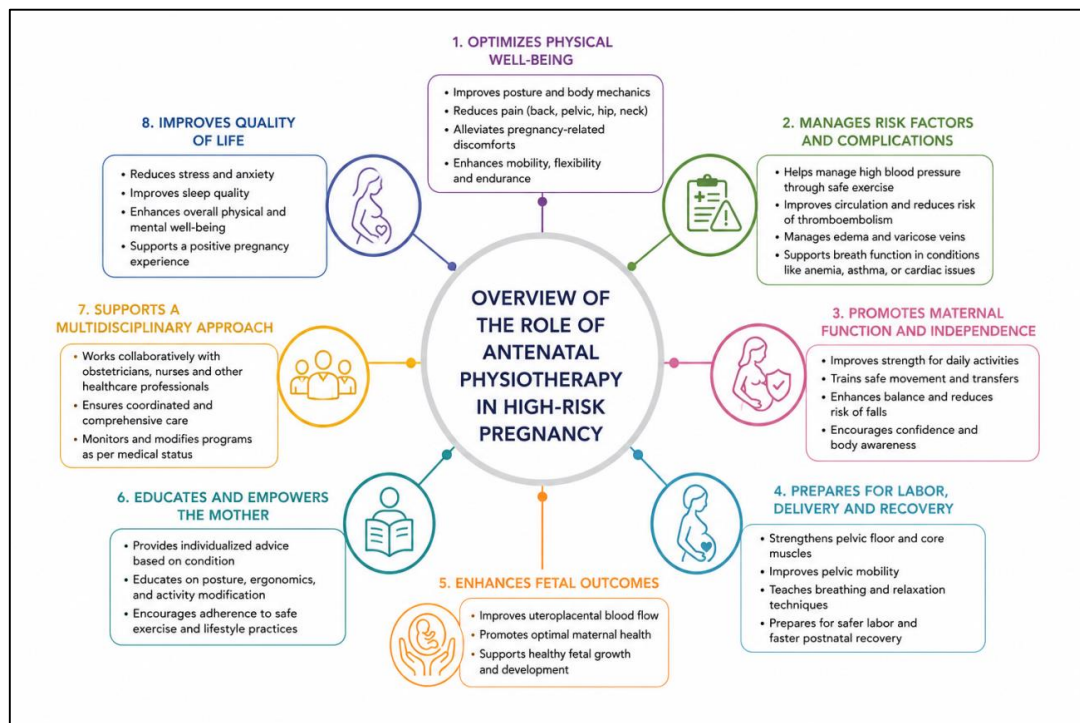


Figure 1: Overview of the Role of Antenatal Physiotherapy in High-Risk Pregnancy

Physiotherapy interventions encompass a broad range of evidence-based strategies including aerobic exercise, resistance training, flexibility exercises, pelvic floor muscle training, postural correction, breathing exercises, relaxation techniques, hydrotherapy, and functional movement training designed to address the unique physiological demands of pregnancy (Bø & Herbert, 2019). These interventions not only improve physical fitness but also contribute to better metabolic regulation, cardiovascular function, musculoskeletal health, and psychological well-being (Perales et al., 2020). Emerging research indicates that structured antenatal exercise may significantly reduce the incidence of gestational diabetes mellitus by enhancing insulin sensitivity and improving glucose metabolism throughout pregnancy (Ruchat et al., 2018). Similarly, regular physical activity has been associated with lower rates of excessive gestational weight gain, a major risk factor for maternal obesity, cesarean section, and adverse neonatal outcomes (Perales et al., 2016). In women with hypertensive disorders of pregnancy, carefully supervised exercise programs may improve vascular function, endothelial health, and blood pressure regulation, thereby contributing to better maternal outcomes (Davenport et al., 2018). Furthermore, physiotherapy interventions are effective in reducing common pregnancy-related musculoskeletal complaints such as low back pain, pelvic girdle pain, neck discomfort, and postural instability that can significantly impair quality of life and functional independence (Evensen et al., 2017). Pelvic floor muscle training has also emerged as a key component of antenatal physiotherapy because of its demonstrated

effectiveness in preventing urinary incontinence, improving pelvic support, facilitating labor, and promoting postpartum recovery (Bø et al., 2017). Beyond physical benefits, antenatal physiotherapy positively influences mental health by reducing anxiety, stress, depression, and fear associated with pregnancy and childbirth (Harrison et al., 2018). Exercise-induced improvements in psychological well-being are particularly important in high-risk pregnancies, where uncertainty regarding maternal and fetal outcomes often contributes to emotional distress and reduced quality of life (Coll et al., 2017). Figure 2 highlights the multidimensional benefits of antenatal physiotherapy, emphasizing its positive effects on maternal fitness, fetal health, cardiovascular function, metabolic regulation, musculoskeletal integrity, and psychological resilience. Recent technological advances, including tele-rehabilitation, wearable monitoring devices, smartphone-based exercise applications, and remote physiotherapy consultations, have further expanded opportunities for delivering individualized antenatal care, particularly in women with mobility limitations or restricted access to healthcare services (Fazzi et al., 2021). These innovations are increasingly relevant in modern obstetric practice and may improve adherence to exercise programs while facilitating continuous monitoring of maternal health indicators (Skow et al., 2022). Given the growing body of evidence supporting physiotherapy interventions during pregnancy, there is a need for comprehensive evaluation of their role in managing high-risk pregnancies and improving maternal-fetal outcomes. Therefore, this review aims to critically examine the physiological basis, clinical applications, therapeutic interventions, safety considerations, and emerging developments related to antenatal physiotherapy in high-risk pregnancy, while highlighting its importance as an integral component of evidence-based prenatal healthcare (Reed et al., 2022).

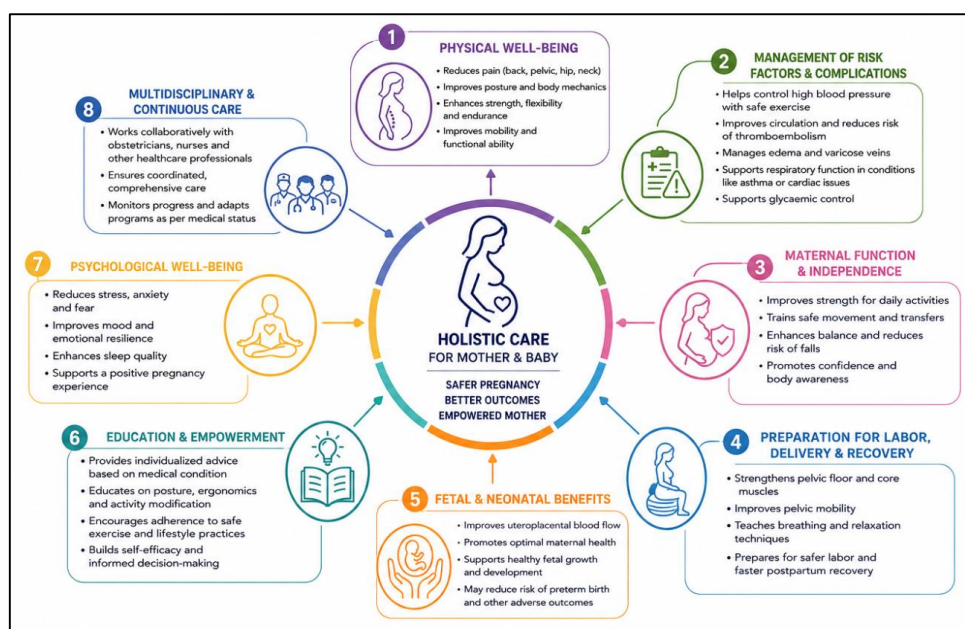


Figure 2: Multidimensional Benefits of Antenatal Physiotherapy in High-Risk Pregnancy

2. Physiological changes during pregnancy:

Pregnancy is accompanied by a series of complex physiological adaptations that enable the maternal body to support fetal growth, maintain placental function, and prepare for labor and delivery. These changes affect nearly every organ system and significantly influence exercise tolerance, physical performance, and physiotherapy management throughout gestation (Meah et al., 2020). Understanding these physiological alterations is essential for physiotherapists because exercise prescription during pregnancy must account for maternal cardiovascular, respiratory, musculoskeletal, endocrine, and metabolic adaptations to ensure both maternal and fetal safety (Mottola et al., 2018). The magnitude of these changes increases progressively across trimesters and may be further exaggerated in women with high-risk pregnancies, necessitating individualized assessment and intervention planning (Dipietro et al., 2019). Physiological adaptations are generally beneficial and represent normal responses to pregnancy. However, they can contribute to symptoms such as fatigue, dyspnea, postural instability, musculoskeletal pain, and reduced exercise capacity, which may affect daily functioning and quality of life (Santos-Rocha, 2022). Consequently, antenatal physiotherapy programs should be designed with a comprehensive understanding of pregnancy-related physiological changes to maximize therapeutic benefits while minimizing potential risks (Barakat et al., 2021).

3. Cardiovascular adaptations:

The cardiovascular system undergoes substantial modifications during pregnancy to accommodate the increased metabolic demands of the mother and developing fetus. Maternal blood volume begins to rise early in pregnancy and typically increases by approximately 40–50% above pre-pregnancy levels by the third trimester (Skow et al., 2022). Plasma volume expansion exceeds the increase in red blood cell mass, resulting in physiological hemodilution commonly referred to as the “physiological anemia of pregnancy” (Reed et al., 2022). Simultaneously, heart rate increases by approximately 10–20 beats per minute, while stroke volume and cardiac output increase significantly, reaching levels 30–50% higher than those observed before pregnancy (Meah et al., 2020). These adaptations ensure adequate uteroplacental perfusion and facilitate oxygen and nutrient delivery to the fetus (Davenport et al., 2019). Systemic vascular resistance decreases due to hormonal influences, particularly progesterone and relaxin, leading to reduced blood pressure during early and mid-pregnancy before returning toward baseline near term (Szymanski & Satin, 2018). Although these cardiovascular adaptations are generally well tolerated, women with gestational hypertension, preeclampsia, congenital heart disease, or other cardiovascular disorders require careful monitoring during exercise to prevent adverse maternal and fetal outcomes (Davenport et al., 2018). Physiotherapists must therefore consider cardiovascular status, exercise intensity, and maternal symptoms when developing exercise programs for high-risk pregnant women (Gibbs et al., 2019).

4. Respiratory adaptations:

Pregnancy also induces significant respiratory changes aimed at meeting the increased oxygen demands of maternal tissues and the developing fetus. Oxygen consumption increases progressively throughout pregnancy and may rise by approximately 20–30% by term due to enhanced metabolic activity (Dipietro et al., 2019). Hormonal influences, particularly progesterone, stimulate the respiratory center and increase ventilatory drive, resulting in greater tidal volume and minute ventilation (Skow et al., 2022). Although respiratory rate remains relatively unchanged, the depth of breathing increases significantly, contributing to a state of physiological hyperventilation (Meah et al., 2020). As the uterus enlarges, the diaphragm is elevated by approximately 4 cm, altering thoracic mechanics and reducing functional residual capacity and expiratory reserve volume (Santos-Rocha, 2022). Despite these anatomical changes, total lung capacity remains relatively stable because of compensatory widening of the rib cage (Reed et al., 2022). Many pregnant women experience sensations of breathlessness or dyspnea, particularly during the second and third trimesters, even in the absence of respiratory pathology (Harrison et al., 2018). Physiotherapists should recognize these normal adaptations and incorporate breathing exercises, postural correction, and graded aerobic conditioning into antenatal rehabilitation programs to optimize respiratory efficiency and exercise tolerance (Barakat et al., 2021).

5. Musculoskeletal adaptations:

The musculoskeletal system experiences profound changes during pregnancy as a result of hormonal influences, weight gain, and biomechanical alterations associated with fetal growth. Increased secretion of relaxin, progesterone, and estrogen contributes to ligamentous laxity and enhanced joint mobility, particularly in the pelvic region, to facilitate childbirth (Bø et al., 2017). While these hormonal adaptations are physiologically advantageous, they may also reduce joint stability and increase susceptibility to musculoskeletal discomfort and injury (Evensen et al., 2017). Progressive uterine enlargement shifts the center of gravity anteriorly, leading to compensatory postural changes including increased lumbar lordosis, anterior pelvic tilt, thoracic kyphosis, and forward head posture (Harrison et al., 2021). These alterations increase mechanical stress on the spine, pelvis, and lower extremities, contributing to low back pain and pelvic girdle pain, which affect a substantial proportion of pregnant women (Evensen et al., 2017). Additionally, maternal weight gain increases loading on weight-bearing joints and may impair balance and gait stability (Perales et al., 2020). These biomechanical changes are particularly significant in women with obesity, multiple gestations, or previous musculoskeletal disorders (Nascimento et al., 2017). Physiotherapy interventions focusing on postural education, core stabilization, flexibility exercises, pelvic floor strengthening, and functional movement training can effectively address these challenges and improve physical functioning throughout pregnancy (Bø & Herbert, 2019). The figure 3 summarizes cardiovascular, respiratory, endocrine, and musculoskeletal changes relevant to physiotherapy planning.

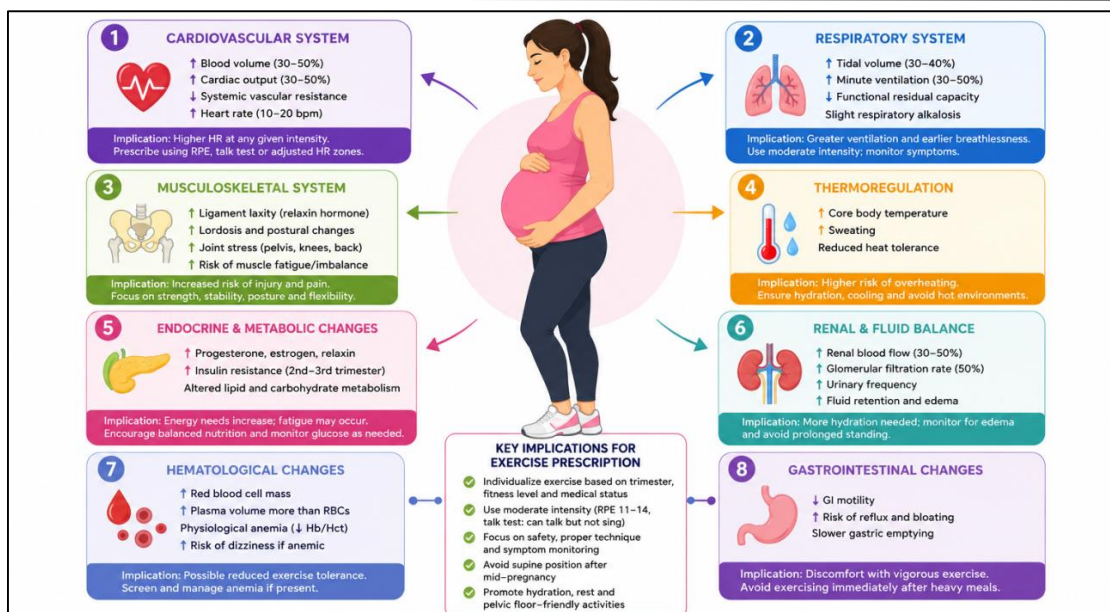


Figure. 3: Physiological adaptations during pregnancy affecting exercise prescription

6. Metabolic and endocrine adaptations:

Pregnancy is characterized by substantial endocrine and metabolic changes that support fetal development while ensuring adequate maternal energy availability. Hormones produced by the placenta, including human placental lactogen, progesterone, cortisol, and growth hormone, contribute to progressive insulin resistance, particularly during the second and third trimesters (Ruchat et al., 2018). This physiological insulin resistance facilitates increased glucose availability for fetal growth but may predispose susceptible women to gestational diabetes mellitus (Davenport et al., 2019). Maternal metabolism also shifts toward greater utilization of lipids as an energy source, preserving glucose for fetal needs (Coll et al., 2017). Basal metabolic rate increases significantly during pregnancy, contributing to elevated energy expenditure and nutritional requirements (Mottola et al., 2018). Furthermore, changes in calcium metabolism, fluid balance, and thermoregulation influence exercise responses and should be considered during physiotherapy planning (Szymanski & Satin, 2018). Women with obesity, polycystic ovary syndrome, family history of diabetes, or previous gestational diabetes are particularly vulnerable to metabolic complications and may benefit substantially from individualized physiotherapy interventions emphasizing aerobic exercise and resistance training (Fazzi et al., 2021). Evidence suggests that appropriately prescribed physical activity can improve insulin sensitivity, regulate gestational weight gain, enhance metabolic health, and reduce the risk of adverse maternal and neonatal outcomes associated with metabolic dysfunction (Fazzi et al., 2021). Collectively, these physiological adaptations underscore the importance of comprehensive antenatal assessment and individualized physiotherapy management to promote maternal health, optimize fetal development, and ensure safe participation in physical activity throughout pregnancy (Barakat et al., 2021).

7. Classification of high-risk pregnancy:

High-risk pregnancy refers to a pregnancy in which maternal, fetal, obstetric, demographic, or lifestyle-related factors increase the probability of adverse outcomes for either the mother, the fetus, or both, thereby necessitating specialized monitoring and multidisciplinary management throughout the antenatal period (American College of Obstetricians and Gynecologists [ACOG], 2021). Maternal medical disorders constitute one of the most common categories of high-risk pregnancy and include conditions such as gestational diabetes mellitus, chronic hypertension, thyroid dysfunction, cardiovascular disease, renal disease, autoimmune disorders, and epilepsy, all of which may negatively affect maternal health and fetal development if not adequately controlled (Davenport et al., 2019). Women with pre-existing diabetes or gestational diabetes are at increased risk of fetal macrosomia, cesarean delivery, preeclampsia, and neonatal metabolic complications, making close medical supervision and lifestyle modification essential components of care (Fazzi et al., 2021). Similarly, hypertensive disorders of pregnancy, including gestational hypertension and preeclampsia, remain leading causes of maternal and perinatal morbidity worldwide and often require individualized antenatal management strategies (Brown et al., 2018). Obstetric complications represent another major category of high-risk pregnancy and include conditions such as placenta previa, placental abruption, recurrent miscarriage, cervical insufficiency, preterm labor, and previous cesarean delivery, which can significantly increase the

likelihood of maternal hemorrhage, fetal compromise, and adverse birth outcomes (Jauniaux et al., 2019). Women with a history of recurrent pregnancy loss or previous obstetric complications frequently require enhanced surveillance and supportive interventions to improve pregnancy outcomes (ESHRE Guideline Group, 2018). Fetal conditions also contribute substantially to pregnancy risk and may include fetal growth restriction, congenital anomalies, chromosomal abnormalities, oligohydramnios, polyhydramnios, and multiple gestations, all of which may necessitate specialized prenatal assessment and intervention to optimize neonatal health (Figueras & Gratacós, 2021). Demographic factors are increasingly recognized as important determinants of pregnancy risk, particularly advanced maternal age, generally defined as pregnancy occurring at or above 35 years of age, which has been associated with increased rates of gestational diabetes, hypertension, chromosomal abnormalities, cesarean section, and stillbirth (Pinheiro et al., 2019). Conversely, adolescent pregnancy is also considered high risk because of its association with preterm birth, low birth weight, nutritional deficiencies, and socioeconomic challenges that may negatively affect maternal and infant outcomes (Mayor, 2017). Lifestyle-related factors such as obesity, smoking, alcohol consumption, substance abuse, poor nutrition, and physical inactivity further contribute to pregnancy-related complications by increasing the risk of metabolic disorders, hypertensive conditions, fetal growth abnormalities, and adverse neonatal outcomes (Harrison et al., 2021). Maternal obesity in particular has emerged as a major global health concern and is strongly associated with gestational diabetes, preeclampsia, cesarean delivery, and long-term health consequences for both mother and child (Fell et al., 2019). Table 1 Summarizes the Major Categories of High-Risk Pregnancy. Collectively, these categories highlight the multifactorial nature of high-risk pregnancy and emphasize the importance of early identification, comprehensive assessment, and evidence-based interventions to improve maternal and fetal outcomes (Mottola et al., 2018).

Table 1: Major Categories of High-Risk Pregnancy

Category	Examples
Maternal Medical Disorders	Diabetes, hypertension, thyroid disorders
Obstetric Complications	Placenta previa, recurrent miscarriage
Fetal Conditions	Growth restriction, congenital anomalies
Demographic Factors	Advanced maternal age, adolescent pregnancy
Lifestyle Factors	Obesity, smoking, physical inactivity

8. Assessment in antenatal physiotherapy:

A comprehensive assessment is the cornerstone of safe and effective antenatal physiotherapy, particularly in women with high-risk pregnancies, as it enables physiotherapists to identify risk factors, determine exercise suitability, establish baseline functional status, and develop individualized intervention programs that optimize maternal and fetal outcomes (ACOG, 2020). Before initiating any physiotherapy intervention, a detailed medical and obstetric history should be obtained, including information regarding pre-existing medical conditions, current pregnancy complications, medication use, gestational age, and previous antenatal management, as these factors directly influence exercise safety and rehabilitation planning (Mottola et al., 2018). Assessment of previous pregnancy outcomes is equally important because a history of recurrent miscarriage, preterm birth, cesarean delivery, fetal growth restriction, or hypertensive disorders may indicate increased susceptibility to complications during the current pregnancy and necessitate specialized monitoring (Jauniaux et al., 2019). Evaluation of exercise history and physical activity patterns provides valuable insight into maternal fitness levels, exercise tolerance, and potential barriers to participation, allowing physiotherapists to prescribe appropriately tailored exercise programs that promote adherence and safety (Dipietro et al., 2019). Cardiovascular screening is an essential component of assessment because pregnancy-related cardiovascular adaptations may be exaggerated in women with hypertension, cardiac disease, obesity, or diabetes, requiring careful monitoring of heart rate, blood pressure, exercise response, and signs of cardiovascular compromise (Meah et al., 2020). Musculoskeletal evaluation should include assessment of posture, spinal alignment, joint mobility, muscle strength, flexibility, balance, gait characteristics, and pregnancy-related discomforts such as low back pain and pelvic girdle pain, which frequently affect physical function and quality of life during pregnancy (Evensen et al., 2017). Functional mobility assessment further helps determine the woman's ability to perform activities of daily living, maintain independence, and safely participate in exercise programs by evaluating movement efficiency, endurance, and physical capacity (Barakat et al., 2021). Pain assessment using validated scales and clinical examination techniques is important for identifying musculoskeletal dysfunctions that may limit participation in physical activity or contribute to functional disability (Harrison et al., 2021). Pelvic floor evaluation is another critical component because pregnancy-related hormonal and biomechanical changes can weaken pelvic floor musculature and increase the risk of urinary incontinence,

pelvic organ prolapse, and labor-related complications, making early identification and intervention beneficial (Bø & Herbert, 2019). Additionally, psychological screening should be incorporated into routine assessment because anxiety, stress, depression, and fear of childbirth are common among women with high-risk pregnancies and can adversely affect maternal well-being, treatment adherence, and pregnancy outcomes (Coll et al., 2017). Physiotherapists must also carefully identify absolute and relative contraindications to exercise, including severe preeclampsia, uncontrolled hypertension, significant cardiovascular disease, placenta previa after 26 weeks of gestation, active vaginal bleeding, ruptured membranes, cervical insufficiency, severe fetal growth restriction, and preterm labor, all of which may necessitate modification or avoidance of physical activity until medical clearance is obtained (Davenport et al., 2019). Through systematic evaluation and clinical reasoning, physiotherapists can make informed decisions regarding exercise prescription, intensity progression, monitoring requirements, and safety precautions to ensure optimal maternal and fetal outcomes throughout pregnancy (Gibbs et al., 2019). Figure 4 Antenatal Physiotherapy Assessment Algorithm for High-Risk Pregnancy illustrates a structured assessment pathway beginning with medical and obstetric screening, followed by cardiovascular, musculoskeletal, functional, pelvic floor, and psychological evaluation, ultimately guiding individualized exercise prescription and clinical decision-making in women with high-risk pregnancies (Santos-Rocha, 2022).

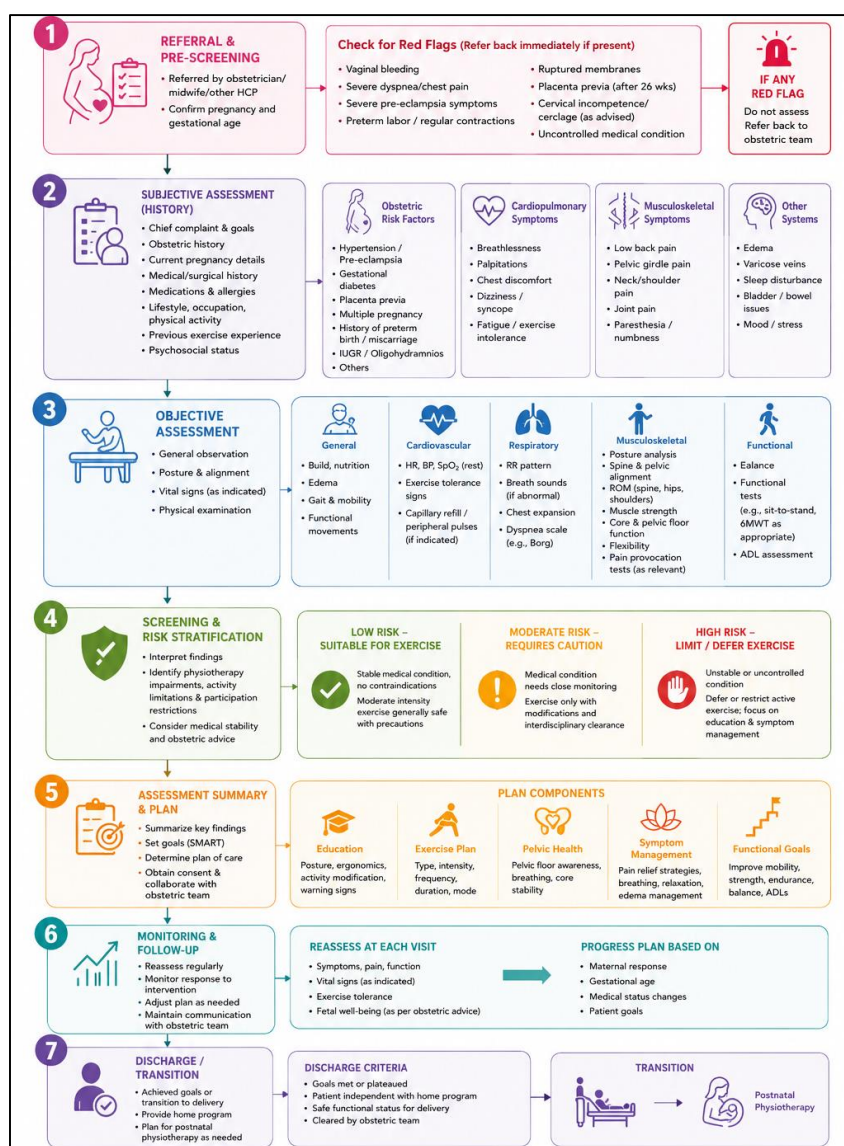


Figure 4: Antenatal Physiotherapy Assessment Algorithm for High-Risk Pregnancy

9. Exercise prescription principles:

Exercise prescription during pregnancy should be individualized and evidence-based, ensuring maternal and fetal safety while maximizing the physical and psychological benefits associated with regular physical activity (Mottola et al., 2018). The most widely accepted framework for designing antenatal exercise programs is the FITT principle, which encompasses Frequency, Intensity, Time, and Type of exercise, allowing

physiotherapists to systematically tailor interventions according to the woman's medical condition, gestational age, fitness level, and pregnancy-related risk factors (ACOG, 2020). Current international guidelines recommend that medically stable pregnant women engage in at least 150 minutes of moderate-intensity physical activity per week, distributed across several days, to achieve optimal health outcomes and reduce the risk of pregnancy-related complications (Dipietro et al., 2019). Frequency refers to the number of exercise sessions performed each week, with most recommendations suggesting participation on three to five days per week to ensure consistency while allowing adequate recovery and adaptation (Meah et al., 2020). Exercise intensity should generally remain within the moderate range and may be monitored using subjective measures such as the Rating of Perceived Exertion (RPE) scale or the talk test, both of which provide practical methods for maintaining safe exertion levels during pregnancy (Davenport et al., 2019). Moderate-intensity exercise is typically characterized by the ability to carry on a conversation while exercising without excessive breathlessness, thereby minimizing cardiovascular stress and maintaining adequate uteroplacental blood flow (Szymanski & Satin, 2018). The duration or time component of exercise prescription usually ranges from 20 to 45 minutes per session depending on maternal fitness, gestational stage, and clinical condition, with gradual progression being preferred over abrupt increases in workload (Barakat et al., 2021). Type of exercise encompasses the specific mode of physical activity selected and should ideally include a combination of aerobic, strengthening, flexibility, and pelvic floor exercises to address the multidimensional needs of pregnant women (Santos-Rocha, 2022). Aerobic activities such as walking, stationary cycling, swimming, and low-impact aerobics improve cardiovascular fitness, metabolic regulation, and weight management, whereas resistance training enhances muscular strength, postural stability, and functional capacity (Perales et al., 2020). Flexibility exercises help maintain joint mobility and reduce musculoskeletal discomfort, while pelvic floor muscle training contributes to continence, pelvic support, and labor preparation (Bø & Herbert, 2019). Monitoring during exercise is an essential aspect of prescription, particularly in high-risk pregnancies, and should include assessment of symptoms such as dizziness, excessive fatigue, vaginal bleeding, uterine contractions, chest pain, shortness of breath, or reduced fetal movement, which may indicate the need for immediate medical evaluation (Gibbs et al., 2019). Women with gestational diabetes, obesity, hypertension, or other pregnancy complications often benefit from closely supervised exercise programs that incorporate regular monitoring of maternal responses and individualized progression strategies (Fazzi et al., 2021). Table 2 Exercise Prescription Guidelines in High-Risk Pregnancy summarizes recommended exercise parameters, including a frequency of three to five sessions per week, moderate exercise intensity, session durations of approximately 20–45 minutes, a combination of aerobic, strengthening, and flexibility exercises, and monitoring through perceived exertion, symptom evaluation, and the talk test to ensure safe and effective participation throughout pregnancy (Harrison et al., 2021).

Table. 2: Exercise Prescription Guidelines in High-Risk Pregnancy

Parameter	Recommendation
Frequency	3–5 days/week
Intensity	Moderate
Duration	20–45 minutes
Mode	Aerobic + Strength + Flexibility
Monitoring	RPE, talk test, symptoms

10. Aerobic exercise:

Aerobic exercise remains one of the most important and widely recommended components of antenatal physiotherapy because of its significant benefits for maternal cardiovascular fitness, metabolic regulation, and overall pregnancy health (Mottola et al., 2018). Common aerobic activities such as walking, stationary cycling, swimming, water-based exercise, and low-impact aerobics are considered safe for most pregnant women and can be easily adapted according to gestational age and individual fitness levels (ACOG, 2020). Regular participation in moderate-intensity aerobic exercise enhances cardiovascular efficiency by improving cardiac output, circulation, and oxygen delivery to maternal and fetal tissues while helping maintain functional capacity throughout pregnancy (Meah et al., 2020). Furthermore, aerobic exercise has been shown to improve glucose utilization and insulin sensitivity, thereby reducing the risk of gestational diabetes mellitus and improving metabolic control in women already diagnosed with the condition (Davenport et al., 2019). Evidence from recent studies suggests that physically active pregnant women experience lower rates of excessive gestational weight gain and associated complications compared with sedentary women (Perales et

al., 2020). Aerobic training also contributes to improved lipid metabolism, reduced systemic inflammation, and better endothelial function, all of which are beneficial in preventing pregnancy-related cardiometabolic disorders (Dipietro et al., 2019). For women with obesity, gestational diabetes, or other metabolic risk factors, supervised aerobic exercise programs play a crucial role in maintaining glycemic control, supporting healthy weight management, and reducing the likelihood of adverse maternal and neonatal outcomes (Fazzi et al., 2021).

11. Resistance training:

Resistance training is an important component of antenatal physiotherapy and has gained increasing recognition for its role in improving muscular strength, endurance, postural stability, and functional independence during pregnancy (ACOG, 2020). As pregnancy progresses, physiological and biomechanical changes such as increased body weight, altered center of gravity, ligamentous laxity, and postural adaptations place additional stress on the musculoskeletal system, often leading to discomfort, fatigue, and reduced physical function (Harrison et al., 2021). Structured resistance training programs help counteract these changes by maintaining muscle mass, enhancing neuromuscular control, and improving overall physical performance throughout pregnancy (Mottola et al., 2018). Safe resistance exercises commonly prescribed during pregnancy include elastic band exercises, bodyweight exercises, light free-weight training, machine-assisted strengthening, and functional strengthening activities that mimic daily movements and promote physical independence (Santos-Rocha, 2022). These exercises can be modified according to gestational age, fitness level, and the presence of pregnancy-related complications to ensure maternal and fetal safety (Meah et al., 2020). Strengthening of the core musculature, including the abdominal stabilizers and spinal support muscles, contributes to improved trunk stability and reduced mechanical stress on the lumbar spine, thereby decreasing the prevalence and severity of pregnancy-related low back pain (Evensen et al., 2017). Similarly, strengthening exercises targeting the hip and pelvic musculature improve pelvic stability, gait mechanics, and functional mobility while reducing the incidence of pelvic girdle pain and postural dysfunction (Bø & Herbert, 2019). Lower-limb resistance training enhances muscular endurance, balance, and circulation, which may help reduce fatigue and improve tolerance to daily activities during pregnancy (Barakat et al., 2021). Evidence also suggests that resistance training may contribute to improved glucose metabolism and insulin sensitivity, making it particularly beneficial for women with gestational diabetes mellitus or obesity (Fazzi et al., 2021). Furthermore, improved muscular strength and endurance achieved through resistance exercise may facilitate labor performance by enhancing physical resilience and the ability to tolerate the physiological demands of childbirth (Perales et al., 2020). Despite these benefits, exercise prescription must be carefully individualized in women with high-risk pregnancies, and certain precautions should always be observed (Gibbs et al., 2019). Heavy lifting, maximal resistance training, prolonged isometric contractions, Valsalva maneuvers, and exercises that generate excessive intra-abdominal pressure should be avoided because they may compromise cardiovascular responses, increase pelvic floor strain, and negatively affect maternal comfort (Szymanski & Satin, 2018). Continuous monitoring of symptoms, exercise intensity, and maternal response is essential to ensure safe participation and optimize therapeutic outcomes throughout pregnancy (Davenport et al., 2019).

12. Pelvic floor muscle training:

Pelvic floor dysfunction is a common concern during pregnancy due to the combined effects of hormonal influences, increased intra-abdominal pressure, progressive uterine enlargement, and the mechanical loading imposed on the pelvic structures throughout gestation (Bø et al., 2017). The pelvic floor muscles play a critical role in supporting the pelvic organs, maintaining urinary and fecal continence, contributing to lumbopelvic stability, and facilitating the processes of pregnancy and childbirth (Bø & Herbert, 2019). During pregnancy, elevated levels of hormones such as relaxin and progesterone increase connective tissue laxity and alter the mechanical properties of the pelvic floor, making these muscles more susceptible to weakness and dysfunction (Sangsawang & Sangsawang, 2016). As fetal growth progresses, the additional weight borne by the pelvic floor further increases the risk of urinary incontinence, pelvic girdle pain, pelvic organ prolapse, and impaired pelvic stability (Mørkved & Bø, 2018). Pelvic floor muscle training (PFMT) is widely recognized as an effective and evidence-based physiotherapy intervention for preventing and managing these complications during pregnancy (Woodley et al., 2020). PFMT involves repeated voluntary contractions and relaxations of the pelvic floor muscles with the objective of improving muscle strength, endurance, coordination, and neuromuscular control (Dumoulin et al., 2018). Regular participation in PFMT has been shown to significantly reduce the incidence and severity of urinary incontinence by enhancing urethral support and improving the functional capacity of the pelvic floor musculature (Bø et al., 2017). In addition to continence benefits, strengthening the pelvic floor contributes to improved pelvic stability and lumbopelvic alignment, thereby

supporting functional mobility and reducing pregnancy-related musculoskeletal discomfort (Harrison et al., 2021). Pelvic floor exercises also play an important role in labor preparation by increasing maternal awareness and control of the pelvic musculature, which may facilitate effective relaxation and coordinated muscle function during childbirth (Mottola et al., 2018). Furthermore, women who engage in antenatal PFMT often experience enhanced postpartum recovery, including earlier restoration of pelvic floor function and reduced risk of long-term pelvic floor disorders (Woodley et al., 2020). Figure 5 Pelvic Floor Muscle Training Protocol During Pregnancy illustrates progressive PFMT techniques recommended throughout the different stages of pregnancy, including slow sustained contractions, quick contractions, endurance training, and functional pelvic floor activation integrated with breathing and postural exercises (Santos-Rocha, 2022). Current evidence supports the inclusion of PFMT as a routine component of antenatal physiotherapy programs because consistent practice significantly improves pelvic floor strength, enhances quality of life, and reduces the prevalence of pregnancy-associated urinary incontinence and related pelvic floor dysfunctions (Dumoulin et al., 2018).

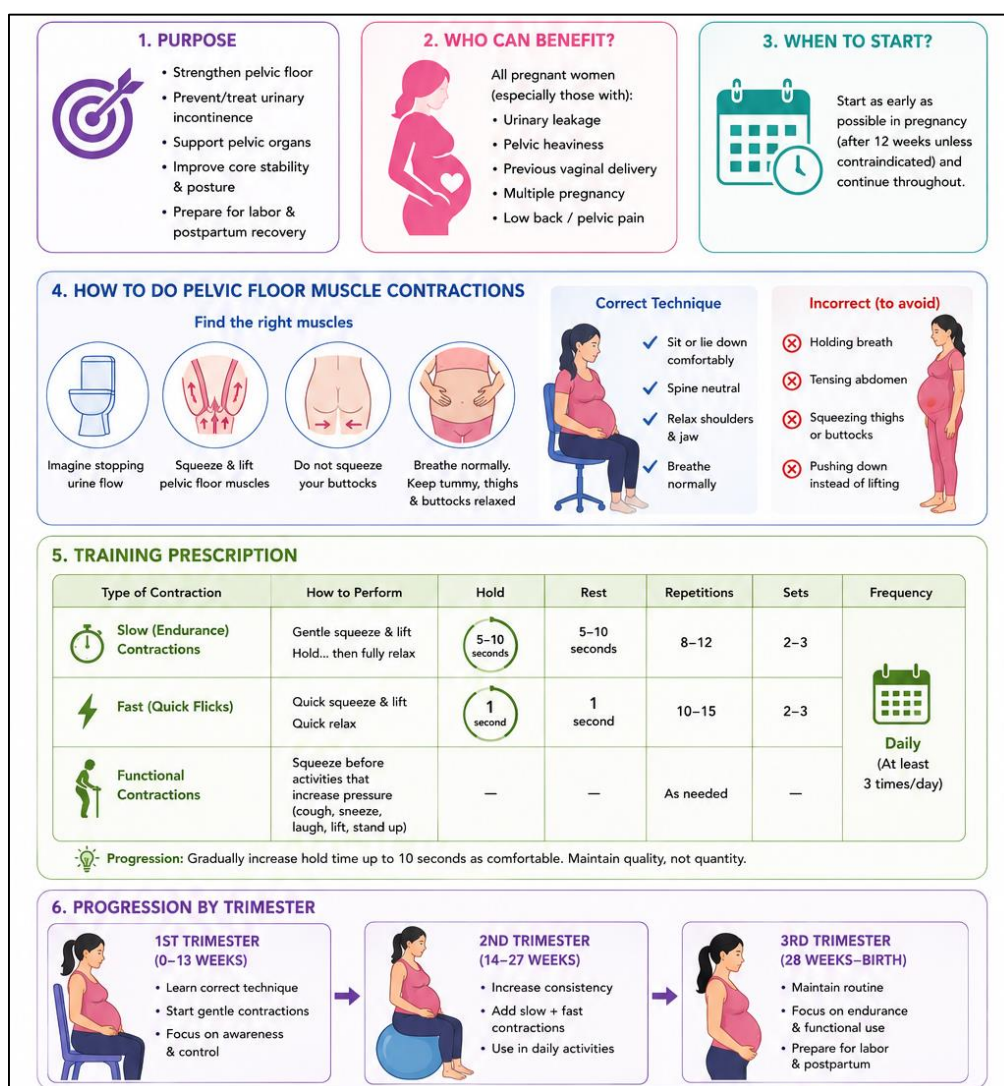


Figure. 5: Pelvic Floor Muscle Training Protocol During Pregnancy

13. Breathing exercises:

Breathing exercises constitute an important component of antenatal physiotherapy and are widely recommended to address the physiological, respiratory, and psychological changes that occur during pregnancy (Santos-Rocha, 2022). As pregnancy progresses, the enlarging uterus elevates the diaphragm and alters thoracic mechanics, resulting in changes in respiratory function, increased oxygen demand, and a heightened perception of breathlessness, particularly during the second and third trimesters (Meah et al., 2020). These adaptations, combined with increased metabolic requirements, necessitate efficient respiratory function to ensure adequate oxygen delivery to both maternal and fetal tissues (Dipietro et al., 2019). Structured breathing exercises help improve ventilation efficiency, optimize oxygenation, and enhance respiratory muscle performance, thereby supporting maternal cardiopulmonary health throughout pregnancy (Skow et al., 2022).

One of the primary benefits of breathing exercises is improved oxygen exchange through enhanced diaphragmatic movement and better utilization of lung capacity, which can reduce the sensation of dyspnea commonly experienced during pregnancy (Reed et al., 2022). Additionally, breathing exercises exert a positive influence on the autonomic nervous system by promoting parasympathetic activity and reducing sympathetic overactivation, resulting in decreased stress, anxiety, and emotional tension (Coll et al., 2017). This psychological benefit is particularly important for women with high-risk pregnancies who may experience heightened levels of fear and uncertainty regarding maternal and fetal outcomes (Harrison et al., 2018). Common breathing techniques incorporated into antenatal physiotherapy include diaphragmatic breathing, which emphasizes deep abdominal expansion and efficient diaphragm activation. pursed-lip breathing, which improves respiratory control and prolongs expiration. segmental breathing, which enhances expansion of specific thoracic regions. and relaxation breathing techniques designed to facilitate mental calmness and stress reduction (Szymanski & Satin, 2018). These techniques not only improve respiratory efficiency but also prepare women for labor by promoting controlled breathing patterns that may assist with pain management, relaxation, and endurance during childbirth (Miquelutti et al., 2018). Furthermore, regular breathing exercises can improve postural awareness and facilitate coordinated activation of the diaphragm, abdominal muscles, and pelvic floor musculature, thereby contributing to better trunk stability and functional movement (Bø & Herbert, 2019). Women with respiratory compromise, obesity, reduced physical fitness, or anxiety disorders may derive particular benefit from structured breathing programs because these interventions can improve exercise tolerance, reduce perceived exertion, and enhance overall well-being during pregnancy (Fazzi et al., 2021). Consequently, breathing exercises are considered a safe, cost-effective, and evidence-based strategy within antenatal physiotherapy that supports maternal respiratory health, psychological resilience, labor preparedness, and positive pregnancy outcomes (Barakat et al., 2021).

14. Postural correction and ergonomic training:

Progressive anatomical and biomechanical changes during pregnancy significantly alter maternal posture and movement patterns, increasing susceptibility to various musculoskeletal disorders and functional limitations (Harrison et al., 2021). As gestation advances, the enlarging uterus causes a forward displacement of the center of gravity, resulting in compensatory postural adaptations such as increased lumbar lordosis, anterior pelvic tilt, thoracic kyphosis, and forward head posture (Evensen et al., 2017). These changes are further influenced by pregnancy-related weight gain, ligamentous laxity induced by hormonal fluctuations, and weakening of the abdominal musculature, all of which contribute to altered load distribution across the spine and pelvis (Mottola et al., 2018). Consequently, musculoskeletal complaints are highly prevalent during pregnancy, with low back pain being one of the most frequently reported conditions, affecting a substantial proportion of pregnant women and often interfering with daily activities, sleep quality, and overall quality of life (Wu et al., 2018). Pelvic girdle pain is another common complaint and may occur due to instability of the sacroiliac joints and altered pelvic biomechanics, while neck pain and shoulder discomfort frequently result from postural strain and compensatory muscular overactivity associated with changes in body alignment (Santos-Rocha, 2022). Physiotherapy plays a crucial role in managing these symptoms through comprehensive postural correction and ergonomic training programs tailored to the individual needs of pregnant women (Barakat et al., 2021). Postural education focuses on teaching optimal body alignment during standing, sitting, walking, sleeping, and functional activities, thereby reducing mechanical stress on the musculoskeletal system and improving movement efficiency (Meah et al., 2020). Ergonomic counseling further assists women in modifying workplace and household activities to minimize excessive spinal loading, repetitive strain, and awkward postures that may aggravate pain and discomfort (Perales et al., 2020). Stretching programs targeting shortened muscle groups, particularly the lumbar extensors, hip flexors, hamstrings, and pectoral muscles, help maintain flexibility, improve posture, and reduce muscle tension (Dipietro et al., 2019). Core stabilization exercises are also fundamental components of antenatal physiotherapy because they strengthen the deep abdominal, pelvic floor, and spinal stabilizing muscles responsible for maintaining trunk control and lumbopelvic stability (Bø & Herbert, 2019). Enhanced core function contributes to improved balance, reduced pain intensity, and greater functional independence throughout pregnancy (Davenport et al., 2019). Furthermore, postural correction strategies may positively influence respiratory mechanics and circulation by optimizing thoracic expansion and reducing unnecessary muscular effort during daily activities (Skow et al., 2022). By promoting proper posture and movement patterns, physiotherapy interventions effectively minimize joint stress, improve biomechanical efficiency, reduce musculoskeletal discomfort, and enhance overall maternal well-being, making postural correction and ergonomic training essential components of comprehensive antenatal care (Gibbs et al., 2019).

15. Hydrotherapy:

Hydrotherapy is a valuable component of antenatal physiotherapy that utilizes the therapeutic properties of water to promote physical fitness, pain relief, and functional well-being during pregnancy (Rodriguez-Blanque et al., 2020). The unique characteristics of the aquatic environment make hydrotherapy particularly suitable for pregnant women because water provides buoyancy, hydrostatic pressure, viscosity, and thermal effects that facilitate safe and comfortable exercise participation (Santos-Rocha, 2022). Buoyancy significantly reduces the effects of gravity on the musculoskeletal system, decreasing body weight loading on the spine, pelvis, hips, knees, and ankles, thereby allowing pregnant women to perform movements with less discomfort and greater ease than on land (Backhausen et al., 2017). This reduction in joint loading is especially beneficial during the later stages of pregnancy when increasing body mass and biomechanical changes place substantial stress on weight-bearing structures (Mottola et al., 2018). Water-based exercise also enhances circulation through the hydrostatic pressure exerted by the surrounding water, which promotes venous return, reduces peripheral edema, and improves cardiovascular efficiency without imposing excessive physiological stress (Meah et al., 2020). Improved circulation may be particularly beneficial for women experiencing lower-limb swelling, varicose veins, or mild circulatory impairments commonly associated with pregnancy (Skow et al., 2022). Furthermore, the supportive nature of water provides enhanced comfort and freedom of movement, enabling pregnant women to engage in aerobic conditioning, strengthening exercises, stretching activities, and balance training with reduced fear of injury or falls (Barakat et al., 2021). Hydrotherapy has demonstrated effectiveness in reducing pregnancy-related musculoskeletal pain, including low back pain and pelvic girdle pain, by decreasing mechanical stress on affected joints and muscles while facilitating gentle movement and relaxation (Evensen et al., 2017). Women with obesity often derive substantial benefit from aquatic exercise because the buoyant environment allows them to exercise at moderate intensities with lower perceived exertion and reduced joint strain compared with land-based activities (Harrison et al., 2021). Additionally, aquatic exercise may contribute to improved cardiovascular fitness, healthy gestational weight management, enhanced flexibility, and psychological well-being throughout pregnancy (Perales et al., 2020). The relaxing properties of warm water can further reduce muscle tension, stress, and anxiety, thereby promoting overall maternal comfort and quality of life (Coll et al., 2017). Consequently, hydrotherapy is considered a safe, effective, and enjoyable physiotherapy intervention that supports maternal health and functional capacity, particularly among women with obesity, musculoskeletal disorders, lower-limb edema, and other pregnancy-related physical challenges (Davenport et al., 2019).

16. Yoga-based physiotherapy:

Prenatal yoga has emerged as an increasingly popular and evidence-based component of antenatal physiotherapy, integrating physical postures (asanas), breathing techniques (pranayama), relaxation strategies, and mindfulness practices to support maternal health during pregnancy (Santos-Rocha, 2022). Unlike conventional exercise programs, yoga-based physiotherapy emphasizes the harmonious interaction between physical, mental, and emotional well-being, making it particularly beneficial for women experiencing the physiological and psychological demands of pregnancy (Field, 2017). The physical postures incorporated in prenatal yoga improve flexibility, muscular endurance, postural alignment, and balance while accommodating the progressive anatomical changes associated with gestation (Barakat et al., 2021). Regular participation in prenatal yoga has been associated with reduced musculoskeletal discomfort, particularly low back pain and pelvic girdle pain, through gentle stretching and strengthening of the supporting musculature (Harrison et al., 2021). Controlled breathing exercises enhance respiratory efficiency, promote relaxation, and facilitate oxygen delivery to maternal and fetal tissues (Meah et al., 2020). Furthermore, mindfulness and meditation practices help reduce stress, anxiety, and emotional distress, which are commonly experienced during pregnancy, particularly among women with high-risk conditions (Corrigan et al., 2022). Research suggests that prenatal yoga contributes to improved sleep quality, enhanced emotional well-being, and greater self-efficacy during pregnancy and childbirth (Beddoe & Lee, 2018). Emerging evidence also indicates that mind-body interventions may positively influence autonomic nervous system regulation, thereby reducing sympathetic activity, improving cardiovascular function, and potentially lowering the risk of hypertensive complications during pregnancy (Newham et al., 2019). Consequently, yoga-based physiotherapy provides a holistic and safe therapeutic approach that addresses both physical and psychological aspects of maternal health while promoting overall pregnancy well-being.

17. Physiotherapy in gestational diabetes mellitus:

Gestational diabetes mellitus (GDM) is among the most common metabolic complications of pregnancy and is associated with increased risks of maternal and neonatal morbidity, including fetal macrosomia, cesarean

delivery, hypertensive disorders, and future development of type 2 diabetes mellitus (American Diabetes Association, 2024). Physiotherapy, particularly through structured exercise interventions, plays a vital role in the prevention and management of GDM by improving glucose metabolism and promoting metabolic health throughout pregnancy (Davenport et al., 2019). Exercise stimulates glucose uptake by skeletal muscles through insulin-dependent and insulin-independent pathways, thereby improving glycemic control and reducing circulating blood glucose levels (Ruchat et al., 2018). Regular physical activity also enhances insulin sensitivity, enabling more efficient glucose utilization and reducing the metabolic burden associated with pregnancy-induced insulin resistance (Fazzi et al., 2021). Furthermore, exercise contributes to healthy gestational weight gain and helps prevent excessive adiposity, which is a major risk factor for poor glycemic control and adverse pregnancy outcomes (Perales et al., 2020). Current evidence indicates that a combination of aerobic and resistance training produces the most favorable effects on blood glucose regulation because aerobic exercise improves cardiovascular and metabolic function while resistance training enhances muscle mass and glucose storage capacity (Mottola et al., 2018). Women diagnosed with GDM should receive individualized exercise prescriptions that consider gestational age, obstetric status, fitness level, blood glucose monitoring results, and the presence of any pregnancy-related complications (Dipietro et al., 2019). Appropriate physiotherapy interventions can reduce the need for insulin therapy, improve maternal health outcomes, and support favorable fetal growth and development throughout pregnancy (Nascimento et al., 2017).

18. Physiotherapy in hypertensive disorders of pregnancy:

Hypertensive disorders of pregnancy, including gestational hypertension and preeclampsia, remain major contributors to maternal and perinatal morbidity and mortality worldwide (Brown et al., 2018). These conditions are characterized by abnormal vascular responses, endothelial dysfunction, increased oxidative stress, and impaired placental perfusion, all of which can adversely affect maternal and fetal outcomes (Magee et al., 2022). Although exercise recommendations for women with hypertensive disorders require careful consideration, emerging evidence suggests that appropriately supervised low-to-moderate intensity physical activity may provide beneficial cardiovascular effects without compromising maternal or fetal safety (Davenport et al., 2018). Regular exercise has been shown to improve endothelial function by enhancing nitric oxide availability and promoting vascular relaxation, thereby supporting healthy blood flow and cardiovascular regulation (Skow et al., 2022). Physical activity may also reduce oxidative stress and systemic inflammation, both of which play significant roles in the pathophysiology of hypertensive pregnancy disorders (Reed et al., 2022). Additionally, exercise contributes to improved vascular health, better weight management, and enhanced cardiorespiratory fitness, which may indirectly reduce the severity of pregnancy-related hypertension (Barakat et al., 2021). However, exercise prescription in women with hypertensive disorders must always be individualized and implemented under close medical supervision because disease severity, maternal symptoms, and fetal status may influence the appropriateness and safety of physical activity (Gibbs et al., 2019). Continuous monitoring and multidisciplinary collaboration are therefore essential to ensure optimal maternal and fetal outcomes.

19. Physiotherapy in maternal obesity:

Maternal obesity has become a major public health concern and is increasingly recognized as a significant risk factor for adverse pregnancy outcomes and long-term health complications in both mother and child (Fell et al., 2019). Obese pregnant women are at increased risk of developing gestational diabetes mellitus, hypertensive disorders, cesarean delivery, fetal macrosomia, thromboembolic events, and postpartum complications compared with women of normal body weight (Harrison et al., 2021). Physiotherapy plays an important role in managing maternal obesity by promoting physical activity, improving functional capacity, and supporting healthy gestational weight gain (Mottola et al., 2018). Structured exercise programs incorporating aerobic training, resistance exercises, flexibility activities, and functional movement training help improve cardiometabolic health and reduce obesity-related pregnancy complications (Perales et al., 2020). Regular physical activity enhances insulin sensitivity, improves lipid metabolism, supports cardiovascular function, and contributes to energy expenditure, thereby facilitating healthier weight management throughout pregnancy (Fazzi et al., 2021). Additionally, exercise can reduce musculoskeletal discomfort, improve mobility, and enhance quality of life in obese pregnant women who often experience greater physical limitations than their normal-weight counterparts (Santos-Rocha, 2022). Evidence suggests that combining physiotherapy interventions with individualized nutritional counseling yields superior outcomes compared with standard antenatal care alone, resulting in improved maternal metabolic health, reduced gestational weight gain, and better pregnancy outcomes (Dodd et al., 2020). Consequently, physiotherapy represents a

fundamental component of multidisciplinary obesity management during pregnancy and contributes significantly to improving maternal and fetal well-being.

20. Psychological benefits of antenatal physiotherapy:

Pregnancy is accompanied by significant emotional, psychological, and social changes that may predispose women to anxiety, stress, depression, and reduced psychological well-being, particularly when pregnancy is classified as high-risk (Corrigan et al., 2022). Psychological distress during pregnancy has been associated with adverse maternal and neonatal outcomes, including poor sleep quality, increased perception of pain, preterm birth, and impaired maternal-infant bonding (Howard & Khalifeh, 2020). Antenatal physiotherapy contributes substantially to maternal mental health by incorporating physical activity, relaxation techniques, breathing exercises, and movement-based interventions that positively influence emotional well-being (Santos-Rocha, 2022). Regular physical activity stimulates the release of endorphins, serotonin, dopamine, and other neurochemicals that promote feelings of well-being and reduce symptoms of anxiety and depression (Dipietro et al., 2019). Exercise also improves self-efficacy by enhancing confidence in physical abilities, promoting a sense of control over bodily changes, and increasing preparedness for labor and delivery (Barakat et al., 2021). Furthermore, participation in structured physiotherapy programs has been linked to improved sleep quality, reduced fatigue, and enhanced mood regulation throughout pregnancy (Beddoe & Lee, 2018). Relaxation-based interventions and mindfulness techniques incorporated within antenatal physiotherapy may further strengthen psychological resilience and coping strategies, particularly among women experiencing pregnancy-related stress or fear of childbirth (Field, 2017). Consequently, antenatal physiotherapy represents an important non-pharmacological strategy for promoting maternal psychological health and improving overall quality of life during pregnancy (Coll et al., 2017).

21. Maternal outcomes:

Evidence from recent clinical studies demonstrates that antenatal physiotherapy produces a wide range of beneficial maternal outcomes that extend beyond musculoskeletal health and contribute significantly to overall pregnancy well-being (Mottola et al., 2018). Structured physiotherapy interventions improve functional capacity by enhancing muscular strength, endurance, flexibility, and cardiopulmonary fitness, thereby enabling pregnant women to perform daily activities more efficiently and with reduced fatigue (Meah et al., 2020). Regular exercise also supports healthy gestational weight gain and reduces the risk of obesity-related complications, including gestational diabetes mellitus and hypertensive disorders (Fazzi et al., 2021). Physiotherapy interventions effectively reduce common pregnancy-related complaints such as low back pain, pelvic girdle pain, postural discomfort, and physical inactivity, resulting in improved quality of life and functional independence (Evensen et al., 2017). Enhanced cardiovascular fitness achieved through aerobic and strengthening exercises contributes to better circulatory health, exercise tolerance, and metabolic regulation throughout pregnancy (Skow et al., 2022). Psychological benefits, including reduced anxiety, improved mood, increased confidence, and better stress management, further enhance maternal well-being and pregnancy experience (Corrigan et al., 2022). Additionally, physiotherapy assists in labor preparation by improving physical conditioning, breathing control, postural awareness, and pelvic floor function, which may facilitate labor performance and postpartum recovery (Bø & Herbert, 2019). Table 3 summarizes the Maternal and Fetal Outcomes Associated with Antenatal Physiotherapy.

Table 3: Maternal and Fetal Outcomes Associated with Antenatal Physiotherapy

Maternal Outcomes	Fetal Outcomes
Reduced risk of gestational diabetes mellitus	Improved placental function
Better gestational weight control	Healthy birth weight
Reduced low back and pelvic pain	Reduced fetal complications
Improved cardiovascular fitness	Enhanced oxygen delivery
Reduced anxiety and stress	Better neonatal adaptation

22. Fetal outcomes:

Current evidence strongly supports the safety of appropriately prescribed maternal exercise and indicates that antenatal physiotherapy does not adversely affect fetal growth, development, or neonatal health outcomes (Davenport et al., 2019). On the contrary, maternal physical activity is associated with several positive fetal adaptations that contribute to improved pregnancy outcomes (Mottola et al., 2018). Regular exercise enhances

placental perfusion and vascular function, promoting efficient transfer of oxygen and nutrients from mother to fetus (Reed et al., 2022). Improved maternal cardiovascular fitness further contributes to enhanced oxygen delivery and optimal fetal growth patterns throughout gestation (Skow et al., 2022). Studies have demonstrated that physically active mothers are more likely to deliver infants with healthy birth weights and lower risks of fetal overgrowth or growth restriction compared with sedentary mothers (Perales et al., 2020). Additionally, maternal exercise has been associated with improved neonatal adaptation following birth, including favorable cardiometabolic responses and enhanced physiological resilience (Davenport et al., 2018). Emerging evidence also suggests that prenatal physical activity may positively influence long-term offspring metabolic health by reducing susceptibility to obesity, insulin resistance, and cardiovascular disease later in life through developmental programming mechanisms (Santos-Rocha, 2022). These findings highlight the importance of physiotherapy interventions not only for maternal health but also for promoting optimal fetal and neonatal outcomes.

23. Safety considerations:

Safety remains a fundamental consideration when prescribing physiotherapy interventions during pregnancy, particularly in women with high-risk conditions (ACOG, 2020). Prior to initiating exercise, physiotherapists must conduct comprehensive screening and obtain appropriate medical clearance when necessary (Gibbs et al., 2019). During exercise sessions, continuous monitoring of maternal symptoms and physiological responses is essential to identify potential complications and ensure maternal-fetal safety (Meah et al., 2020). Warning signs requiring immediate cessation of exercise and urgent medical evaluation include vaginal bleeding, dizziness, syncope, chest pain, dyspnea before exertion, severe headache, uterine contractions, amniotic fluid leakage, calf pain or swelling, and reduced fetal movement (Davenport et al., 2019). Women presenting with these symptoms should be referred promptly for obstetric assessment to prevent adverse outcomes (Szymanski & Satin, 2018). Appropriate exercise intensity, hydration, environmental conditions, and individualized progression strategies are also critical components of safe antenatal physiotherapy practice (Dipietro et al., 2019). Through careful assessment and monitoring, physiotherapists can maximize therapeutic benefits while minimizing potential risks associated with physical activity during pregnancy.

24. Emerging technologies in antenatal physiotherapy:

Rapid advancements in digital health technologies are transforming the delivery of antenatal physiotherapy and expanding access to prenatal rehabilitation services worldwide (Fazzi et al., 2021). Tele-rehabilitation platforms allow physiotherapists to provide remote consultations, exercise supervision, and ongoing monitoring, particularly benefiting women residing in rural areas or those with mobility limitations (Cottrell et al., 2023). Wearable activity monitors and biosensors enable continuous tracking of physical activity levels, heart rate, sleep quality, and physiological responses during exercise, facilitating personalized intervention planning and real-time feedback (Skow et al., 2022). Smartphone applications designed specifically for pregnancy health management provide educational resources, exercise guidance, symptom monitoring, and adherence support (Santos-Rocha, 2022). Virtual exercise supervision through video-based platforms enhances accessibility while maintaining professional oversight and individualized progression of exercise programs (Fazzi et al., 2021). Artificial intelligence-assisted monitoring systems represent another emerging innovation, offering predictive analytics, personalized recommendations, and automated risk identification to support clinical decision-making and optimize maternal care (Topol, 2019). Figure 6 Future Integration of Digital Health and Tele-Physiotherapy in High-Risk Pregnancy Management illustrates the integration of wearable sensors, smartphone applications, tele-rehabilitation platforms, cloud-based monitoring systems, and artificial intelligence-assisted decision-support technologies for enhancing antenatal physiotherapy services and improving maternal-fetal outcomes.

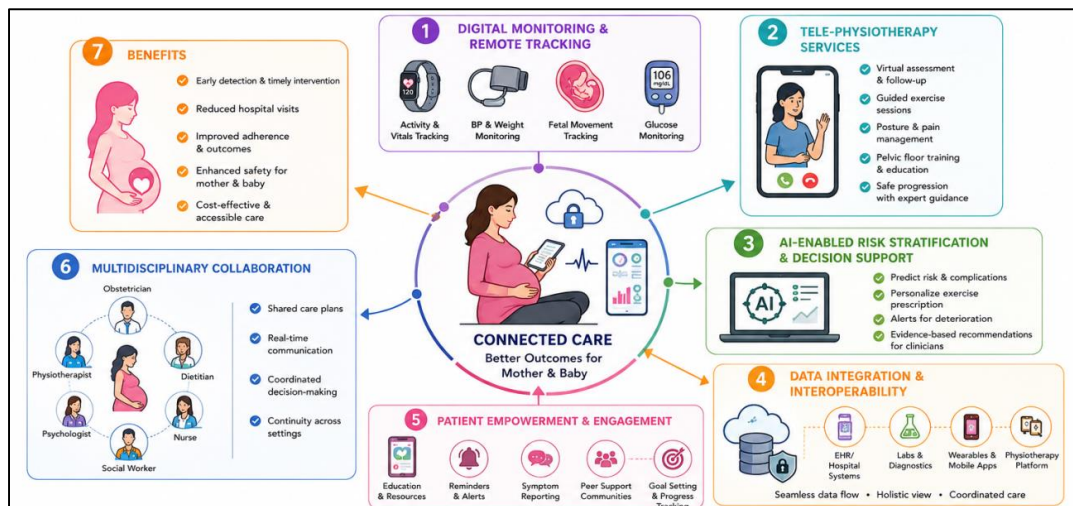


Figure. 6: Future Integration of Digital Health and Tele-Physiotherapy in High-Risk Pregnancy Management

25. Future perspectives:

The future of antenatal physiotherapy is expected to be shaped by advances in personalized medicine, digital technologies, and precision rehabilitation approaches that address the unique needs of individual pregnant women (Topol, 2019). Future research should focus on developing personalized exercise prescriptions based on maternal risk profiles, physiological responses, genetic factors, and pregnancy-specific characteristics to maximize therapeutic effectiveness (Reed et al., 2022). Artificial intelligence-driven rehabilitation systems may facilitate real-time exercise adaptation and predictive monitoring of maternal health parameters, thereby improving clinical outcomes and patient engagement (Fazzi et al., 2021). The integration of wearable biosensors capable of continuously monitoring cardiovascular, metabolic, and biomechanical variables may further enhance individualized care and early detection of pregnancy-related complications (Skow et al., 2022). Virtual reality-assisted physiotherapy and immersive rehabilitation technologies also represent promising areas for future investigation, particularly for improving exercise adherence, pain management, and psychological well-being during pregnancy (Cottrell et al., 2023). Additionally, long-term studies examining the effects of antenatal physiotherapy on offspring health, developmental outcomes, and chronic disease prevention are needed to better understand the intergenerational benefits of maternal physical activity (Santos-Rocha, 2022). Large-scale randomized controlled trials involving diverse high-risk pregnancy populations will be essential for establishing optimal intervention parameters, refining clinical guidelines, and strengthening the evidence base supporting physiotherapy in modern obstetric care (Mottola et al., 2018).

26. Conclusion:

Antenatal physiotherapy has emerged as a vital component of comprehensive prenatal care, particularly in the management of high-risk pregnancies. The growing body of scientific evidence highlights the significant role of physiotherapy in promoting maternal health, enhancing functional capacity, and reducing pregnancy-related complications through safe and individualized exercise interventions. Structured physiotherapy programs incorporating aerobic exercise, resistance training, pelvic floor muscle training, breathing exercises, postural correction, hydrotherapy, and relaxation techniques provide multidimensional benefits that address the physical, metabolic, cardiovascular, musculoskeletal, and psychological challenges associated with high-risk pregnancy. Appropriately prescribed physical activity contributes to improved glycemic control in women with gestational diabetes mellitus, supports cardiovascular health in hypertensive disorders, facilitates healthy gestational weight management in obese mothers, and reduces common musculoskeletal complaints such as low back pain and pelvic girdle pain. Furthermore, antenatal physiotherapy enhances psychological well-being by reducing anxiety, improving sleep quality, increasing self-confidence, and preparing women physically and mentally for labor and postpartum recovery. Importantly, current evidence indicates that carefully monitored exercise is safe for most medically stable high-risk pregnancies and may also improve placental function, fetal oxygenation, neonatal adaptation, and overall pregnancy outcomes. As healthcare continues to evolve, the integration of digital health technologies, tele-rehabilitation, wearable monitoring systems, and personalized exercise prescriptions is expected to further strengthen the effectiveness and accessibility of antenatal physiotherapy, ultimately contributing to better maternal and fetal health outcomes worldwide.

27. References:

- (1) American College of Obstetricians and Gynecologists. (2020). Physical activity and exercise during pregnancy and the postpartum period (Committee Opinion No. 804). *Obstetrics & Gynecology*, 135(4), e178–e188.
- (2) American College of Obstetricians and Gynecologists. (2021). Medically indicated late-preterm and early-term deliveries (Practice Bulletin). *Obstetrics & Gynecology*, 138(1), e35–e39.
- (3) American Diabetes Association. (2024). Management of diabetes in pregnancy: Standards of care in diabetes—2024. *Diabetes Care*, 47(Supplement_1), S282–S299.
- (4) Backhausen, M. G., Tabor, A., Albert, H., Rosthøj, S., Damm, P., & Hegaard, H. K. (2017). The effects of an unsupervised water exercise program on low back pain and sick leave among healthy pregnant women. *Acta Obstetrica et Gynecologica Scandinavica*, 96(7), 849–856.
- (5) Barakat, R., Perales, M., Garatachea, N., Ruiz, J. R., & Lucia, A. (2021). Exercise during pregnancy. A narrative review asking: What do we know? *British Journal of Sports Medicine*, 55(19), 1096–1101.
- (6) Beddoe, A. E., & Lee, K. A. (2018). Mind-body interventions during pregnancy. *Journal of Obstetric, Gynecologic & Neonatal Nursing*, 47(4), 542–553.
- (7) Bø, K., & Herbert, R. D. (2019). There is not yet strong evidence that exercise regimens other than pelvic floor muscle training can reduce stress urinary incontinence in women: A systematic review. *Journal of Physiotherapy*, 65(1), 6–14.
- (8) Bø, K., Hilde, G., Tennfjord, M. K., Engh, M. E., & Kari, B. (2017). Pelvic floor muscle function and dysfunction during pregnancy and postpartum. *International Urogynecology Journal*, 28(6), 825–828.
- (9) Brown, M. A., Magee, L. A., Kenny, L. C., et al. (2018). Hypertensive disorders of pregnancy: ISSHP classification, diagnosis, and management recommendations. *Pregnancy Hypertension*, 13, 291–310.
- (10) Coll, C. V. N., Domingues, M. R., Hallal, P. C., et al. (2017). Physical activity during pregnancy and emotional well-being. *BMC Pregnancy and Childbirth*, 17(1), 1–9.
- (11) Corrigan, L., Moran, P., McGrath, N., & Egan, B. (2022). Exercise interventions for improving mental health during pregnancy: A systematic review. *Women and Birth*, 35(4), e340–e349.
- (12) Cottrell, M. A., Galea, O. A., O’Leary, S. P., Hill, A. J., & Russell, T. G. (2023). Real-time telerehabilitation for the treatment of musculoskeletal conditions: A systematic review. *Journal of Telemedicine and Telecare*, 29(1), 3–15.
- (13) Davenport, M. H., Ruchat, S. M., Poitras, V. J., et al. (2018). Prenatal exercise for the prevention of gestational hypertensive disorders and preeclampsia: A systematic review and meta-analysis. *British Journal of Sports Medicine*, 52(21), 1367–1375.
- (14) Davenport, M. H., Ruchat, S. M., Sobierajski, F., et al. (2019). Impact of prenatal exercise on maternal harms, labour and delivery outcomes: A systematic review and meta-analysis. *British Journal of Sports Medicine*, 53(2), 99–107.
- (15) Di Mascio, D., Magro-Malosso, E. R., Saccone, G., Marhefka, G. D., & Berghella, V. (2016). Exercise during pregnancy in normal-weight women and risk of preterm birth. *American Journal of Obstetrics and Gynecology*, 215(5), 561–571.
- (16) Dipietro, L., Evenson, K. R., Bloodgood, B., et al. (2019). Benefits of physical activity during pregnancy and postpartum: An umbrella review. *Medicine & Science in Sports & Exercise*, 51(6), 1292–1302.
- (17) Dodd, J. M., Deussen, A. R., Mohamad, I., et al. (2020). The effects of antenatal lifestyle advice for women who are overweight or obese. *The Lancet Diabetes & Endocrinology*, 8(2), 128–140.
- (18) Dumoulin, C., Cacciari, L. P., & Hay-Smith, E. J. C. (2018). Pelvic floor muscle training versus no treatment for urinary incontinence in women. *Cochrane Database of Systematic Reviews*, 10, CD005654.
- (19) ESHRE Guideline Group on Recurrent Pregnancy Loss. (2018). Recurrent pregnancy loss guideline. *Human Reproduction Open*, 2018(2), hoy004.
- (20) Evensen, N. M., Mørkved, S., Salvesen, K. Å., & Stuge, B. (2017). Pelvic girdle pain and low back pain during pregnancy. *BMC Musculoskeletal Disorders*, 18(1), 1–10.
- (21) Fazzi, C., Saunders, D. H., Linton, K., Norman, J. E., & Reynolds, R. M. (2021). Effects of physical activity interventions during pregnancy on maternal and fetal outcomes. *BMJ Open Sport & Exercise Medicine*, 7(1), e000968.
- (22) Fell, D. B., Joseph, K. S., Armson, B. A., & Dodds, L. (2019). The impact of obesity on pregnancy outcomes. *Obesity Reviews*, 20(11), 1506–1518.
- (23) Field, T. (2017). Prenatal yoga research review. *Complementary Therapies in Clinical Practice*, 31, 173–177.

- (24) Figueras, F., & Gratacós, E. (2021). Update on the diagnosis and classification of fetal growth restriction. *Fetal Diagnosis and Therapy*, 48(8), 559–568.
- (25) Gibbs, B. B., Pivarnik, J. M., Macpherson, A. K., et al. (2019). Guidelines for physical activity during pregnancy. *Current Sports Medicine Reports*, 18(11), 404–414.
- (26) Harrison, A. L., Taylor, N. F., Shields, N., & Frawley, H. C. (2018). Attitudes, barriers and enablers to physical activity in pregnancy. *Journal of Physiotherapy*, 64(1), 24–32.
- (27) Harrison, C. L., Lombard, C. B., Moran, L. J., & Teede, H. J. (2021). Exercise and weight management in pregnancy. *The Medical Journal of Australia*, 214(7), 329–335.
- (28) Howard, L. M., & Khalifeh, H. (2020). Perinatal mental health: A review of progress and challenges. *World Psychiatry*, 19(3), 313–327.
- (29) Jauniaux, E., Alfirevic, Z., Bhide, A. G., et al. (2019). Placenta previa and placenta accreta spectrum: Diagnosis and management. *BJOG: An International Journal of Obstetrics & Gynaecology*, 126(1), e1–e48.
- (30) Magee, L. A., Brown, M. A., Hall, D. R., et al. (2022). The 2021 ISSHP classification and management recommendations for hypertensive disorders of pregnancy. *Pregnancy Hypertension*, 27, 148–169.
- (31) Meah, V. L., Davies, G. A. L., & Davenport, M. H. (2020). Why can't I exercise during pregnancy? Time to revisit medical 'absolute' and 'relative' contraindications. *British Journal of Sports Medicine*, 54(23), 1395–1396.
- (32) Miquelutti, M. A., Cecatti, J. G., & Makuch, M. Y. (2018). Antenatal education and breathing techniques during labor. *Revista Brasileira de Ginecologia e Obstetrícia*, 40(2), 78–84.
- (33) Mørkved, S., & Bø, K. (2018). Effect of pelvic floor muscle training during pregnancy and after childbirth. *Current Women's Health Reviews*, 14(1), 15–22.
- (34) Mottola, M. F., Davenport, M. H., Ruchat, S. M., et al. (2018). 2019 Canadian guideline for physical activity throughout pregnancy. *British Journal of Sports Medicine*, 52(21), 1339–1346.
- (35) Nascimento, S. L., Surita, F. G., Godoy, A. C., et al. (2017). Physical activity patterns and factors related to exercise during pregnancy. *Revista Brasileira de Ginecologia e Obstetrícia*, 39(12), 681–690.
- (36) Newham, J. J., Wittkowski, A., Hurley, J., et al. (2019). Effects of antenatal yoga on maternal anxiety and depression. *Complementary Therapies in Clinical Practice*, 35, 208–214.
- (37) Perales, M., Refoyo, I., Coteron, J., et al. (2020). Exercise during pregnancy and maternal health outcomes: A systematic review. *International Journal of Environmental Research and Public Health*, 17(18), 1–17.
- (38) Perales, M., Santos-Lozano, A., Sanchis-Gomar, F., et al. (2016). Maternal cardiorespiratory fitness and pregnancy outcomes. *Mayo Clinic Proceedings*, 91(6), 760–769.
- (39) Reed, J. L., Prince, S. A., Cole, C. A., et al. (2022). Physical activity and pregnancy outcomes: Emerging evidence and future directions. *Sports Medicine*, 52(4), 795–812.
- (40) Rodriguez-Blanque, R., Sánchez-García, J. C., Sánchez-López, A. M., et al. (2020). The effectiveness of aquatic exercise in pregnancy: A systematic review. *Healthcare*, 8(3), 1–15.
- (41) Ruchat, S. M., Mottola, M. F., Skow, R. J., et al. (2018). The role of exercise in reducing gestational diabetes mellitus risk. *Clinical Obstetrics and Gynecology*, 61(4), 641–655.
- (42) Sangsawang, B., & Sangsawang, N. (2016). Stress urinary incontinence in pregnant women: A review. *Nurse Midwifery Studies*, 5(2), e32572.
- (43) Santos-Rocha, R. (Ed.). (2022). Exercise and physical activity during pregnancy and postpartum: Evidence-based guidelines. Springer Nature.
- (44) Skow, R. J., King, E. C., Steinback, C. D., & Davenport, M. H. (2022). Maternal physiological adaptations to exercise during pregnancy. *Sports Medicine*, 52(4), 729–746.
- (45) Szymanski, L. M., & Satin, A. J. (2018). Exercise during pregnancy: Fetal responses and safety considerations. *Clinical Obstetrics and Gynecology*, 61(4), 593–602.
- (46) Topol, E. J. (2019). Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again. Basic Books.
- (47) Woodley, S. J., Lawrenson, P., Boyle, R., et al. (2020). Pelvic floor muscle training for preventing and treating urinary and fecal incontinence in antenatal and postnatal women. *Cochrane Database of Systematic Reviews*, 5, CD007471.
- (48) Wu, W. H., Meijer, O. G., Uegaki, K., et al. (2018). Pregnancy-related pelvic girdle pain and low back pain: A systematic review. *European Spine Journal*, 27(7), 1606–1622.