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Physical Exercise During Pregnancy: benefits, risks and prescription

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Physical Exercise During Pregnancy: benefits, risks and prescription

REVISÃO BIBLIOGRÁFICA

Dissertação de Candidatura ao grau de Mestre em Medicina submetida ao Instituto de Ciências Biomédicas de Abel Salazar, Universidade do Porto

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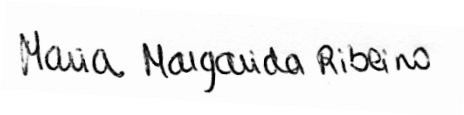

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Resumo

Enquadramento: A prática regular de exercício físico na gravidez está associada a inúmeros benefícios - diminuição da incidência de diabetes gestacional, doenças hipertensivas da gravidez, parto por cesariana ou instrumentado, ganho ponderal em excesso, depressão pós-parto, entre outros. O não aconselhamento das grávidas neste sentido, aliado às preocupações relativas aos potenciais riscos, contribuem para que a maioria das mulheres abandone ou não inicie a prática de exercício físico durante este período.

Objetivos: Fornecer uma base de aconselhamento sobre a prática de exercício físico durante a gravidez, reunindo a melhor evidência sobre riscos e benefícios, e prescrição do exercício físico de acordo com as características de cada mulher, seus antecedentes pessoais e gravidez atual.

Métodos: Foi realizada uma pesquisa na *MEDLINE* utilizando palavras-chave relevantes. A pesquisa incluiu estudos publicados entre janeiro de 1990 e dezembro de 2020, redigidos em inglês ou português e considerados com o nível de evidência científica mais elevado. Artigos com foco no seguimento pós-gestacional a longo-prazo ou no período pré-gestacional foram excluídos.

Resultados: Cinquenta e sete artigos, incluindo 32 meta-análises, 9 revisões sistemáticas e 16 ensaios clínicos randomizados foram incluídos. Mulheres que praticaram exercício físico durante a gravidez obtiveram um melhor controlo do peso, menor prevalência de ansiedade, depressão e dor lombo-pélvica menos intensa; menor risco de desenvolver diabetes gestacional, doenças hipertensivas da gravidez e incontinência urinária e menor risco de macrossomia fetal. O exercício não influenciou a frequência de partos por cesariana, partos instrumentados ou a duração do trabalho de parto, em alguns estudos; noutros aumentou a probabilidade de parto vaginal. O exercício não aumentou o risco de anomalias congénitas, aborto espontâneo, parto pré-termo, baixo peso ao nascer, mortalidade perinatal ou baixo Índice de Apgar. A maioria dos benefícios do exercício físico são alcançados com o cumprimento das atuais *guidelines* internacionais. A intensidade do exercício físico deve ser proporcional ao nível de condição física prévio.

Conclusão: O exercício físico pode prevenir patologias importantes do período gestacional, melhorando a saúde e a qualidade de vida maternas. Não se verificou um aumento do risco de desfechos maternos ou perinatais adversos. O cumprimento das atuais normas orientadoras parece ser suficiente para alcançar os benefícios descritos. Investigações futuras deverão incluir tipos específicos de exercício físico e respetivos efeitos materno-fetais.

Palavras-chave: *Pregnancy, Physical Activity, Physical Exercise, Outcome*

Abstract

Background: Regular physical exercise during pregnancy is associated with numerous benefits - decreased incidence of gestational diabetes, hypertensive disorders of pregnancy, operative delivery, excessive weight gain, postpartum depression, among others. The fact that pregnant women are not adequately advised on this matter, together with their concerns regarding the potential risks, contributes to the abandonment or refusal to start exercising during this period.

Objectives: To provide a comprehensive literature review regarding the practice of physical exercise during pregnancy, gathering the strongest evidence about its risks and benefits, and the prescription of physical exercise according to women's individual characteristics, medical history and current pregnancy.

Methods: A search was conducted in the *MEDLINE* using relevant keywords. Searches included studies published between January 1990 and December 2020, written in English or Portuguese, and considered to have the highest level of scientific evidence. Articles focusing on long-term post-gestational follow-up or pre-gestational period were excluded.

Results: Fifty-seven articles, including 32 meta-analysis, 9 systematic reviews and 16 randomized controlled trials were included in the final review. Women who exercised during pregnancy had better weight-gain control, lower prevalence of anxiety and prenatal depression, and less intense lumbo-pelvic pain; lower risk of developing gestational diabetes, hypertensive disorders and urinary incontinence, and lower risk of delivering macrosomic newborns. Exercise did not influence cesarean delivery rates, labor duration or instrumented delivery in some studies, but increased the probability of vaginal delivery in others. Exercise was not related to an increased risk of congenital anomalies, miscarriage, preterm birth, small for gestational age or low birth weight newborns, perinatal mortality, or low Apgar scores. Benefits can be achieved with compliance with current international guidelines. Exercise intensity should be based on women's previous fitness level.

Conclusion: Exercise can help preventing relevant pregnancy related disorders. Exercise was not related with an increased risk of maternal or perinatal adverse outcomes. Compliance with current guidelines is sufficient to achieve the main benefits. Specific types of exercise and their particular effect in each pregnancy outcome need a more extensive research.

Keywords: Pregnancy, Physical Activity, Physical Exercise, Outcome

List of abbreviations

BP – Blood Pressure
CA – Congenital Anomalies
CD – Cesarean Delivery
CG – Control Group
CI – Confidence Interval
EG – Exercise Group
EGWG – Excessive Gestational Weight Gain
FD – Fetal Death
FHR – Fetal Heart Rate
GC – Glucose Control
GDM – Gestational Diabetes *Mellitus*
GH – Gestational Hypertension
GRADE - Grading of Recommendations Assessment, Development and Evaluation
GWG – Gestational Weight Gain
HR – Heart Rate
ID – instrumental delivery
IUGR – Intrauterine Growth Restriction
LBW – Low Birth Weight
LD – Labor Duration
LGA – Large for Gestational Age
LP – Lumbopelvic Pain
LTPA – Leisure Time Physical Activity
MCT – Maternal Core Temperature
MD – Mean Deviation
MVPA – Moderate to Vigorous Physical Activity
ND – Neonatal Death
OR – Odds Ratio
PA – Perinatal Anxiety
PD – Perinatal Depression
PE – Preeclampsia
PFMT – Pelvic Floor Muscle Training
PM – Perinatal Mortality
PP – Postpartum
PPD – Postpartum Depression
PPWR – Postpartum Weight Retention
PTB – Preterm Birth
RCTs – Randomized Controlled Trials
RR – Relative Risk
SD – Standard Deviation
SGA – Small for Gestational Age
UBF – Uterine Blood Flow
UI – Urinary Incontinence
VD – Vaginal Delivery
VPA – Vigorous Physical Activity

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Introduction

Physical exercise, defined as a planned, structured physical activity which goal is to improve one or more components of physical fitness is a key element of a healthy lifestyle, contributing to the prevention and treatment of several diseases.[1] Pregnancy is a great time to start exercising, since it is associated with an increased motivation to maintain or start a healthy lifestyle. Additionally, this is a particular period associated with increased frequency of medical appointments, which helps in physical exercise monitoring.[2]

Regular physical exercise during pregnancy is associated with known numerous benefits, such as decreased incidence of gestational diabetes, hypertensive disorders, operative deliveries, excess weight gain and weight retention in the postpartum period, postpartum depression, among others.[3-7]

The fact that pregnant women are not properly advised in this matter, together with their concerns regarding the potential risks associated with exercise, contributes to the abandonment or refusal to start exercising during this period.[8,9]

The primary goal of this bibliographic review project is to provide a basis for clinical counseling regarding the practice of physical exercise during pregnancy, gathering the strongest scientific evidence to date about its risks and benefits, taking into account the adaptations and the prescription of physical exercise according to woman's individual characteristics, personal history and characteristics of the ongoing pregnancy.

Anatomical and physiological adaptations during pregnancy

The physiological adaptations that women undergo during pregnancy modify their response to physical exercise. Main changes are summarized below, divided by systems.

MUSCULO-SKELETAL. On average, women gain 13kg during pregnancy[10], shifting the mother's center of gravity. This affects balance, coordination and also posture, since lumbar lordosis is accentuated. Aiming to soften the pubic symphysis and ease the delivery process, women acquire a greater joint laxity which implies an additional risk for strains or sprains.[11]

RESPIRATORY. In the thorax, the higher diaphragm position affects the chest cage: residual lung volume and expiratory reserve volume are reduced, inspiratory capacity is increased, but there is no major effect on vital capacity.[12] On the other hand, as a response to fetal oxygen requirement, an increased maternal oxygen demand, together with a mild increase in tidal volume and greater oxygen consumption are noticed, causing an enhanced exercise subjective effort. [11]

METABOLIC. The energy cost of exercise is also altered. In fact, energy demands during physical exercise depend on the type of exercise performed, namely if the activity is weight bearing or weight supported. If the activity is weight bearing, as walking or jogging, the energy requirement increases proportionally to the maternal weight gain. If the activity is weight supported, like stationary cycling, the energy cost is not significantly different from non-pregnant individuals.[13]

During the first half of pregnancy, maternal temperature rises about 0,5°C. Fetal temperature is normally higher than maternal temperature (+0,4-0,6°C), promoting heat loss by a fetal to maternal gradient.[14] There is a theoretical possibility of reversing this mechanism under strenuous exercise, especially if under hot and humid conditions, endangering fetal well-being.[15] On the other hand, pregnant women have mechanisms to balance increases in maternal core temperature and dissipate heat, such as an enhanced peripheral vasodilation and a lower temperature threshold for sweating.[15]

CARDIOVASCULAR. The maternal cardiovascular system continuously adapts to the demands of the fetus. The first hemodynamic change is the rise in the heart rate between the 2nd and 5th weeks.[16]. This effect is more noticeable at rest and during light exercise, rather than higher exercise intensities.[17] Consequently, measuring the heart rate is a less precise way of estimating exercise intensity and to guide exercise prescription, since it overestimates the intensity at lower work rates and underestimates it at higher work rates.[17] Although the resting heart rate is increased, maximal heart rate is decreased, which leads to a reduced heart rate reserve, reducing woman's capacity to adapt to exercise-related stress.[17]

Between the 10th and 20th weeks, blood volume rises about 1500mL. As a result of increased heart rate and blood volume, the resting cardiac output increases about 1L/min around the 8th week.[18] Additionally, after the 20th week, the cardiac output is also affected by positional changes (specially on supine position), as the gravid uterus may obstruct the aorta and inferior vena cava, diminishing the uteroplacental blood flow and venous return to the heart, which potentially influences the type of exercise women can do.[18]

The blood pressure does not increase during normal pregnancies, specially because peripheral vascular resistance is decreased[17]. Regarding exercise's effect on maternal blood pressure, it varies with the type of exercise performed, as well as the woman's previous physical condition.[19]

It is expected an increase in fetal heart rate, proportionally to the intensity and duration of exercise. On the other hand, it can be observed a transient fetal bradycardia associated with more intense exercise. In fact, bradycardia is the initial response to acute hypoxia, and it is more probable to happen immediately after exercise due to an abrupt fall in maternal cardiac output, which reduces the uterine blood flow. However, this is not frequently observed, since healthy maternal regulatory systems provide both for maternal and fetal demands.[20]

ENDOCRINE. In early pregnancy, pancreatic beta cells suffer hyperplasia, increasing insulin secretion. However, in later gestation, placental hormones increase insulin resistance, in order to control blood glucose usage and preserve available glucose for the fetus. In fact, if insulin resistance is excessive, it can later evolve to gestational diabetes.[15] During and following prolonged exercise in late gestation, there is a reduction in plasma glucose concentration resulting in a transient reduction in fetal glucose utilization, which can impact fetal growth.[21]

PSICOLOGICAL. Emotional changes (like mood variations), also occur during pregnancy. These conditions are due to hormone changes, sleep difficulties, body image alterations, among others.[22] Regarding this matter, exercise can generate improvements in mood and self-esteem and improve body satisfaction.[23]

Methods

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses protocols (PRISMA-P) recommendations were used to guide this review.[24]

This review aimed to include studies focusing on the practice of physical exercise during the gestational period and their respective maternal and fetal outcomes. Meta-analyses, Systematic Reviews, Randomized Controlled Trials (RCTs) and Prospective Studies were considered for this review. Case reports, case series and narrative reviews were excluded.

A search on *MEDLINE* was conducted using the following queries with terms from the Medical Subject Heading of the Index Medicus as keywords: "pregnancy AND (physical exercise OR physical activity) AND outcome". Articles found by cross-referencing that met the inclusion criteria were also included. All studies identified were screened for these inclusion criteria: (1) published in English or Portuguese, (2) between January 1990 and December 2020, (3) with full-text available, (4) maternal and fetal outcomes related to physical exercise during pregnancy.

A selection of the articles was carried out. First, articles were filtered by reviewing titles and abstracts using the same inclusion criteria. Secondly, the remaining articles were screened based on the full text. Studies focusing on long-term post-gestational follow-up or pre-gestational period were excluded.

The Grading of Recommendations Assessment, Development and Evaluation (GRADE) framework was used to assess the quality of evidence across studies for each considered outcome.[25] Evidence from randomized controlled trials was first rated as "high" quality of evidence, and was graded down if a risk of bias, indirectness, inconsistency, imprecision or risk of publication bias was detected. Evidence from all non-randomized interventions and observational studies was first rated as "low" quality of evidence. If there was no cause to downgrade, it could be upgraded if there was (1) a large magnitude of effect, (2) evidence of dose–response effect, (3) all residual confounding factors would decrease the magnitude of effect.

Results

The search strategy resulted in 266 articles. Two additional articles were added by cross-referencing. Two duplicates were identified, remaining 266 articles. After examining title and abstract to determine those that met the inclusion criteria, 132 articles were excluded. The remaining 134 articles were accessed and analyzed for eligibility, and 77 articles were further excluded, for the following reasons: long-term post-gestational follow-up, focus on pre-gestational period, and no relevant outcomes recorded. Fifty-seven articles were finally included in this review. A PRISMA diagram of the search results is shown in figure 1.

The review included 32 meta-analysis, 9 systematic reviews and 16 RCTs. The main characteristics of each study are described in tables I – XIV.

1. Benefits associated with exercise during pregnancy

1.1. Gestational weight gain, excessive gestational weight gain and postpartum weight retention

The Institute of Medicine recommends, for normal-weight women, a weight gain during pregnancy between 11,5 and 16,0 kg. As for overweight women, gestational weight gain (GWG) should be between 7,0 and 11.5 kg and for obese women between 5,0 kg – 9,0 kg.[10] An Excessive Gestational Weight Gain (EGWG) can be considered if these recommendations are exceeded. It is estimated that almost 50% of pregnant women exceed their goals, with overweight and obesity as important risk factors.[26] Moreover, EGWG is associated with postpartum weight retention (PPWR), an increased risk of cesarean section, trauma of the birth canal, gestational diabetes and newborns large for the gestational age.[26]

Seven meta-analysis[27-33] and four systematic reviews[34-37], analyzing various types of exercise interventions in women without contraindications to exercise, found a significantly reduced GWG in the exercise groups compared with controls (Table I). Total GWG mean deviations (MD) between groups ranged from -1.61kg (95% CI = - 1.99 to - 1.22, $p<0.01$)[32] to -0.61kg (95% CI = -1.17 to -0.06, p=0.03).[31] Additionally, Wang *et al*[27] found in their subgroup analysis that this effect was greater with interventions done at least 3 times per week, during 30-45 min per session and conducted throughout the entire pregnancy. Chan *et al*[34] added that a greater effect on the improvement of pregnant women's level of physical activity was seen among supervised exercise classes.

This relationship was also sought among overweight and obese pregnant women [28,38,39] (Table I), and all studies confirmed this hypothesis when exercise interventions were structured, either supervised or home-based (MD -1.14kg, 95% CI= - 1.67 to -0.62, p<0.0001[28] and -0.91kg, 95% CI = - 1.76 to - 0.06, p=0.035[38]). Exercise interventions that included only counseling and encouragement were not effective.[39]

An identified limitation was the fact that all the included studies measured total body weight difference, instead of body fat. This is particularly important in exercise interventions that included muscle training/resistance exercises, since women may have increased their global muscle mass, independently of the body weight variation.

EGWG was an outcome evaluated in four meta-analysis[29,30,35,37], and three RCTs [40,41,42], with the majority[29,30,35,37,41] (n=5) finding a significant better weight gain control in the exercise groups (Table I). In fact, the decrease in the odds of having EGWG with exercise varied between 18% (odds ratio (OR)= 0.82, 95% CI = 0.68 to 0.99[29]) and 61% (OR=0.39, 95% CI = 0.17 to 0.89[41]). Nobles *et al*[40], who did not find a significant correlation, prescribed an unsupervised exercise intervention, without indicating a specific type of exercise to be performed, which may have hampered the efficacy of the exercise intervention. However, Da Silva *et al*[42] included an individually supervised exercise intervention, and also did not find significant results.

On the other hand, other systematic reviews and meta-analysis did not find significant effects of exercise interventions on GWG[43-45], along with three RCTs.[42,46,47] These studies analyzed GWG and not EGWG. In fact, Bacchi *et al*[41] found no significant difference in mean GWG, but found significantly reduced odds of EGWG in the intervention group (OR= 0.39 95% CI = 0.17 to 0.89, p=0.02). Also, most of the studies' populations included mainly previously healthy women - though if only a small proportion of women gained more weight than expected, perhaps significant differences between groups could not be noticed. A correlation between type of exercise, program duration and mean GWG results cannot be drawn, since a great variety of exercise interventions were included in each review.

Considering PPWR, a meta-analysis[30] related exercise during pregnancy with reduced PPWR (MD= - 0.92kg, 95% CI= - 1.84 to 0.00, p=0.05), together with two RCTs[47,48] (Table I). All included aerobic exercises and were performed for at least 20 weeks, finishing at the end of the 3rd trimester.

1.2 Gestational diabetes *mellitus*

Gestational diabetes *mellitus* (GDM) is a condition in which carbohydrate intolerance develops during pregnancy[49], and it is considered the most common metabolic disorder during pregnancy.[50] Indeed, GDM is associated with many adverse outcomes, such as higher risk of preeclampsia, macrosomia and birth trauma, neonatal hypoglycemia, diabetes later in life, among others.[50] A known modifiable risk factor for developing GDM is obesity[51], along with a sedentary lifestyle[50] which raises the question of the possible impact of physical exercise on GDM.

Several meta-analysis[6,28,32,52-56], two systematic reviews[29,45] and one RCT[57] evidenced that exercise during pregnancy had a beneficial effect on GDM (Table II), reporting a risk reduction between 28% (RR=0.72, 95% CI= 0.58 to 0.91)[55] and 59% (RR = 0.41, 95% CI= 0.24 to 0.68).[56] This benefit was found across different populations, namely obese and overweight pregnant women (RR=0.71, 95% CI= 0.57 to 0.89)[28] and previously healthy pregnant women.[6,29,32,45,52-57]

Moreover, Davenport *et al*[6] found a dose-dependent relationship between exercise and GDM prevention: to achieve a 25% reduction, it was necessary to perform 140 min per week of moderate-intensity exercise. Accordingly, Cordero *et al*[57] reported that engaging in physical exercise 150-180min per week during pregnancy reduced the odds of developing GDM by 90% (OR=0.103, 95% CI= 0.013 to 0.803, p=0.009), comparing to standard care.

Furthermore, physical exercise can also play a role in disease control (Table II).[37,58-60] A RCT[58] with pregnant women previously diagnosed with GDM concluded that structured aerobic and resistance exercise lowered postprandial glucose at the end of pregnancy (4.66±0.46 mmol/L (EG) vs 5.30±0.47 mmol/L (CG), p<0.001). However, no difference was found regarding fasting glucose. Accordingly, a meta-analysis[60] described that both acute and chronic exercise were able to reduce maternal glucose values, and sensitivity analysis showed that this reduction was driven mainly by pregnant women previously diagnosed with diabetes (MD= -2.76 mmol/L, 95% CI= -3.18 to -2.34, p<0.00001). Harrison *et al*[59] found that exercise interventions significantly lowered both postprandial levels (MD= - 0.33 mmol/L, 95% CI= - 0.49 to - 0.17) and fasting blood glucose levels (MD= - 0.31 mmol/L, 95% CI= - 0.56 to - 0.05), among women previously diagnosed with GDM. On the other hand, the insulin requirement was not significantly different between groups.

Regarding glucose control studies, a recognized limitation was the inability to detect the interference of insulin or other glucose sensitizing agents on the presented results. As for

the studies focused on GDM risk, different applied diagnostic criteria for gestational diabetes is considered a constraint.

On the contrary, a systematic review from Perales *et al*[36] found only a weak level of evidence between exercise interventions and a reduced incidence of GDM. Correspondingly, no significant difference between groups was found by Han *et al*[61] (OR=1.10, 95% CI=0.66 to 1.84), Nascimento *et al*[37] nor by Da Silva *et al*[42] (OR=1.0, 95% CI=0.6 to 1.9).

The great majority of the presented studies analyzed only previously healthy pregnant women. However, other populations such as overweight or obese women have a greater risk of developing GDM. Thus, it is possible that a diminished ability to detect significant differences between groups may have resulted from a selection bias.

1.3 Excessive fetal growth

Excessive fetal growth includes definitions such as macrosomia – a newborn with a birth weight superior to 4000-4500g, and large for gestational age (LGA) – a birth weight equal or superior to the 90th percentile for a given gestational age.[62] In fact, approximately 7.8% of all newborns in the United States are born with 4000g or more.[63] An increased birth weight is associated with an increased likelihood of postpartum hemorrhage, cesarean sections, instrumental delivery, shoulder dystocia and birth trauma.[62]

The potential positive impact of exercise on reducing the risk of delivering a LGA or macrosomic infant was confirmed by five meta-analysis[7,29,33,64,65] and a systematic review[36] (Table III). Risk reduction regarding macrosomia varied between 4% (RR= 0.96, 95% CI= 0.94 to 0.98)[64] and 61% (RR= 0.41, 95% CI= 0.25 to 0.68)[65]. As for LGA infants, it was found a risk reduction between 19% (RR= 0.81, 95% CI= 0.69 to 0.96)[65] and 49% (RR= 0.51, 95% CI= 0.30 to 0.87)[29]. All studies included women without contraindications to exercise, and no specific subgroup analysis was made. Pastorino *et al*[64] found a significant correlation only when exercise was performed during late pregnancy, rather than during early pregnancy, possibly indicating a greater contribution of exercise interventions when carried out during the 3rd trimester on this outcome.

Two meta-analysis[28,61] and two systematic reviews[35,36] found no significant difference in the odds of delivering a macrosomic infant between exercise and standard antenatal care groups (Table III). This was verified across different study populations, including overweight and obese women[28] and previously healthy women.[35,36,61] Additionally, Bennett *et al*[65] did not find significant differences between groups regarding LGA risk (RR=1.13, 95% CI= 0.54 to 2.36), as opposed to macrosomia risk (RR=0.41, 95% CI= 0.25 to 0.68). A correlation between type of

exercise, program duration and macrosomia/LGA results cannot be drawn, since a great variety of exercise interventions were included in each review.

1.4. Delivery mode and duration

Regarding cesarean delivery (CD), three meta-analysis[33,56,66] and one RTC[67] showed a significant reduction in the group who exercised during pregnancy (Table IV). Sanda *et al*[67] analyzed an exercise intervention of moderate-to-vigorous intensity, and found 67% reduced odds of CD (OR=0.33, 95% CI=0.11 to 0.97, p=0.044). In Poyatos-León *et al*[66] this effect was significant when exercise was performed during the 2nd and 3rd trimesters[66] (RR=0.78, p= 0.105 vs RR=0.66, p=0.028) regardless of the exercise type. This finding is in line with the ones in Pastorino *et al*[64], who found a decreased risk of macrosomia when exercise was performed during the 3rd trimester. However, four meta-analysis[5,28,32,61], two systematic reviews[35,36] and one RCT[46] did not find significant differences in CD rates (Table IV). This was verified with different populations, namely obese and overweight women[28], previously healthy women[5,35,36,61] and previously inactive women.[46] Types of exercise, frequency and session's duration were largely diverse across interventions. Thus, a correlation between different samples, interventions and CD outcomes cannot be drawn.

Two meta-analysis[56,66] and one RCT[67] evaluated the impact of exercise in vaginal delivery rates (Table IV). All found an increase in vaginal births in the exercise groups (RR= 1.09, 95% CI= 1.04 to 1.15[56], RR= 1.12, 95% CI= 1.01 to 1.24[66] and OR= 2.69, 95% CI= 1.02–7.09[67]).

Instrumental delivery had a lower prevalence in the exercise group of one meta-analysis.[5] In fact, a reduction of 24% on the odds of ID (OR=0.76, 95% CI=0.63 to 0.92, p=0.004) was found among previously healthy pregnant women.[5] On the other hand, two RCTs[67,68] and two meta-analysis[56,66] did not find any significant differences (Table IV). In terms of delivery duration, evidence is not consensual (Table IV). On one hand, Sanda *et al*[67], Perales *et al*[36] and Agur *et al*[68] found no differences in labor duration; on the other hand, Barakat *et al*[69] reported that the intervention group had shorter first stage (409.15 ± 185.74 min (EG) vs 462.83 ± 208.37 min (CG), p=0.01) and shorter total duration of labor (450.74 ± 188.64min (EG) vs 507.19 ± 2.16.06min (CG), p=0.01). Included populations were diverse (i.e. previously inactive women[66], women with antenatal bladder neck mobility[68], normal-weight women and previously healthy women[61,67,70]), however, none included overweight or obese women, conditions related to a slower labor progression and an increased need for ID[71], possibly underestimating the effect of exercise on these outcomes.

1.5. Hypertensive disorders of pregnancy

Hypertensive disorders of pregnancy include Gestational Hypertension (GH) and Preeclampsia (PE).[70] These disorders are relatively common during pregnancy - PE complicates 2 to 8% of pregnancies worldwide. Furthermore, 16% of maternal deaths are related to hypertensive disorders, as well as other adverse outcomes, such as inadequate fetal growth, preterm delivery and perinatal death.[72]

A systematic review[45] and three meta-analysis[6,56,73] showed a significant risk reduction of GH and PE among previously healthy women who exercised during pregnancy (Table V). Davenport *et al*[6] found a 39% reduced risk of developing GH (RR= 0.61, 95% CI= 0.43 to 0.85, p=0.003) and 41% reduction of developing PE (RR= 0.59, 95% CI= 0.37 to 0.90, p=0.03). Furthermore, a meta-regression analysis revealed that these benefits were achieved when exercise interventions were performed ≥3 days per week, at least 25 min per session, and with a higher compliance, which was found in supervised programs. Additionally, a RCT investigated the effect of exercise during pregnancy on blood pressure[74], among previously inactive women, showing a significantly reduced systolic blood pressure (MD= 7.5 mmHg, p=0.013).

Contrarily, a meta-analysis[28] and two systematic reviews[42,75] found no significant differences on PE and GH risk between groups (Table V). Comparing the three studies, two considered a population with an increased risk of developing hypertensive disorders (i.e. women at risk of developing PE[75] and overweight/obese women[28]), which can sustain that exercise may be only effective in preventing GH and PE among women without a previously increased risk for these conditions. However, these findings need to be interpreted with caution, since in Meher *et al*[75] sample size was considered too small to draw reliable conclusions.

1.6. Lumbopelvic pain

Lumbopelvic pain includes low back pain (between the ribs and the gluteal folds, with/without radiation down to the legs) and pelvic girdle pain (between the posterior iliac crest and the gluteal folds, with/without radiation to the posterior thigh). As a matter of fact, it is a prevalent condition among pregnant women, with more than 50% of them experiencing it.[76]

Two systematic reviews[34,37] found a beneficial effect of exercise during pregnancy on lumbopelvic pain (Table VI). Chan *et al*[34] reported a significant effect on pain intensity of low back and pelvic pain, but findings regarding pain prevalence were inconsistent. Nascimento *et*

al[37] also related exercise interventions with decreased lumbopelvic pain intensity, but not with lumbopelvic pain prevalence.

Both studies reviewed the impact of exercise interventions among women without contra-indications to exercise, and no specific subgroup analysis was performed. Exercise interventions varied on type, frequency, intensity and duration, hindering a possible association of specific types of exercise interventions with these outcomes.

1.7. Urinary incontinence

Urinary incontinence (UI) is a prevalent pathology in the prenatal and postpartum period, affecting 18%–75% of women in late gestation[77] and one-third of women after childbirth.[78] Literature is not consensual, since high-impact activities, including aerobic exercise, by increasing intra-abdominal pressure, are described as potential risk factors for pelvic floor weakening.[79] Nevertheless, aerobic exercise performed during pregnancy can be related to the prevention of EGWG and LGA babies, known important risk factors for prenatal and postnatal UI.

UI benefited from exercise during pregnancy[36,37,80,81] (Table VII). Considering its prevention, in Davenport *et al*[80], exercise reduced the odds of UI by 52% during the pregnancy (OR=0.48, 95% CI= 0.32 to 0.73, p=0.0005) and by 39% in the postpartum period (OR=0.61, 95% CI= 0.48 to 0.77, p<0.0001). However, exercise did not show a beneficial effect regarding UI treatment.[80]

Most exercise interventions included pelvic floor muscle training (PFMT).[37,80,81] Hence, PFMT appears to play an important role on UI prevention in pregnancy and post-partum period. On the other hand, a systematic review[36] described a strong level of evidence for aerobic plus resistance exercise programs, possibly indicating that exercise in general can have a beneficial effect on UI prevention. Studies' samples included previously healthy women, and one RCT[81] focused on pregnant women with pelvic floor weakness (including women with antenatal bladder neck mobility). It would be also important to investigate the effect of exercise interventions on overweight and obese pregnant women. Indeed, since overweight is a modifiable risk factor for UI, perhaps exercise interventions could be effective in reducing its prevalence in this population.

1.8. Psychological outcomes: postpartum depression, perinatal depression and anxiety

Depression during pregnancy and in the postpartum period affects approximately 13% of women, and anxiety up to 39%.[82,83] In fact, pregnant women tend to report more negative feelings than non-pregnant individuals[84], evidencing pregnancy as a potential vulnerable period for women's psychological well-being.

Exercise during pregnancy was related to a significant beneficial effect on prenatal depression in a meta-analysis[3] and three systematic reviews[34,37,85] (Table VIII). In fact, Davenport *et al*[3] reported a 67% reduction on the odds of prenatal depression (OR=0.33, 95% CI=0.21 to 0.53). Likewise, several studies[3,34,37,85,86] revealed that symptom severity was reduced with exercise. Haakstad *et al*[23] found a significant difference only when results were analyzed per-protocol, pointing that adherence is an important aspect to achieve exercise's benefit on psychological outcomes.

Concerning postpartum depression, a systematic review[37] found positive effects on depressive symptoms severity, but no strong evidence was found considering its prevalence. Still, two RCTs[87,88] and one meta-analysis[3] found no significant differences on symptom severity[3,87,88] or prevalence[3,87] (Table VIII). Exercise programs were only performed during the prenatal period, which may indicate that, for exercise to have a beneficial effect on postpartum depression, it should also be performed in the postpartum period.

Regarding anxiety symptoms, a significant reduction was shown in two systematic reviews[34,85] and one RCT[23] (Table VIII). Haakstad *et al*[23] added that feelings of sadness, hopelessness and anxiety had a significant improvement with exercise when women had complete exercise adherence (4.64±0.5 (EG) vs 4.15±1.0 (CG), p=0.01). On the other hand, Davenport *et al*[3] found no evidence supporting the benefits of exercising on anxiety prevalence nor symptom severity.

2. Risks associated with exercise during pregnancy

2.1. Preterm Birth

Preterm birth (PTB) is a leading cause of perinatal morbidity and mortality, occurring in approximately 10% of all live births worldwide, and in about 6% of all live births in Europe.[89] Physical activity was thought to be related to an increased risk of PTB, as it could reduce placental circulation, and increase the release of catecholamines, which stimulate myometrial

activity.[90] On the contrary, exercise may have a protective effect by preventing pregnancy complications such as PE, obesity or GDM[91], which are related to an increased PTB risk.

The risk of PTB among women who exercised during pregnancy was shown not only to be neutral[7,28,35,37,42,46,52,56] but also to be reduced[29,43,45,92], in several RCTs[42,46], meta-analysis[7,28,29,52,56] and systematic reviews[35,37,45,92] (Table IX). Da Silva *et al*[29] found a 20% reduction in the odds of PTB (OR= 0.80, 95% CI=0.70 to 0.91). Considering specific types of populations, PTB was not related to exercise among overweight and obese women[28], previously inactive women[46] or normal weight women.[56]

Most studies evaluated this outcome among previously healthy women, with only observational studies considering a broader and less restrained population. Consequently, the level of evidence regarding populations with a higher PTB risk is low to moderate.

2.2. Inadequate fetal growth

Small for gestational age (SGA) is defined as birth weight below the 10th percentile of a population-specific birth weight and gestational age plot. Low birth weight (LBW) is considered when birth weight is inferior to 2500g, regardless of gestational age.[93] Worldwide, nearly 15% of infants are born with LBW, but occurring mostly in low and middle income countries, where approximately 27% of infants are born SGA.[94] The effects of exercise during pregnancy have particular interest, since birth weight is an important predictor of neonatal morbidity and mortality.[95] Indeed, during exercise there is increased substrate use and maternal insulin sensitivity and blood flow is redirected to the working muscles, phenomena that can hamper the greater demands required by the fetus during pregnancy.[96]

Seven studies, including meta-analysis[7,43,56,65], systematic reviews[37,45] and a RCT[46], evaluated the effect of exercise on the risk of delivering a LBW newborn (Table X). In all articles, the incidence of LBW was not increased, regardless of the population, intervention type or gestational age.

Similarly, all the systematic reviews[97] and meta-analysis[7,28,29,33,43,61,64,65] that examined the impact of exercise during pregnancy on the risk of delivering SGA newborns found no significant difference (Table X). In particular, Wiebe *et al*[33] performed a subgroup analysis considering women with different comorbidities. In all groups, including overweight and obese women (OR=0.90, 95% CI=0.31 to 2.63, p=0.85[33]) and women with chronic hypertension or a history of PE (OR=0.75, 95% CI=0.28 to 1.98, p=0.56[33]), exercise did not significantly increase the odds of SGA.

An inadequate GWG can impair fetal growth, increasing the risk of SGA and LBW.[98] In this sense, Bennett *et al*[65] included in their review only studies designed to reduce GWG. Although a small reduction in newborn birthweight was noticed, exercise did not increase the risk for SGA (RR=0.38, 95% CI= 0.01 to 15.0) or LBW (RR=0.88, 95% CI= 0.60 to 1.29).

Thus, the available evidence supports the safety of exercise during pregnancy regarding the risk of SGA and LBW, including low, moderate and vigorous intensity physical exercise.

2.3. Miscarriage and perinatal mortality

Miscarriage (spontaneous loss of the embryo or fetus before 24 weeks of gestation) is a common adverse outcome, occurring in approximately 15% of all pregnancies.[99] Perinatal mortality (PM) includes fetal death (more than 24 weeks of gestation) and neonatal death (ND, between birth and 28 days of life), and rates in the United States are around 6 per 1000 live births.[100] Obesity, hypertension and diabetes are known risk factors[100], conditions that can possibly be attenuated by regular exercise.

The risk of miscarriage in women who exercise during pregnancy was assessed by a meta-analysis[4] and a systematic review[45], and neither found a significant correlation (OR= 0.69, 95% CI=0.40 to 1.22, p=0.20)[4], suggesting that exercise is not associated with this outcome (Table XI). However, in Davenport *et al*[4], most of the evaluated studies included pregnancies after the 8th week of gestation, when the risk of miscarriage is smaller. Furthermore, amount, intensity or frequency of exercise did not seem to alter the odds of PM or miscarriage.[4] The maximum session duration registered was 60 min, at moderate intensity and, therefore, it is not possible to infer about the safety of more intense and prolonged exercise exposures.

Similarly, regarding PM and ND, none of the analyzed studies[4,97] found significantly increased odds associated with exercise (Table XI).

2.4. Apgar score

A worldwide used measurement of newborn status is the Apgar score. This score comprises five components (heart rate, respiration, muscle tone, reflexes, and color), each of which is given a value of 0 to 2. The total score is the sum of the five components, and a score superior to 7 ensures a good to excellent newborn condition.[101] As exercise during pregnancy was considered in the past potentially harmful to the fetus[90], evidence regarding maternal and newborn well-being was needed.

Two meta-analysis[52,61], one systematic review[37] and three RCTs[46,58,69] concluded that exercise does not affect Apgar scores (Table XII). This evidence was found consistently among different population groups, namely previously healthy women (OR= 0.78, 95% CI=0.21 to 2.91, p=0.71)[52], previously inactive women (Apgar score (1st min) ± SD=9.89±0.47 (EG) vs 9.80±0.70 (CG), p=0.828)[46] and women diagnosed with GDM (Apgar score (1st min) (interquartile range) = 8 (7-9) (EG) vs 8 (7-9) (CG), p=0.18)[58]. Ramírez-Vélez *et al*[46] found a reduction in newborn complications, such as cyanosis or respiratory distress (5% (EG) vs 12% (CG), p=0.01). Hence, evidence supports the safety of exercise across different populations and exercise programs, regarding the overall health status of the newborn.

2.5. Fetal heart rate and uterine blood flow

There is a potential risk of fetal bradycardia (FHR <110 bpm) in response to exercise, since maternal cardiac output is being redistributed to the working muscles and away from the utero-placental circulation[96], decreasing uterine blood flow (UBF). Additionally, maternal position during exercise can also influence UBF. On the contrary, chronic exercise can promote vascular remodeling and angiogenesis in umbilical and uterine arteries[102], which may help to counterbalance the acute effect of exercise on fetal blood supply.

Fetal heart rate was assessed by a meta-analysis[103] and a systematic review[97] (Table XIII). In both, FHR response was measured in acute and chronic exercise exposure. Skow *et al*[103] evaluated low to moderate intensity exercise, in chronic exposures, and also high and vigorous intensity, in acute exercise exposures. In both situations, FHR response was not considered clinically relevant, although differences between FHR at baseline and during acute exercise (MD=6.35bpm, p=0.002) and following acute exercise (MD=4.05bpm, p<0.00001) reached statistical significance. It is important to notice that the maximal exercise intensity considered was 92% of maximal heart rate. There is no evidence regarding the safety of higher intensities. On the other hand, Mottola *et al*[97] found potential adverse FHR responses (reduced FHR variability, reduced reactivity or fetal bradycardia) in 31% of the assessed fetus during acute supine exercise.

The impact of exercise interventions on UBF was also reviewed (Table XIII).[97,103] In Skow *et al*[103], no significant uteroplacental responses were found in both acute and chronic exposures to exercise. In Mottola *et al*[97], considering acute supine exercise, UBF was 16%±23% lower than in the left lateral rest position. However, the impact of chronic supine exercise exposures could not be correctly assessed, since interventions included several other types of exercise.

2.6. Maternal hyperthermia

One systematic review[104] and one meta-analysis[105] evaluated the exercise effect on maternal core temperature (Table XIV). Ravanelli *et al*[104] included trials with exercise performed in different conditions: land based and water immersion exercise. In neither study women exceeded the threshold of 39ºC (highest Tcore= 38.9°C [104]), nor changed core temperature more than 1,5ºC (MD= 0.26 ºC, 95% CI= 0.12 to 0.40 [105]). Thus, a safe zone was defined regarding exercise intensity and conditions: land based exercise for up to 35 min (80%–90% of maximum heart rate, 25°C and 45% relative humidity), and water immersion exercise for up to 45 min (≤33,4°C), irrespective of pregnancy stage.

Davenport *et al*[105] also assessed the odds of congenital anomalies and found no significant differences between groups (OR=1.23, 95% CI= 0.77 to 1.95). However, exercise was performed in most studies after 12 weeks' gestation (as is well established the risk of developing congenital abnormalities is greater in the 1st trimester).

A common limitation identified in both studies was the fact that it is currently not possible to infer conclusions concerning exercise performed at different intensities, durations and environmental conditions other than those included in these trials. Accordingly, the safety of more vigorous exercise or exercise performed at more critical conditions remains unknown.

3. Prescription

Exercise prescription is addressed by several international guidelines.[106-110] Regarding its frequency and duration, it is advised to accumulate 150 to 300 min of exercise per week, with sessions in most days of the week (≥ 3 days) of at least 20-30 min.[106-108]

Women's previous fitness level should always be considered to decide about exercise intensity. Although previously active pregnant women can be advised to exercise at moderate intensity, previously sedentary women should start their exercise program with light intensity exercise, followed by a more gradual progression.[106] Considering exercise at higher intensities, research is limited, but there is no evidence so far suggesting that vigorous exercise is harmful (in women with a previously high fitness level).[108]

Regarding exercise type, there are certain activities that were found to be safe in pregnancy, such as walking, stationary cycling, aerobic dancing, resistance exercises (using light weights, body weight, elastic bands), stretching exercises, swimming and water aerobics.[106,108] Moreover, a variety of aerobic and resistance exercises should be performed for greater benefits.[107] Specific PFMT exercises should also be performed to prevent UI.[36,37,80,81]

Contact activities and sports with increased risk of trauma should be avoided.[109] Exercise in the supine position should be addressed carefully, avoiding long periods of training, especially after the first trimester. [107,108]

Additionally, all women should be advised to remain well hydrated and have an adequate caloric intake before exercise. They should also be informed of the warning signs that should motivate them to stop: vaginal bleeding, abdominal pain, regular painful uterine contractions, amniotic fluid leakage, persistent excessive shortness of breath, dizziness, headache, severe chest pain, muscle weakness, calf pain or swelling. [106-108]

3.1. Contra-indications

Before recommending an exercise program, a thorough clinical evaluation should be conducted, to secure that there are no medical or obstetrical reasons to either avoid exercise, or to modify exercise routines.[106,109]

According to the 2019 Canadian Guidelines, absolute contraindications to exercise are: ruptured membranes, premature labor, unexplained persistent vaginal bleeding, placenta praevia after 28 weeks' gestation, PE, incompetent cervix, intrauterine growth restriction, high-order multiple pregnancy (eg. triplets), uncontrolled type I diabetes, uncontrolled hypertension, uncontrolled thyroid disease and other serious cardiovascular, respiratory or systemic disorders.[107] Additionally, relative contraindications are: recurrent pregnancy loss, history of spontaneous PTB, twin pregnancy after the 28th week, GH or mild/moderate cardiovascular or respiratory disease, symptomatic anemia, malnutrition, eating disorder, and other significant medical conditions.[107]

3.2. Monitoring

Heart rate response is used to monitor exercise intensity. However, during pregnancy, it can overestimate the intensity at lower work rates and underestimate it at higher work rates.[17] In this sense, tools, such as the Borg Rate of Perceived Exertion, are potentially more useful to monitor exercise intensity during the pregnancy period.[110] This scale goes from 6 to 20, and for moderate-intensity exercise, ratings of perceived exertion should be 13–14. Another way to measure exertion is the "talk test", which relates to the women's ability to carry on a conversation while exercising.[106] The intensity of exercise is considered moderate if the woman can hold a conversation, or vigorous if the woman needs to pause for breath. Additionally, some walking-based interventions used pedometers to monitor exercise.

Another important aspect to consider is exercise adherence. In fact, several reviews reported different results with different sessions´ attendance[23], suggesting that compliance may play a major role in achieving exercise associated benefits. Moreover, supervised exercise interventions, overall, were related to a superior program compliance. This may be due to an increased motivation experienced by the participants. Accordingly, interventions which included group classes reported better compliance compared to programs based only in counseling[39].

Discussion

1.1 Benefits

Exercise proved to have a beneficial impact in all weight-related variables, namely GWG (low to high quality level of evidence, 13 studies[27-37]), EGWG (low to high quality evidence, 5 studies[30,35,37,41,42]) and PPWR (low to moderate quality of evidence, 3 studies[30,47,48]). Similarly, women who exercised during pregnancy had a lower risk of GDM (very low to high quality evidence, 11 studies[6,28,29,32,45,52-57]), and a better post-prandial glucose control (low to moderate quality evidence, 4 studies[37,58-60]). In fact, risk factors for developing GDM are maternal overweight and obesity, which can be improved with exercise (it helps decreasing GWG and EGWG).

Exercise was also related to a lower risk of macrosomia (very low to high quality evidence, 4 studies[7,36,64,65]) and LGA (low to high quality evidence, 3 studies[29,33,64]) newborns. This could be related to the fact that exercise can also reduce the risk of developing GDM, since it is a known risk factor for excessive fetal growth.

Regarding gestational hypertensive disorders, both GH (very low to high quality evidence, 3 studies[6,45,56]) and PE (very low to high quality evidence, 4 studies[6,45,56,73]) risk was lower in women who exercised during pregnancy. Accordingly, the one study that evaluated maternal blood pressure[74] (low quality evidence) found a lower resting systolic blood pressure among the exercise group.

Considering delivery outcomes, exercise did not influence cesarean delivery rates (moderate to high quality evidence, 7 studies[5,28,32,35,36,46,61]), labor duration (low to high quality evidence, 3 studies[36,67,68]) or instrumental delivery rates (moderate to high quality evidence, 4 studies[56,66-68]). However, a higher probability of vaginal delivery (moderate to high quality evidence, 3 studies[56,66,67]) was found in exercise groups. Heterogeneity among these findings may be related with the fact that operative deliveries are influenced by multiple variables (including maternal obesity that was not considered in many studies). Exercise can prevent fetal macrosomia, GDM and improve maternal cardiorespiratory capacity and fitness level, decreasing maternal exhaustion but, on the other hand, it does not influence aspects such as fetal breech presentation, uterine abnormalities, obstetric emergencies such as cord prolapse, maternal request for a cesarean delivery or obstetrical protocols to treat labor dystocia.

Lumbopelvic pain intensity (very low to low quality evidence, 2 studies[34,37]) had a better control in women who exercised during pregnancy, although pain prevalence was similar between groups. However, among the included studies, pain intensity measurement tools varied plenty, hampering the establishment of firm conclusions.

Exercise showed a beneficial effect in urinary incontinence prevalence (very low to moderate quality evidence, 4 studies[36,37,80,81]). Indeed, the fact that exercise lowered LGA, macrosomia and EGWG risk, could also have influenced this outcome. Regarding UI, exercise type seemed to have had an important role, since most studies that presented significant results included PFMT in their intervention.

Considering psychological outcomes, exercise showed to have a beneficial effect on anxiety (low to moderate quality evidence, 3 studies[23,34,85]) and prenatal depression (very low to moderate quality evidence, 4 studies[3,34,37,85]). Postpartum depression was not influenced by prenatal exercise (low to high quality evidence, 3 studies[3,87,88]).

Overall, the level of quality of evidence was rated down mainly because of risk of bias and heterogeneity of the results presented.

1.2 Risks

Two studies[104,105] evaluated maternal core temperature changes with exercise, and concluded that it doesn't rise significantly to dangerous values (very low to moderate quality evidence).

Evidence did not relate exercise to an increased risk of PTB (very low to high quality evidence, 12 studies[7,28,29,35,37,42,43,45,46,52,56,92]). More research is needed regarding women with increased risk for PTB (e.g. history of a previous PTB). Newborn well-being was not affected by exercise - Apgar scores were not significantly different between exercise and control groups (low to high quality evidence, 6 studies[37,46,52,58,61,69]).

Findings about FHR and UBF were inconclusive (very low quality evidence, 2 studies [97,103]). However, in one of the studies[97], exercise performed in the supine position was one of the analyzed interventions and was related to potential adverse FHR responses (reduced FHR variability, reduced reactivity or fetal bradycardia). This may suggest that exercise performed in the supine position is better avoided during the first and second trimesters, but further research is needed.

Low birth weight risk (very low to high quality evidence, 7 studies[7,37,43,45,46,56,65]) and SGA risk (very low to high quality evidence, 9 studies[7,28,29,33,43,61,64,65,97]) were uniformly unaltered with exercise interventions across studies.

Overall, the level of quality of evidence was rated down mainly because of risk of bias, heterogeneity of results and indirectness of evidence.

1.3 Prescription

It should be noted that, when physical exercise had a dose-response relationship with pregnancy outcomes, greater health benefits were seen with more intense and frequent exercise sessions. In fact, a greater GWG reduction was found in interventions done at least 3 times per week, during 30-45 min per session.[27] Also, to reduce the odds of developing GDM by 90%, it was necessary to perform physical exercise 150 to 180 min per week.[57] Benefits regarding hypertensive disorders were achieved when exercise interventions were performed ≥3 days per week, at least 25 min per session.[6] Similarly, for prenatal depression, benefits were greater in women who trained more than 4 times per week, in 30 min sessions of moderate-to-vigorous exercise.[86] In summary, most of the described benefits can be achieved with compliance to the current international guidelines.[106-108] Additionally, interventions that consisted only in counseling were not as effective, probably due to an increased compliance in supervised and structured exercises.

With regard to exercise safety limits, for each outcome a maximum intensity and session duration was registered. Considering LBW as SGA, evidence available pointed that low, moderate and vigorous intensity physical exercise is safe. In studies evaluating miscarriage, the maximum session duration registered was 60 min, at moderate intensity, with no negative outcomes reported. Concerning the environment, exercise for up to 35 min at moderate intensity in 25°C and 45% relative humidity, and water immersion (≤33,4°C) exercise for up to 45 min, are safe, irrespective of pregnancy stage. Regarding fetal well-being, FHR response was not considered clinically relevant for a 92% maximal maternal heart rate. However, exercise in the supine position showed a potential higher risk of adverse FHR responses. It is currently not possible to infer conclusions concerning exercise performed at different intensities, durations and environmental conditions other than those included in these trials.

There are some limitations to this review. First, it only considered studies in English and Portuguese, possibly inducing a publication bias. Additionally, only RCTs, systematic reviews and meta-analysis were included, which may have limited its comprehensiveness. Secondly, the fact that several different types of exercise interventions were considered for each outcome may have influenced the significance of the effect of exercise interventions. Accordingly, the variety of interventions included in each exercise program may have hampered the interpretation of some results. In addition, the fact that some articles included interventions not limited to exercise (such as diet and lifestyle counseling) may have induced some bias. Finally, there is lack of strong evidence for some of the included outcomes, such as

FHR, UBF, LP, PM, miscarriage and congenital anomalies (very low to low quality evidence, from maximum n=3 studies).

Strengths of the current study include the synthesis of evidence from fifteen countries from five different continents, and the application of the GRADE methodology to evaluate the quality of evidence. Additionally, the chosen study design of the included articles provided a strong level of evidence, since only RCTs, systematic reviews and meta-analysis were included.

This review provides important insight to exercise prescription in clinical practice. On one hand, it reassures and increases the confidence in prescribing exercise during pregnancy, since it generally improves maternal and fetal outcomes, in the absence of significant harmful effects. On the other hand, based on international guidelines and dose-response analysis, it was possible to find an appropriate duration, frequency and intensity to be advised as a goal for most pregnant women. In addition, these results can help to improve women's motivation to comply to the exercise programs.

In future studies, more attention should be paid to the impact of specific types of exercises, timing of initiation and total duration on pregnancy outcomes. Moreover, program compliance should be monitored more rigorously, and factors that may influence participants' retention and compliance should be accessed.

The impact of exercise on pregnancy outcomes was mainly evaluated among healthy pregnant women. Future research is needed considering exercise compatible with pregnant women with specific comorbidities.

Additionally, the impact of pre-gestational exercise on pregnancy related outcomes could add important information on these results. Likewise, it would be important to access the effects of a sedentary lifestyle during pregnancy. There is as well a necessity to better define an upper-safe-limit of exercise intensity, frequency and duration, in order to better advise previously active women, namely professional athletes and exercise enthusiasts.

Conclusion

Exercise can help preventing important pregnancy related disorders, such as GDM, GH and PE. Conditions that have an impact in maternal quality of life, such as anxiety, prenatal depression, lumbopelvic pain and UI are also prevented and improved with exercise. Exercise was not found to be related with an increased risk of miscarriage, congenital anomalies, preterm birth, perinatal mortality, low Apgar scores or inadequate fetal growth (SGA and LBW). Considering exercise prescription, most of the described benefits can be achieved with compliance to the current international guidelines. Exercise intensity should be adapted to women's previous fitness level. Specific types of exercise and their particular effect in each maternal and perinatal outcome as well as exercise in women with specific comorbidities need more extensive research.

Appendix

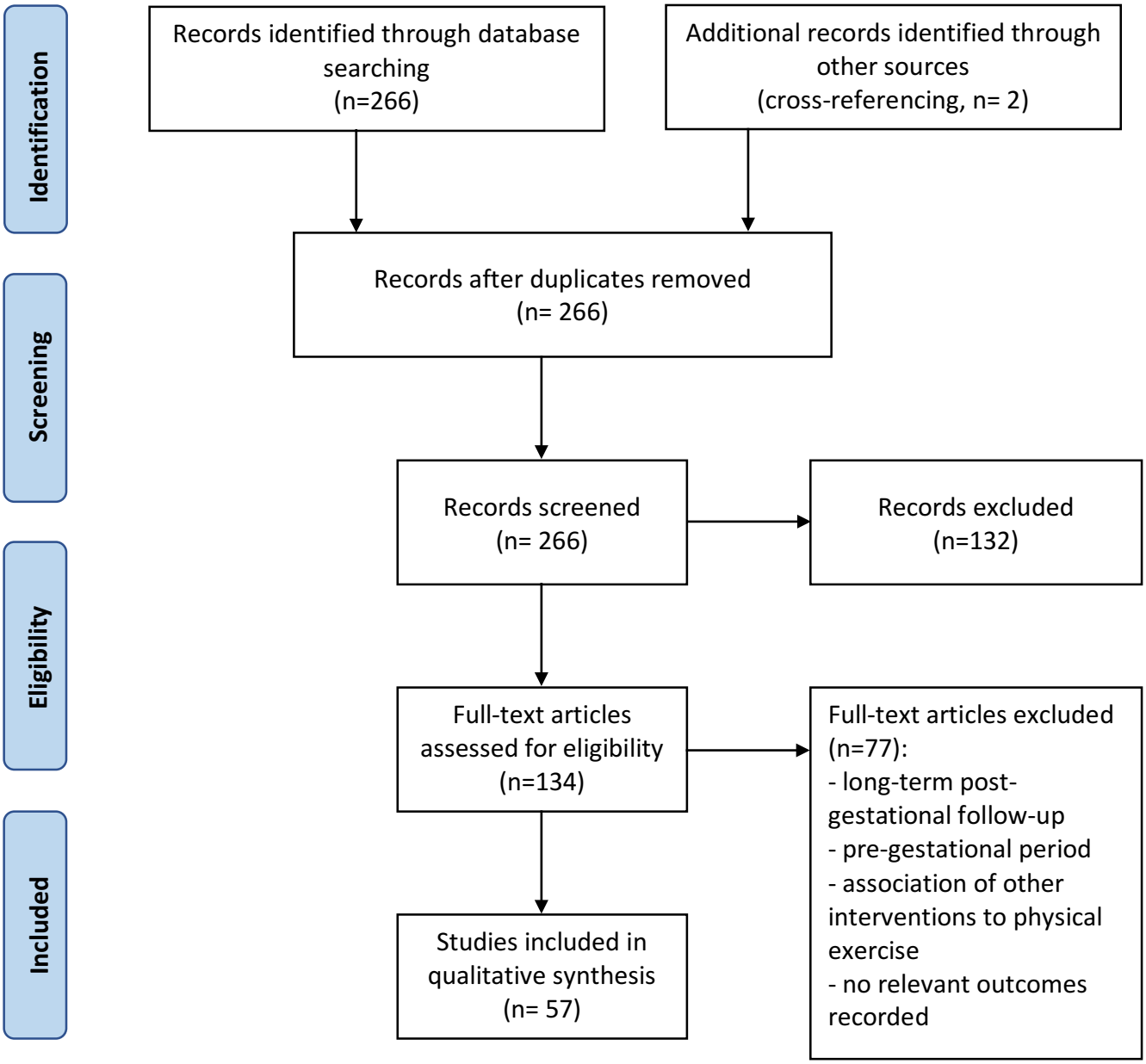

Figure 1 – Flow chart of the literature research, (PRISMA-P)

Table I – Gestational weight gain, excessive gestational weight gain and postpartum weight retention

Author (year, country)	Study design	Population	Intervention	Outcomes	Results	Conclusions	Level of evidence (GRADE)
Wang (2019, China)[27]	Meta-analysis	23 RCTs, n=4462, Pregnant women without contraindications to exercise	Exercise interventions - aerobic exercise, muscle resistance, PFMT and aquatic exercises. Performed 1 to 5 times/ week, sessions of 20-60 min, intensity varied from light to moderate. Interventions performed between the 1st trimester and delivery.	GWG	Total Weight MD= -1.02kg 95% CI= -1.35 to – 0.70 ***3 times per week:** MD= - 1.22kg 95% CI= - 1.55 to - 0.90 ***duration of 30-45min:** MD= - 1.32kg 95% CI= - 1.79 to - 0.85 ***from 1st to the 3rd trimester:** MD= - 1.42 95% CI= - 1.85 to - 0.98	Intervention group had significantly reduced GWG. This benefit was higher with exercise frequency of 3 times/week, 30-45 min per session and during the 1st to the 3rd trimester.	High
Du (2018, China)[28]	Systematic Review and Meta-analysis	12 RCTs, n=1172 Overweight and obese pregnant women, with a singleton pregnancy	Home-based or supervised programs. Exercise interventions - aerobic training, stretching, muscle strength and relaxation exercises. Sessions of 25-60 min, 1-7 times/week. Gestational age at start from 11 to 20 weeks; end of intervention varied between 28 weeks until delivery.	GWG	Total Weight MD= -1.14 kg 95% CI= - 1.67 to -0.62 (p<0.0001)	Physical exercise significantly reduced GWG, in overweight/obese women.	High
Chan (2019, China)[34]	Systematic Review	14 articles (13 RCTs + 1 CCT), n=3834 Pregnant women aged 18 or above, carrying a	Exercise interventions - counseling, unsupervised exercise, supervised or a combination of these. Types of exercise - aerobics, PFMT, stretching and relaxation exercises. Sessions from 15-60 min, frequency 1-7	GWG	—	Physical exercise during pregnancy is potentially useful in reducing GWG. However, several included studies did not find a relationship between	Low

		singleton pregnancy, without contraindications to exercise	times/week, duration from 6 20 weeks until delivery.			exercise and GWG.	
Beetham (2019, Australia)[43]	Systematic Review and Meta-analysis	2 cohort studies, 4 RCTs, 1 case-control, n=1834 Pregnant women without contraindications to exercise	Supervised exercise interventions - aerobic exercises, muscle resistance and water aerobics. Sessions from 13-180 min, and frequency varied between 2-4 times/week. Exercise was performed at vigorous intensity, during the 3rd trimester.	GWG	Total Weight Gain MD= - 0.46kg 95% CI = - 2.05 to 1.12 kg (p=0.50)	Physical exercise did not significantly change maternal GWG. RCTs targeting overweight and obese women did show a significant reduction in maternal weight gain in the intervention groups.	Very Low
Brik (2019, Spain)[47]	Randomized Controlled Trial	n=120 Pregnant women with <16 weeks of gestation, not previously exercising regularly	Supervised exercise intervention - aerobic exercise, strengthening and PFMT, coordination, balance and stretching. Sessions of 60 min, 3 times/week, of light to moderate intensity, performed from week 9 to week 38.	GWG, PPWR	**Total Weight Gain at 38W** = 11.4±4.2 kg (EG) vs 11.2±6.4 kg (CG) (p=0.82) **Total weight loss at 6W PP** = 9.7±3.0 kg (EG) vs 8.1±3.5 kg (CG) (p=0.01)	Physical exercise did not significantly change GWG at 38 weeks of gestation between both groups. At 6 weeks postpartum, the exercise group had a higher weight loss compared to the control group.	**GWG:** Low **PPWR:** Low
Shieh (2018, USA)[44]	Systematic Review and Meta-analysis	6 RCTs, n=348	Exercise interventions - structured and supervised, structured but unsupervised and unsupervised programs. Types of exercise: aerobic, resistance exercise and PFMT. Sessions from 15-60 min, frequency between 1-5 times/week, and duration from 12 to 25 weeks.	GWG	Total Weight MD= - 0.28kg 95% CI = - 1.50 to 0.94 (p=0.65)	Exercise interventions did not significantly reduce GWG.	Moderate
Ruchat (2018, Canada)[30]	Systematic Review and Meta-	46 studies (GWG: n=5819, PPWR: n=420,	Exercise interventions -aerobic exercise, water gymnastics, resistance training, PFMT and yoga.	GWG, EGWG, PPWR	Total Weight MD= - 0.90kg 95% CI = - 1.23 to -0.57	Exercise interventions significantly decreased total GWG, PPWR and reduced	**GWG:** Low **EGWG:** Moderate **PPWR:** Moderate

	analysis	EGWG: n=3519) Pregnant women without contraindications to exercise	Sessions of 10-90 min, at moderate intensity. Frequency of 1-7 times/ week. Programs started before the 20th week, and ended in mid-to-late third trimester.		**PPWR** MD= -0.92 kg 95% CI = - 1.84 to 0.00 (p=0.05) **EGWG** OR= 0.68 95% CI = 0.57 to 0.80 (p<0.00001)	the odds of EGWG.	
Nobles (2018, USA)[40]	Randomized Controlled Trial	N=241 Previously inactive pregnant women at high risk for Gestational Diabetes, without CI to exercise	Unsupervised exercise intervention, with flexibility in choosing the type of exercise, but with an emphasis on increased walking. Goal of 30 min of exercise/day, most days of the week, during 12 weeks. Weekly and biweekly motivational telephone calls were made.	GWG, EGWG	Total Weight MD= -1.67kg 95% CI = -3.91 to 0.56 (p=0.14) **EGWG** OR= 0.74 95% CI = 0.35 to 1.57 (p=0.43)	Exercise intervention was associated with a lower mean GWG and decreased odds of EGWG, but neither reached statistical significance.	**GWG:** Low **EGWG:** Low
Bacchi (2017, Spain)[41]	Randomized Controlled Trial	N=111 Healthy pregnant women, with singleton and uncomplicated pregnancies	Supervised aquatic exercise intervention - aerobic, resistance and relaxation exercises. Sessions of 55-60 min, of light to moderate intensity, 3 times/week. Exercise program performed from 10^{th}-12^{th} week until the end of the third trimester.	GWG, EGWG	Total Weight Gain= 12.7±2.6kg (EG) vs 13.9±4.3kg (CG) (p=0.10) **EGWG** OR= 0.39 95% CI = 0.17 to 0.89 (p=0.02)	Exercise interventions reduced the odds of EGWG. No differences were found regarding total maternal GWG.	**GWG:** Moderate **EGWG:** Moderate
Ramírez-Vélez (2017, Colombia)[46]	Randomized Controlled Trial (secondary analysis)	N=50 Previously inactive pregnant women, nulliparous, without contraindications to exercise	Supervised exercise intervention - aerobic, resistance and relaxation exercises. Sessions of 60 min, of moderate to vigorous intensity, 3 times/week. Exercise program performed during 12 weeks.	GWG	Total Weight MD= -0.60kg 95% CI = - 4.0 to 2.0 (p=0.82)	Physical exercise did not significantly change maternal GWG.	Moderate

Da Silva (2016, Brazil)[29]	Systematic Review and Meta-analysis	18 RCTs (n=3203) + 6 cohort studies (n=9795) Pregnant women without contraindications to exercise	**RCTs:** exercise interventions - muscle resistance, aerobic exercises, PFMT and stretching. Sessions of 20-60 min, at light to moderate intensity, and performed 1-5 times per week. Exercise programs started between 6 and 27 weeks, and finished generally at the end of the 3rd trimester. **Cohort:** exercise was performed during the 1st, 2nd and/or 3rd trimester. Type of exercise was not specified.	GWG, EGWG	**RCTs (GWG):** Total Weight MD= - 1.11kg 95% CI = - 1.53 to - 0.69 **Cohort (EGWG):** EGWG OR= 0.82 95% CI = 0.68 to 0.99	Exercise interventions significantly reduced EGWG, with active women having a 18% risk reduction. Total GWG was lower in the exercise group compared with controls, although without statistical significance.	**GWG:** Moderate **EGWG:** Very Low
Da Silva (2017, Brazil)[42]	Randomized Controlled Trial	N=639, Healthy pregnant women, without contraindications to exercise	Supervised exercise intervention - aerobic activities, strength training and stretching. Sessions of 60 min, of moderate intensity, 3 times/week. Exercise program was performed for at least 16 weeks.	GWG, EGWG	**GWG:** ***Intention to Treat:** Total Weight MD= - 0.4 kg 95% CI = - 0.8 to 0.60 (p=0.43) ***Per protocol (≥70% adherence):** Total Weight MD= -0.2 kg 95% CI= - 1.7 to 1.3 kg EGWG: ***Intention to treat:** OR= 1.1 95% CI= 0.7 to 1.6 ***Per protocol (≥70% adherence):** OR= 1.3 95% CI= 0.7 to 2.3	Physical exercise did not significantly change maternal GWG, nor EGWG.	**GWG:** Moderate **EGWG:** Moderate
Sanabria-Martínez (2015,	Meta-analysis	13 RCTs, n=2873 Previously inactive and	Supervised (n=12) and home-based (n=1) exercise interventions - aerobic exercises, flexibility, strength	GWG	Total Weight MD= - 1.14 kg 95% CI = - 1.5 to - 0.78	Exercise interventions significantly reduced maternal GWG.	Moderate

Spain)[54]		healthy women, with singleton pregnancy	exercises and PFMT. Sessions of 15-60 min, intensity ranged from very light to moderate and frequency between 2-5 days/week. Exercise programs were conducted throughout pregnancy or from 2nd trimester to the end of pregnancy.		(p<0.001)		
Muktabhant (2015, Thailand)[35]	Systematic review and Meta-analysis	EGWG: 6 RCTs, n=3235; GWG: 8 RCTs, n= 2431 'Low-risk women': normal BMI 'Mixed-risk women': general population 'High-risk women': overweight and/or obese women or women with or at risk of gestational diabetes	Unsupervised and supervised interventions - aerobic, strength exercises and relaxation. Sessions of 35-60 min, 1-7 times/week, at light to moderate intensity. Exercise programs started between the 6th and 14th weeks, and finished generally at the end of the 3rd trimester.	GWG, EGWG	**EGWG:** **Low-risk pop**. RR= 0.69 95% CI = 0.47 to 1.02 (p=0.063) **Mixed risk pop.** RR= 0.77 95% CI = 0.66 to 0.88 (p=0.00022) **High risk pop.** RR= 0.84 95% CI = 0.73 to 0.95 (0.0077) **GWG:** **Low-risk pop.** MD= -1.50kg 95% CI = -2.08 to -0.92 (p<0.00001) **Mixed risk pop.** MD= -1.00kg 95% CI = -2.01 to 0.01 (p=0.051) **High risk pop.** MD= -0.34kg 95% CI = -1.15 to 0.47 (p=0.41)	Exercise interventions significantly reduced the risk of EGWG (low, mixed and high risk populations) and mean GWG (low risk population).	**GWG:** ***Low-risk:** High ***Mixed risk:** Low ***High risk:** Moderate **EGWG:** ***Low-risk:** Moderate ***Mixed risk:** Moderate ***High risk:** High

Kong (2014, USA)[48]	Randomized Controlled Trial	N=34 Previously inactive, overweight or obese pregnant women	Unsupervised walking program, performed at least 150 min per week, at moderate intensity, between the 15th and 35th weeks of gestation. Treadmills were provided to the intervention group.	PPWR	Total Weight at 6M PP = -0.10±8.11kg (EG) vs 6.35±7.47kg (CG) (p=0.046)	Exercise intervention significantly reduced PPWR among overweight and obese pregnant women.	Moderate
Lamina (2013, Nigeria)[35]	Systematic Review and Meta-analysis	11 RCTs, n=1177 Pregnant women without contraindications to exercise	Aerobic exercise interventions, of moderate intensity, at least 3 times per week, starting between the 6th and 24th weeks, and finishing at the end of the 3rd trimester.	GWG	Total GWG = 11.31±7.44kg (EG) vs 14.42±6.60kg (CG) (p<0.05)	Aerobic exercise interventions significantly decreased mean GWG.	Moderate
Choi (2013, USA)[38]	Systematic Review and Meta-analysis	2 RCTs, n=52 Overweight or obese pregnant women	Exercise interventions included 1) muscle resistance group training, sessions of 35-40 min, 3 times/week, at light to moderate intensity, during 26 weeks; and 2) stationary cycling, sessions of 35-65 min, 3 times/week, at moderate intensity, during 10 weeks.	GWG	Total Weight MD= −1.74 kg 95% CI: −3.66 to 0.19 p = 0.077	Exercise interventions did not significantly decrease mean GWG among overweight and obese pregnant women.	High
Nascimento (2012, Brazil)[37]	Systematic Review	GWG: n=149, 2 RCTs EGWG: n=377, 4 RCTs Pregnant women without contraindications to exercise	Supervised and home-based exercise interventions - aerobic exercises, muscle conditioning and relaxation exercises. Sessions of 40-60 min, 1 to 3 times/week, and intensity varied between light and moderate. Program's duration was only mentioned in one study (12-week plan).	GWG, EGWG	—	Exercise interventions provided benefits regarding EGWG and GWG.	**GWG:** Moderate **EGWG:** Moderate
Streuling (2011, Germany)[31]	Systematic Review and Meta-analysis	12 RCTs, n=906 Pregnant women without contraindications	Supervised and home-based exercise interventions - aerobic exercise or muscle strengthening. Sessions of 20-60 min, 3-5 times/week, at	GWG	Total Weight MD= -0.61 kg 95% CI = - 1.17 to - 0.06 (p=0.03)	Exercise interventions significantly reduced mean GWG.	Moderate

		to exercise	moderate to vigorous intensity. Exercise programs were performed between the first trimester until delivery.				
Schlüssel (2008, Brazil)[45]	Systematic Review	5 observational studies, n=2115 Pregnant women without contraindications to exercise	Physical exercise including Leisure-time physical activities (purpose of health promotion or simply for leisure) or occupational physical activities, performed at light-to-vigorous intensity.	GWG	—	The majority of the studies (n=3) analyzing GWG did not find a relationship between exercise during pregnancy and lower mean GWG. Two other studies found a significant relationship between exercise and GWG.	Very Low
Perales (2016, Spain)[36]	Systematic Review	29 RCTs Pregnant women without contraindications to exercise	Exercise interventions - aerobic, resistance, combined and exercise counseling interventions. Session frequency, intensity and duration were not specified.	GWG	—	A weak level of evidence was found relating exercise with a better GWG control.	Moderate
Wiebe (2015, Canada)[33]	Systematic Review and Meta-analysis	19 RCTs, n=3525 low-risk pregnant women (n=15), overweight and obese (n=1), diagnosed with GD (n=3)	Exercise interventions - aerobic exercise and/or resistance training. Sessions of 30-60 min, 1 to 5 times/week. Exercise programs were performed during 6 to 33 weeks, ending in the mid to late third trimester.	GWG	SD= - 1.06 95% CI= -1.51 to - 0.62 p=< 0.00001	Exercise during pregnancy was associated with significantly reduced odds of GWG.	Moderate

Ming (2018, China)[32]	Systematic Review and Meta-analysis	5 RCTs, n=1688 Normal-weight pregnant women, without contraindications to exercise	Exercise interventions - aerobic exercises, muscle training, flexibility and aquatic activities. Sessions of 35 to 60 min, at light-to-moderate intensity, performed 3 times/week. Interventions started between 6-13 weeks and finished at the end of the 3rd trimester.	GWG	MD = − 1.61 kg 95% CI= − 1.99 to − 1.22 kg p<0.01	Exercise interventions significantly decreased GWG in normal weight women.	Moderate

GWG: Gestational Weight Gain; EGWG: Excessive Gestational Weight Gain; PFMT: Pelvic Floor Muscle Training; PPWR: Postpartum Weight Retention; PP: postpartum; MD: Mean deviation; OR: odds ratio; RR: relative risk; CI: confidence interval

Table II – Gestational diabetes *mellitus* and glucose control

Author (year, country)	Study design	Population	Intervention	Outcomes	Results	Conclusions	Level of Evidence (GRADE)
Du (2018, China) [28]	Systematic Review and Meta-analysis	10 RCTs, n=1120 Overweight and obese pregnant women	Home-based or supervised programs - aerobic training, muscle resistance and relaxation exercises. Sessions of 25-60 min, 1-5 times/week. Start at 11-28 weeks; end of intervention varied between 32 weeks until delivery.	GDM	RR = 0.71 95% CI= 0.57 to 0.89 (p=0.004)	Physical exercise significantly reduced GDM risk, on overweight/obese women.	High
Yu (2017, China)[52]	Systematic Review and Meta-analysis	5 RCTs, n=1408 Pregnant women without contraindications to exercise	Exercise interventions - supervised cycling program, 3 times/week, and exercise programs based on ACOG guidelines: 30 minutes or more of moderate-intensity physical activity on most days of the week. Duration varied between 12 and 30 weeks.	GDM	OR = 0.59 95% CI= 0.39 to 0.88 (p=0.01)	Exercise interventions significantly reduced the odds of developing GDM.	Moderate

Sklempe (2017, Croatia)[58]	Randomized Controlled Trial	N=42 Pregnant women diagnosed with GDM	Supervised exercise intervention - aerobic and strength exercises, PFMT and stretching. Sessions of 60 min, performed 2 times/week at moderate intensity. Additionally, women were encouraged to do 30 min of cardio exercises at least three times a week.	GC	**Fasting glucose level:** 4.32±0.26 mmol/L (EG) vs 4.44±0.46 mmol/L (CG) (p=0.367) **Average of 3 postprandial glucose levels:** 4.66±0.46 mmol/L (EG) vs 5.30±0.47 mmol/L (CG) (p<0.001)	Exercise significantly reduced postprandial glucose levels measured at the end of pregnancy, but the levels of fasting glucose were not different.	**Fasting glucose level:** Moderate **Postprandial glucose levels:** Moderate
Ming (2018, China)[32]	Systematic Review and Meta-analysis	8 RCTs, n=3256 Normal-weight pregnant women, without contraindications to exercise	Exercise interventions - aerobic exercises, muscle strength and flexibility. Sessions of 35 to 60 min, at light-to-moderate intensity, performed 1-3 times/week. Interventions started between 6-20 weeks and finished at the end of the 3rd trimester.	GDM	**WHO criteria:** RR = 0.58 95% CI= 0.37 to 0.90 (p=0.01) **IADPSG criteria:** RR = 0.60 95% CI= 0.36 to 0.98 (p=0.04)	Exercise interventions significantly decreased the risk of developing GDM, in normal weight women.	**WHO criteria:** Very Low **IADPSG criteria:** Very Low

Mijatovic-Vukas (2018, Australia)[53]	Systematic Review and Meta-analysis	8 observational studies, n= n=23767 Pregnant women without contraindications to exercise	Not available.	GDM	OR= 0.79 95% CI= 0.64 to 0.97 (p=0.03)	Early pregnancy physical activity was associated with reduced odds of GDM, compared to no physical activity during pregnancy.	Low
Davenport (2018, Canada)[60]	Systematic Review and Meta-analysis Pregnant women without contra-indications to exercise	58 studies, n=8699 (31 RCTs + 7 non-randomized interventions + 8 cohort studies + 12 cross-sectional studies)	Exercise interventions - aerobic exercise, yoga, resistance training PFMT. Sessions of 15 to 60 min, from 1 to 7 days/week.	GC	**Blood glucose** ***pre-exercise to during exercise:** MD= - 0.94 mmol/L 95% CI= -1.18 to -0.70 ***pre-exercise to post- exercise:** MD= - 0.57 mmol/L 95% CI= -0.72 to -0.41, p<0.00001 -women with GDM: MD= - 1.42 mmol/L 95% CI= -2.69 to -1.16, p<0.00001 ***chronic exercise vs no exercise:** MD= −0.48 mmol/L 95% CI= −0.76 to −0.19 -women with GDM: MD= - 2.76 mmol/L 95% CI= -3.18 to -2.34	Acute and chronic exercise reduced maternal blood glucose concentrations, with a greater effect in women with GDM.	***pre-exercise to during exercise:** Low ***pre-exercise to post exercise:** Low ***chronic exercise vs no PE**: Low

Davenport, (2018, Canada)[6]	Systematic Review and Meta-analysis	26 RCTs, n=6934 Pregnant women without contraindications to exercise	Exercise interventions - aerobic exercises, aquatic exercises, resistance training, yoga and PFMT. Sessions of 10-90 min, from 1 to 7 days per week.	GDM	OR= 0.62 95% CI= 0.52 to 0.75 (p<0.00001)	Exercise interventions reduced the odds of GDM.	Moderate
Da Silva (2016, Brazil)[29]	Systematic Review and Meta-analysis	10 RCTs (GD: n=3362) + 6 cohort studies (GD: n=6754) Pregnant women without contraindications to exercise	**RCTs:** interventions - aerobic exercises, muscle resistance, PFMT, stretching and balance exercises. Sessions of 35 to 60 min, at light to moderate intensity, and 1-4 times/week. Exercise programs started between 6 and 20 weeks, and finished at the end of the 3rd trimester. **Cohort:** exercise was performed during the 1st, 2nd and/or 3rd trimester. The type of exercise performed was not specified.	GDM	**RCTs:** RR= 0,67 95% CI= 0.49 to 0.92 **Cohort:** OR=0.75 95% CI= 0.55-1.01	Exercise interventions reduced the risk of GDM.	**RCTs:** Moderate **Cohort:** Low
Da Silva (2017, Brazil)[42]	Randomized Controlled Trial	N=639, Healthy pregnant women, without contraindications to exercise	Supervised exercise intervention - aerobic activities, strength training and stretching exercises. Sessions of 60 min, of moderate intensity, 3 times/week. Exercise program was performed during 16 weeks.	GDM	OR= 1.0 95% CI= 0.6 to 1.9 (p=0.98)	Physical exercise did not change significantly the incidence of GDM.	Moderate

Perales (2016, Spain)[36]	Systematic Review	15 RCTs Pregnant women without contraindications to exercise	Exercise interventions - aerobic, resistance and combined interventions, and exercise counseling. Session frequency, intensity and duration was not specified.	GDM	—	Only four studies found a relationship between exercise and a lower risk of GDM.	High
Harrison (2016, Australia)[59]	Systematic Review and Meta-analysis	8 RCTs, n=588 Pregnant women diagnosed with GDM	Exercise interventions - aerobic exercise, resistance exercise and yoga. Sessions of 20 to 45 min, intensity ranged from low to heavy and frequency varied between 1 to 7 days/ week. Program's duration varied between 6 and 25 weeks.	GC	**Postprandial glycaemic control:** MD= - 0.33 mmol/L 95% CI= - 0.49 to - 0.17 **Fasting blood glucose:** MD= - 0.31 mmol/L 95% CI= - 0.56 to - 0.05	Exercise interventions significantly lowered postprandial glucose levels and fasting blood glucose. Insulin requirement was not significantly different between groups.	**Postprandial glycaemic control:** Moderate **Fasting blood glucose:** Moderate
Sanabria-Martínez (2015, Spain)[54]	Systematic Review and Meta-analysis	Meta análise: 8 RCTs, n=2501 Review: 13 RCTs, 2873 Previously inactive healthy pregnant women	Supervised exercise interventions including aerobic exercises, resistance, flexibility and PFMT. Sessions of 15-60 min, intensity ranged from light to moderate and frequency varied between 3 to 4 days/week. Exercise programs were conducted throughout pregnancy or from 2nd trimester to the end of pregnancy.	GDM	RR= 0.69 95% CI= 0.52 to 0.91 (p=0.009) ***when exercise was performed throughout pregnancy:** RR= 0.64 95% CI= 0.36 to 0.98 (p=0.038)	Exercise interventions significantly reduced maternal risk of GDM.	Moderate

Russo (2015, USA)[55]	Systematic Review and Meta-analysis	10 RCTs, n=3401 Pregnant women without contraindications to exercise	Exercise interventions - aerobic, strength and balance exercises. Sessions of 30 to 60 min, performed 2 to 5 times/week. Programs conducted from 6-8 weeks to 18-22 weeks.	GDM	RR= 0.72 95% CI= 0.58 to 0.91 (p=0.005)	Exercise interventions significantly reduced the risk of GDM.	High
Cordero (2015, Spain)[57]	Randomized Controlled Trial	N=342 Pregnant women without contraindications to exercise	Exercise interventions - stretching, aerobics, muscular strength, PFMT and swimming. Sessions of 50-60 min, 3 times/week, at moderate-high intensity. Program conducted from weeks 10-14 to the end of the third trimester.	GDM	OR= 0.103 95% CI= 0.013 to 0.803 (p=0.009)	The risk of developing GDM was significantly reduced in the exercise group.	Moderate
Han (2012, Australia)[61]	Systematic Review and Meta-analysis	3 RCTs, n=826; Pregnant women without contraindications to exercise	Exercise interventions - aerobic exercises, aquatic activities, strength and balance training. Sessions of 35 to 60 min, 1-3 times/week, and intensity varied between light and moderate. One study provided an individualized exercise plan. Programs began between weeks 6 and 20, and finished at the end of the 3rd trimester.	GDM	RR= 1.10 95% CI= 0.66 to 1.84	Exercise interventions did not significantly change the incidence of GDM.	Moderate

Schlüssel (2008, Brazil)[45]	Systematic Review	3 observational studies, n=14249 Pregnant women without contraindications to exercise	Exercise interventions - Leisure-time physical activities (purpose of health promotion or simply for leisure) or occupational physical activities, performed at light-to-moderate intensity.	GDM	—	Both light and moderate leisure-time and occupational physical activities showed a decreased risk of developing GDM.	Low
Nascimento (2012, Brazil)[37]	Systematic Review	3 RCTs, n=1002 Pregnant women without contraindications to exercise	Supervised and home-based exercise interventions - land and aquatic activities, and resistance exercise. Sessions were performed 3 times/week, and intensity varied between moderate and high.	GDM, GC	—	Evidence was not found regarding the effect of exercise on GDM prevention, but a better maternal glucose control was associated with exercise during pregnancy.	**GDM:** Low **Glucose control:** Low
Di Mascio, (2016, Italy)[56]	Systematic Review and Meta-analysis	4 RCTs, n=1686 Normal-weight pregnant women with singleton, uncomplicated gestations	Exercise interventions - aerobic, resistance, PFMT and stretching. Sessions of 50- 60 min, 3 times/week, at light to moderate intensity. Exercise programs started before the 11th week.	GDM	RR= 0.41 95% CI= 0.24 to 0.68	Women in the exercise group had a significantly lower incidence of GDM.	High

GC: Glucose Control; GDM: Gestational Diabetes Mellitus; PFMT: Pelvic Floor Muscle Training; RR: relative risk; OR: odds ratio; CI: confidence interval

Table III – Excessive fetal growth

Author (year, country)	Study design	Population	Intervention	Outcomes	Results	Conclusions	Level of Evidence (GRADE)
Du (2018, China)[28]	Meta-analysis	4 RCTs, n=595 Overweight and obese pregnant women	Home-based or supervised programs - aerobic training, stretching, muscle exercises and relaxation. Sessions of 30-60 min, 3-7 times/week. Gestational age at start from 11 to 18 weeks; end of intervention varied between 35 weeks until delivery.	Macrossomia	RR= 0.91 95% CI= 0.61 to 1.36 (p=0.64)	No significant differences were found between groups regarding the odds of delivering a macrosomic infant.	High
Davenport (2018, Canada)[7]	Systematic Review and Meta-analysis	15 RCTs, n=3670 Pregnant women without contraindications to exercise	Exercise interventions - aerobic exercise, water gymnastics, resistance training, yoga and PFMT. Sessions of 10 to 90 min, intensity ranged from low to vigorous, from 1 to 7 days/week. Exercise programs initiated in the 1st, 2nd or 3rd trimester.	Macrosomia	OR= 0.61 95% CI= 0.41 to 0.92 (p=0.02)	Exercise interventions reduced the odds of delivering a macrosomic baby.	High

Da Silva (2016, Brazil)[29]	Systematic Review and Meta-analysis	3 RCTs, n=603 Pregnant women without contraindications to exercise	Exercise interventions - aerobic exercises, aquatic resistance and stretching. Sessions of 15-50 min, at light to moderate intensity, and were performed 3 times/week. Exercise programs started between 6 and 20 weeks, and finished at the end of the 3rd trimester.	LGA	RR= 0.51 95% CI= 0.30 to 0.87	A lower risk of delivering a LGA infant was found in the exercise group.	Moderate
Perales (2016, Spain)[36]	Systematic Review	39 RCTs (8 aerobic, 21 combined exercise interventions, 5 resistance, and 5 exercise counseling interventions) Pregnant women without contraindications to exercise	Exercise including aerobic, resistance and combined interventions, and exercise counseling. Session frequency, intensity and duration was not specified.	Birth weight	—	Women who do aerobic exercise during pregnancy are more likely to have a normal birth weight, thereby reducing the risk of macrosomia.	Moderate
Muktabhant (2015, Thailand)[35]	Systematic review and Meta-analysis	9 RCTs, n=3636 Pregnant women without contraindications to exercise	Unsupervised and supervised interventions - aerobic exercises, balance and strength exercises. Sessions of 35 to 60 min, performed 2-7 times/week, at light to vigorous intensity. Programs started between the 6th and 27th weeks, and finished generally at the end of the 3rd trimester.	Macrosomia	**Unsupervised exercise:** RR= 1.16 95% CI= 0.74 to 1.81 (p=0.53) **Supervised exercise:** RR= 0.81 95% CI= 0.64 to 1.02 (p=0.074)	The odds of delivering a macrosomic infant showed no significant difference between groups.	**Unsupervised exercise:** High **Supervised exercise:** Moderate

Han (2012, Australia)[61]	Systematic Review and Meta-analysis	2 RCTs, n=934 Pregnant women without contraindications to exercise	Exercise intervention - aerobic activity, strength training and balance exercises. Sessions of 40- 60min, 1-5 times per week. Exercise program was conducted between 20-40 weeks of gestation.	Macrosomia	RR= 0.91 95% CI= 0.68 to 1.22	Exercise interventions did not significantly change the incidence of macrosomia between groups.	Moderate
Pastorino (2019, UK)[64]	Systematic Review and Meta-analysis	8 population-based studies, n= 75083	Leisure-time physical activity, at low, moderate and vigorous intensity. Exercise was performed in early (8-18 weeks gestation) or late pregnancy (30+ weeks). Session duration varied between 2h to 6,5h per week (early pregnancy) and 1h to 7h (late pregnancy).	Macrosomia, LGA	***Early pregnancy, LGA (RR (95% CI)):** LTPA: 0.99 (0.98, 1.00) MVPA: 1.00 (0.98, 1.01) VPA: 1.00 (0.98, 1.01) ***Early pregnancy, Macrosomia (RR (95% CI)):** LTPA: 0.99 (0.98, 1.01) MVPA: 1.00 (0.98, 1.01) VPA: 1.00 (0.98, 1.01) ***Late pregnancy, LGA (RR (95% CI)):** LTPA: 0.98 (0.97, 0.99) MVPA: 0.97 (0.96, 0.98) VPA: 0.89 (0.84, 0.94) ***Late pregnancy, Macrosomia (RR (95% CI)):** LTPA: 0.98 (0.96, 1.00) MVPA: 0.96 (0.94, 0.98) VPA: 0.89 (0.84, 0.95)	Leisure time physical activity during late, but not early pregnancy, reduced the risk of macrosomia and LGA.	**LGA:** Very Low **Macrosomia:** Very Low
Bennett (2018, Australia)	Systematic Review and Meta-analysis	M: 6 studies, n=2401 LGA: 2 studies, n=125 Studies designed to reduce GWG	Exercise interventions - aerobic, resistance exercises, stretching and relaxation exercises. Sessions of 30 to 60 min, 2-5 times/week, and intensity varied between very-light to moderate. Programs were performed during 12 - 33 weeks.	Macrossomia, LGA	**Macrosomia:** RR= 0.41 95% CI= 0.25 to 0.68 **LGA:** RR= 1.13 95% CI= 0.54 to 2.36	Exercise interventions reduced the risk of delivering a macrosomic infant. LGA risk was not significantly different between groups.	**Macrosomia:** Moderate **LGA:** High

Wiebe et al (2015, Canada)[33]	Systematic Review and Meta-analysis	19 RCTs, n=3982 low-risk pregnant women (n=14), overweight and obese (n=3), diagnosed with GD (n=1) women with chronic hypertension, a history of preeclampsia, or both (n=1)	Exercise interventions - aerobic exercise and/or resistance training. Sessions of 15-70 min, 1 to 5 times/week. Exercise programs were performed during 6 to 33 weeks, ending in the mid to late third trimester.	LGA	OR= 0.69 95% CI= 0.55 to 0.86 p=0.0009	Exercise during pregnancy was associated with significantly reduced odds of delivering a LGA infant.	High

LGA: Large-for-Gestational-Age; LTPA: Leisure Time Physical Activity; MVPA: Moderate to Vigorous Physical Activity; PFMT: Pelvic Floor Muscle Training; VPA: Vigorous Physical Activity; CI: Confidence Interval; RR: Relative Risk; OR: Odds Ratio

Table IV – Delivery mode and duration

Author (year, country)	Study design	Population	Intervention	Outcomes	Results	Conclusions	Level of Evidence (GRADE)
Du (2018, China)[28]	Systematic Review and Meta-analysis	10 RCTs, n=982 Overweight and obese pregnant women with a singleton pregnancy and no exercise contraindication	Home-based or supervised - aerobic training, stretching, muscle exercises and relaxation. Sessions of 25-60 min, 2-7 times/week. Gestational age at start from 11 to 28 weeks; end of intervention varied between 32 weeks until delivery.	CD	RR= 1.02 95% CI= 0.87 to 1.20 (p=0.79)	No significant differences were found between exercise and control groups regarding the risk of CD.	High
Ramírez-Vélez (2017, Colombia)[46]	Randomized Controlled Trial (secondary analysis)	N=50 Previously inactive, nulliparous pregnant women, without contraindications to exercise	Supervised exercise intervention - aerobic, resistance and relaxation exercises. Sessions of 60 min, of moderate to vigorous intensity, 3 times/week. Exercise program performed during 12 weeks.	CD	Percentage of CD: 27% (EG) vs 13%(CG) (p=0.89)	Physical exercise did not significantly change the odds of CD.	Moderate

Sanda (2018, Norway)[67]	Randomized Controlled Trial	N=271 Healthy pregnant women with singleton pregnancy and no contraindications to exercise	Supervised exercise intervention - aerobic exercises, strength training, PFMT and stretching. Sessions of 60 min, performed 2 times/week at moderate intensity. Women were also encouraged to undertake 30 min of cardio exercises at least three times a week.	CD, LD, VD	**VD:** OR= 2.69 95% CI= 1.02–7.09, (p = 0.046) **CD:** OR= 0.33, 95% CI= 0.11 to 0.97 (p=0.044) **LD, active labor:** 323±167min (EG) vs 278±164min (CG) (p=0.027) **LD, prolonged active labor:** OR= 2.02, 95% CI= 0.68 to 6.01 (p=0.20)	Exercise intervention was associated with a lower odds ratio of acute CD and higher odds of VD in high active women. The intervention group had a 44 min longer total duration of labor, considered of little clinical importance.	**CD:** Moderate **LD:** Low **VD:** Moderate
Poyatos-León (2015, Spain)[66]	Systematic Review and meta-analysis	CD: 10 RCTs, n= 3125 ID: 6 RCTs, n= 1637 ND: 8 RTCs, n= 1735 Healthy pregnant women with previously low to moderate levels of physical activity.	Supervised exercise interventions - aerobic exercises, resistance, flexibility PFMT. Sessions of 35 to 60 min, performed 3 to 4 times a week, and intensity ranged from very light to moderate. Programs performed throughout pregnancy or from 2nd trimester to the end of pregnancy.	CD, ID, VD	**VD:** RR= 1.12, 95% CI= 1.01 to 1.24 (p=0.041) **CD:** RR= 0.78, 95% CI= 0.58 to 1.05 (p=0.105) **ID:** RR= 0.88, 95% CI= 0.68 to 1.15 (p=0.365) ***exercise during the 2nd and 3rd trimester:** **VD:** RR= 1.14, 95% CI= 1.01 to 1.32 (p=0.048) **CD:** RR= 0.66, 95% CI= 0.46 to 0.96 (p=0.028)	Exercise interventions decreased the risk of CD and increased the frequency of VD, particularly when interventions took place during the 2nd and 3rd trimester. No significant changes were found regarding ID.	**CD:** Moderate **ID:** Moderate **VD:** Moderate

Davenport (2018, Canada)[5]	Systematic Review and Meta-analysis	ID:20 RCTs, n=3819 CD: 49 RCTs, n=8000 Pregnant women without contraindications to exercise	Exercise interventions - aerobic exercise, aquatic activities, resistance training, yoga and PFMT. Sessions of 10 to 120 min and were performed 1 to 7 days/week.	ID, CD	**ID:** OR= 0.76, 95% CI= 0.63 to 0.92, (p=0.004) **CD:** OR= 0.91, 95% CI= 0.79 to 1.05, (p=0.19)	Exercise interventions reduced the odds of ID. No difference was found between groups regarding odds of CD.	**ID:** Moderate **CD:** Moderate
Barakat (2018, Spain)[67]	Randomized Controlled Trial	N=325, Healthy pregnant women, with singleton and uncomplicated pregnancies	Supervised exercise interventions - aerobic, light muscle strengthening, balance exercises, stretching PFMT and relaxation. Sessions of 55-60 min, of moderate intensity, 3 times/week. Exercise program performed from 9th-11th week until the end of the 3rd trimester.	LD	**LD (first stage):** 409.15 ± 185.74 min (EG) vs 462.83 ± 208.37 min (CG), (p=0.01) **LD (second stage):** 33.23±22.53 min (EG) vs 36.21 ± 25.93min (CG), (p=0.68) **LD (third stage):** 8.37 ± 2.16min (EG) vs 8.14±1.86min (CG), (p=0.66) **LD (total):** 450.74 ± 188.64min (EG) vs 507.19 ± 2.16.06min (CG), (p=0.01)	Women in the exercise group had a shorter first stage and total LD.	Moderate
Muktabhant (2015, Thailand)[35]	Systematic review and Meta-analysis	10 RCTs, n=3595 Pregnant women without contraindications to exercise, of any BMI	Unsupervised and supervised interventions - aerobic exercises, balance, strength exercises, stretching and relaxation. Sessions of 35 to 60 min, 1-7 times/week, at light to high intensity. Exercise programs started between the 6th - 14th weeks, and finished at the end of the 3rd trimester.	CD	**Low-risk pop.:** RR=0.88, 95% CI= 0.63 to 1.21 (p=0.42) **Mixed-risk pop.:** RR=0.96, 95% CI= 0.76 to 1.22 (p=0.75) **High-risk pop.:** RR=0.98, 95% CI= 0.81 to 1.20 (p=0.88)	The odds of CD had no significant difference between groups.	**Low-risk:** High **Mixed risk:** Moderate **High risk:** High

Han (2012, Australia)[61]	Systematic Review and Meta-analysis	2 studies, n=934; Pregnant women without contraindications to exercise	Exercise interventions - aerobic sessions, aquatic activities, strength training and balance exercises. Sessions of 35 to 60 min, 1-3 times/week, and intensity varied between light and moderate. Exercise program between weeks 6 - 20, and finished at the end of the 3rd trimester.	CD, ID	**CD:** RR=1.33, 95% CI= 0.97 to 1.84 **ID:** RR= 0.83, 95% CI= 0.58 to 1.17.	Exercise interventions did not significantly change the incidence of CD or ID between groups.	**CD:** Moderate **ID:** Moderate
Perales (2016, Spain)[36]	Systematic Review	Duration: 4 RCTs CD: 15 RCTs Pregnant women without contraindications to exercise	Exercise interventions - aerobic, resistance and exercise counseling interventions. Session frequency, intensity and duration was not specified.	CD, LD	—	Most studies (89%) did not find a relationship between exercise and CD rates. Only one study found a significant reduction in LD with exercise during pregnancy.	Moderate

Agur (2007, UK)[68]	Randomized Controlled Trial	N=268 Primigravidae with antenatal bladder neck mobility	Exercise intervention based on home-based daily PFMT, with monthly supervised sessions. Exercises consisted in 3 repetitions of 8-12 contractions. Program was performed between the 20th week until delivery.	ID, LD	**LD, second stage (min):** 74, 5–206 (EG) versus 60 (6–232) (CG), p=0.87 **LD, active phase (min):** 47 (5–170) (EG) versus 45 (2–145) (CG), p=0.89 **Prolonged active labour (>60min, %):** 35.8% (EG) versus 30.5% (CG), p=0.47 **ID:** PFMT group: 21.4% versus control group: 24.1%; p = 0.40	There was no significant difference between groups regarding LD or odds of ID.	**ID:** Moderate **DL:** Moderate
Di Mascio (2016, Italy)[56]	Systematic Review and Meta-analysis	VD: 6 RCTs, n= 2150 ID: 4 RCTs, n=1396 CD: 6 RCTs, n=2150 Normal-weight pregnant women with singleton, uncomplicated gestations	Exercise interventions including aerobic exercise, resistance, PFMT, flexibility and relaxation. Sessions of 35-60 min, 3 times/week, at light to moderate intensity. Programs started in the first or early second trimester (≤20 weeks).	VD, ID, CD	**VD:** RR= 1.09, 95% CI= 1.04 to 1.15 **ID:** RR= 0.78, 95% CI= 0.61 to 1.01 **CD:** RR= 0.82, 95% CI= 0.69 to 0.97	Women in the exercise group had a significantly higher incidence of VD and significantly lower incidence of CD compared to controls. The incidence of ID was similar in both groups.	**VD:** High **ID:** High **CD:** HIgh

Wiebe et al (2015, Canada)[33]	Systematic Review and Meta-analysis	23 RCTs, n=4414 low-risk pregnant women (n=17), overweight and obese (n=3), diagnosed with GD (n=2), with GH/PE (n=1)	Exercise interventions - aerobic exercise and/or resistance training. Sessions of 30-70 min, 1 to 5 times per week. Programs were performed during 6 to 33 weeks, ending in the mid to late third trimester.	CD	OR= 0.80, 95% CI= 0.69 to 0.64, p= 0.006	Exercise during pregnancy was associated with significantly reduced odds CD.	High
Ming (2018, China)[32]	Systematic Review and Meta-analysis	7 RCTs, n=2691 Normal-weight pregnant women, without contraindications to exercise	Exercise interventions - aerobic exercises, muscle strength and flexibility. Sessions of 35 to 60 min, at light-to-moderate intensity, 1-3 times/week. Interventions started between 6-20 weeks and finished at the end of the third trimester.	CD	RR = 0.88 95% CI= 0.72 to 1.08 p = 0.21	Cesarean delivery risk was not significantly different between groups.	Moderate

CD: cesarean delivery; CI: confidence interval; ID: instrumental delivery; LD: Labor Duration; PFMT: Pelvic Floor Muscle Training; OR: odds ratio; RR: relative risk; VD: vaginal delivery;

Table V – Hypertensive disorders of pregnancy

Author (year, country)	Study design	Population	Intervention	Outcomes	Results	Conclusions	Level of Evidence (GRADE)
Du (2018, China)[28]	Systematic Review and Meta-analysis	GH: 5 RCTs, n=671 PE: 4 RCTs, n=596 Overweight and obese pregnant women	Home-based or supervised programs - aerobic training, stretching, muscle exercises and relaxation. Sessions of 25-60 min, 3-7 times/ week. Gestational age at start - 11 - 20 weeks; end of intervention varied between 28 weeks until delivery.	GH, PE	**GH:** RR= 0.63, 95% CI= 0.38 to 1.05 (p=0.08) **PE:** RR= 1.39, 95% CI= 0.66 to 2.93 (p=0.38)	No significant differences were found between exercise and control groups regarding the risk of developing GH or PE, in overweight/obese women.	**GH:** High **PE:** High
Davenport (2018, Canada)[6]	Systematic Review and Meta-analysis	GH: 22 RCTs, n=5316 PE: 15 RCTs, n=3322 Pregnant women without contraindications to exercise	Exercise interventions - aerobic exercises, aquatic activities, resistance training, yoga or PFMT. Sessions of 10-90 min, from 1 to 7 days/week.	GH, PE	**GH:** RR= 0.61, 95% CI= 0.43 to 0.85 (p=0.003) **PE:** RR= 0.59, 95% CI= 0.37 to 0.94 (p=0.03)	Exercise interventions reduced the odds of GH and PE.	**GH:** High **PE:** Moderate

Haakstad (2016, Norway)[74]	Randomized Controlled Trial	N=61, Previously inactive nulliparous, healthy pregnant women	Supervised exercise interventions - aerobic and muscular strength exercises. Sessions of 60 min, of moderate intensity, 2 times/week. Duration of 12 weeks. Participants were advised to undertake 30 min of moderate physical activity on the remaining days.	BP	**Resting systolic BP:** 112±8mmHg (EG) vs 119±14mmHg (CG) MD= 7.5 mmHg, 95% CI= 1.5 to 12.6 (p=0.013) **Resting diastolic BP:** 71±9 mmHg (EG) vs 76±8mmHg MD=3.9mmHg, 95% CI=-0.07 to 7.8 (p=0.054)	Exercise intervention significantly lowered resting systolic BP.	Low
Schlüssel (2008, Brazil)[45]	Systematic Review	PE: 4 observational studies, n=4633 GH: 2 observational studies, n=3569 Pregnant women without contraindications to exercise	Exercise interventions - Leisure-time physical activities (health promotion or simply for leisure) or occupational physical activities, performed at light-to-moderate intensity.	GH, PE	—	Both light and moderate leisure-time and occupational physical activities showed a decreased risk of developing PE and GH.	**PE:** Very Low **GH:** Very Low
Meher (2006, UK)[75]	Systematic Review and Meta-analysis	2 RCTs, n=45 Pregnant women at risk of PE	Supervised and unsupervised sessions, including aerobic exercises. Sessions of 30-45 min, 3-4 times/week, with moderate-high intensity. Interventions started between 18-34 weeks, one was performed during 10 weeks and the other until delivery.	PE	RR= 0.31, 95% CI= 0.01 to 7.09	Aerobic exercise performed during pregnancy did not significantly reduce the risk of developing PE. Sample size was too small to draw reliable conclusions.	Moderate

Aune (2014, Norway)[73]	Systematic Review and Meta-analysis	11 studies, n=168602 4 case-control studies; 7 cohort studies Pregnant women without contraindications to exercise	Leisure Time Physical Activity, performed during ≥ 120-420min/week, at low to high intensity. Exercise was performed in early pregnancy (up to gestational weeks 16–24, up to first antenatal visit or during the 1st trimester).	PE	RR= 0.79, 95% CI= 0.70 to 0.91 *** 1 hour of PE/day:** RR= 0.83, 95% CI=0.72 to 0.95 *** 20 MET-hours/week:** RR= 0.85, 95% CI= 0.68 to 1.07	Exercise during pregnancy was associated with decreased odds of PE.	Very Low
Di Mascio (2016, Italy)[56]	Systematic Review and Meta-analysis	3 RCTs, n=1305 Normal-weight pregnant women with singleton, uncomplicated gestations	Exercise interventions - aerobic exercise, resistance, PFMT, stretching and relaxation. Sessions of 50 to 60 min, 3 times/week, at light to moderate intensity. Exercise programs started before the 18th week.	Hypertensive disorders	RR= 0.36, 95% CI= 0.19 to 0.69	Exercise interventions in normal-weight women significantly reduced the incidence of pregnancy hypertensive disorders.	High
Da Silva (2017, Brazil)[42]	Randomized Controlled Trial	N=639, Healthy pregnant women, without contraindications to exercise	Individually supervised exercise interventions - aerobic activities, strength training and stretching. Sessions of 60 min, of moderate intensity, 3 times/week. Exercise program was performed for at least 16 weeks.	PE	OR=1.0, 95% CI = 0.0 to 2.1	Physical exercise did not change the incidence of PE.	Moderate

CI: confidence interval; GH: gestational hypertension; MD: mean deviation; OR: Odds Ratio; PE: preeclampsia; PFMT: Pelvic Floor Muscle Training; RR: risk ratio.

Table VI – Lumbopelvic pain

Author (year, country)	Study design	Population	Intervention	Outcomes	Results	Conclusions	Level of Evidence (GRADE)
Nascimento (2012, Brazil)[37]	Systematic Review	2 RCTs, n=905 Pregnant women without contraindications to exercise	Supervised and home-based exercise interventions, including aerobic and strength exercises. Sessions were performed 3 times per week. Exercise programs were performed during 10 to 12 weeks.	LP	—	Exercise interventions provided benefits regarding LP.	Low
Chan (2019, China)[34]	Systematic Review	10 RCTs, n=1870 Pregnant women without contraindications to exercise, >18 years old	Exercise interventions including counseling, unsupervised exercise, supervised exercise or a combination of these. Types of exercise - aerobics, stretching, strength, balance, PFMT, and relaxation. Sessions of 20 to 60 min, frequency varied between once every 2 weeks to 3 times per week, and duration for a period of 4-20 weeks.	LP	—	Physical exercise appeared to have no effect on pain prevalence. Exercise interventions during pregnancy are potentially useful in alleviating pregnancy-related pain.	Very Low

LP- Lumbopelvic Pain; PFMT: Pelvic Floor Muscle Training

Table VII – Urinary incontinence

Author (year, country)	Study design	Population	Intervention	Outcomes	Results	Conclusions	Level of Evidence (GRADE)
Davenport (2018, Canada)[80]	Systematic Review and Meta-analysis	15 RCTs, n=2754 Pregnant women without contraindications to exercise	Exercise interventions including aerobic exercise and PFMT. Sessions of 8 to 60 min, at light to moderate intensity, from 1 to 7 days/week. Exercise programs were performed between the 9th and 30th weeks of gestation.	UI	**UI in pregnancy:** *overall: OR= 0.49, 95% CI= 0.33 to 0.72 *subgroup-prevention: OR= 0.48, 95% CI= 0.32 to 0.73 (p=0.0005) *subgroup-treatment: OR= 0.59, 95% CI= 0.23 to 1.52 (p=0.27) **UI in postpartum:** *overall: OR= 0.63, 95% CI= 0.51 to 0.79 * subgroup-prevention: OR= 0.61, 95% CI= 0.48 to 0.77 (p<0.0001) * subgroup-treatment: OR= 0.82, 95% CI= 0.43 to 1.54 (p=0.53) **Symptom severity:** *during pregnancy MD=-0.54, 95% CI= -0.88 to -0.20 *postpartum: MD=-0.54, 95% CI= -0.87 to -0.22	Exercise interventions decreased the odds of antenatal and postnatal UI. Exercise was beneficial at preventing but not in treating UI.	**UI symptom severity during pregnancy:** Moderate **UI symptom severity in postpartum:** Moderate **Prevalence of postpartum UI:** Moderate

Perales (2016, Spain)[36]	Systematic Review	4 RCTs Pregnant women without contraindications to exercise	Exercise interventions - aerobic, resistance and counseling interventions. Session frequency, intensity and duration was not specified.	UI	—	Combined exercise interventions (aerobic + resistance) reduced the odds of UI.	High
Nascimento (2012, Brazil)[37]	Systematic Review	4 RCTs, n=758 Pregnant women without contraindications to exercise	Supervised and home-based exercise interventions - walking, resistance exercise and PFMT. Sessions of 35-60 min, and were performed 2 times/week to twice daily.	UI	—	Exercise interventions provided benefits regarding UI prevention	Moderate
Reilly (2002, UK)[81]	Randomized Controlled Trial	N=268 Primigravidae with increased antenatal bladder neck mobility	Exercise intervention based on home-based daily PFMT, with monthly supervised sessions. Exercises consisted in 3 repetitions of 8-12 contractions. Program was performed between the 20th week until delivery.	UI	Incontinence 3 months postpartum: RR= 0.59 95% CI= 0.37 to 0.92 (p=0.023)	The exercise intervention significantly reduced the incidence of postpartum UI.	Moderate

CI: confidence interval; OR: odds ratio; PFMT: Pelvic Floor Muscle Training; RR: relative risk; UI: urinary incontinence;

Table VIII – Perinatal anxiety, perinatal depression and postpartum depression

Author (year, country)	Study design	Population	Intervention	Outcomes	Results	Conclusions	Level of Evidence (GRADE)
Davenport (2018, Canada)[3]	Systematic Review and Meta-analysis	Anxiety: 7 RCTs, n=1689 Postpartum depression: 4 RCTs, n= 1033 Prenatal depression: 5 RCTs, n=683 Pregnant women without contraindications to exercise	Exercise interventions including aerobic exercise, yoga, resistance training and PFMT. Frequency between 1-7 days per week, 20-75 min per session.	PD, PA, PPD	**PD symptoms:** SD= - 0.38, 95% CI= -0.51 to -0.25 (p<0.00001) Odds of PD: OR= 0.33, 95% CI= 0.21 to 0.53 (p<0.00001) **PPD symptoms:** SD= -0.01, 95% CI= -0.13 to 0.12 (p=0.93) **Odds of PPD:** OR: 1.12, 95%CI 0.85 to 1.48 **PA symptoms:** SD= 0.03, 95% CI= -0.21 to 0.27 (p=0.82)	Exercise interventions reduced the severity and the odds of PD. Exercise did not alter the odds of PPD or the severity of depressive symptoms, nor PA symptom severity.	**PPD:** Low **PD:** Moderate **PA:** Low

Chan (2019, China)[34]	Systematic Review	Perinatal depression: 6 RCTs, n=2015 Perinatal anxiety: 2 RCTs, n=962 Pregnant women without contraindications to exercise	Exercise interventions including counseling, unsupervised exercise, supervised exercise or a combination these. Types of exercise included aerobics, strength exercises, stretching, PFMT and relaxation. Sessions extended from 45 to 60 min, frequency varied between 2 and 3 times per week, and duration from 16 to 24 weeks until delivery.	PD, PA	—	Physical exercise during pregnancy is potentially useful in alleviating PD and PA.	**PD:** Low P**A:** Moderate
Coll (2019, Brazil)[87]	Randomized Controlled Trial	n=639 Pregnant women between 16 - 20 weeks of gestation without contraindications to exercise	Supervised exercise intervention including aerobic, resistance training and PFMT, at moderate intensity, 60 min per session, 3 times per week, during 16 weeks.	PPD	**Scores for postpartum depression:** MD= - 0.6 95% CI= - 1.3 to 0.1 (p=0.11) **Odds of postpartum depression:** OR= 0.65 95% CI= 0.33 to 1.28 (p=0.21)	Physical exercise did not significantly change the rates of PPD between the intervention group and control group. Low compliance may have influenced the results.	Low

Haakstad (2015, Norway)[23]	Randomized Controlled Trial	N=105 Previously inactive nulliparous, normal-weight healthy pregnant women	Supervised general group fitness class, including aerobic exercises, strength exercises and stretching/relaxation. Sessions of 60 min, at least 2 times per week. Exercise program performed during a minimum of 12 weeks.	PA, PD	**Antenatal depression:** EG=5.8% vs CG=17% (p=0.07) **Sadness, hopelessness or anxiety (WHOQOL-bref and SF-36):** *ITT: 4.31±0.9 (EG) vs 4.15±1.0 (CG), (p=0.4) *PP: 4.64±0.5 (EG) vs 4.15±1.0 (CG), (p=0.01)	Exercise intervention, in women with high exercise adherence, significantly reduced PA but no significant difference was found between groups regarding PD. Additionally, the exercise group reported less feelings related to sadness and hopelessness.	**PA:** Moderate **PD:** Moderate
Mohammadi (2014, Iran)[88]	Randomized Controlled Trial	N=127 Pregnant women without contraindications to exercise	Unsupervised exercise intervention, including stretching and breathing exercises, for 20-30 min, performed 3 times per week at low-intensity. The program started from the 26th-32nd week until the end of pregnancy.	PPD	**Mean EPDS scores (1-30)** ***Baseline:** 8.14±3.94 (CG) vs 7.77±3.86 (EG), (p=0.24) ***1 month postpartum:** 7.46±4.50 (CG) vs 7.66±5.46 (EG), (p=0.82) ***2 months postpartum:** 6.50±5.12 (CG) vs 6.58±4.63 (EG), (p=0.70)	Exercise intervention did not significantly change the mean scores of PPD.	High

Nascimento (2012, Brazil)[37]	Systematic Review	2 RCTs, n=799 Pregnant women without contraindications to exercise	Supervised and home-based exercise interventions, including aerobic, strength and stretching and relaxation exercises. Sessions were performed 2 times per week at home plus 1 time supervised. Exercise programs were performed during 12 weeks.	PPD, PD	—	Exercise interventions provided benefits regarding PPD and PD.	Low
Shivakumar (2010, USA)[85]	Systematic Review	6 studies (cross-sectional and cohort), n=424 Pregnant women without contraindications to exercise	Exercise interventions including aerobic or non-aerobic exercises. Sessions extended from 20-45 min, 2-7 times per week, during 4 to 6 weeks.	PA, PD	—	Exercise interventions were related to reduced symptoms of PA and PD.	**PA:** Low **PD:** Very Low

CG: control group; EG: exercise group; OR: odds ratio; PA: Prenatal Anxiety; PD: Perinatal Depression; PPD: Postpartum Depression; MD: mean deviation; SD: standard deviation

Table IX – Preterm birth

Author (year, country)	Study design	Population	Intervention	Outcomes	Results	Conclusions	Level of Evidence (GRADE)
Du (2018, China) [28]	Systematic Review and Meta-analysis	6 RCTs, n=737 Overweight and obese pregnant women	Home-based or supervised programs, - aerobic training, stretching, muscle strength and relaxation exercises. Sessions of 25-60 min, 3-7 times/week. Start from 11 to 20 weeks; ended between 35 weeks until delivery.	PTB	RR= 1.18 95% CI= 0.59 – 2.39 (p=0.54)	Exercise during pregnancy did not increase the risk of PTB in overweight/obese women.	High
Yu et al (2017, China) [52]	Systematic Review and Meta-analysis	3 RCTs, n= 723 Pregnant women without contraindications to exercise	Exercise interventions - supervised cycling program, 3 times/week, and exercise programs based on ACOG guidelines: 30 minutes or more of moderate-intensity physical activity on most days of the week. Duration of intervention between 12 and 30 weeks.	PTB	OR= 0.85 95% CI= 0.43 to 1.66 (p=0.63)	Exercise during pregnancy had no effect on the incidence of PTB.	High
Davenport (2018, Canada)[7]	Systematic Review and Meta-analysis	30 RCTs, n=5283 Pregnant women without contraindications to exercise	Exercise interventions - aerobic exercises, aquatic activities, resistance training, yoga and PFMT. Sessions from 10 to 90 min, intensity from low to vigorous, from 1 to 7 days/week. Programs initiated in the 1st, 2nd or 3rd trimester.	PTB	RR= 1.12 95% CI= 0.88 to 1.42 (p=0.35)	Exercise during pregnancy did not affect the odds of PTB.	Moderate

Ramírez-Vélez (2017, Colombia)[46]	Randomized Controlled Trial (secondary analysis)	N=50 Previously inactive pregnant women, without contraindications to exercise	Supervised exercise intervention - aerobic, resistance and relaxation exercises. Sessions of 60 min, moderate to vigorous intensity, 3 times/week. Program performed during 12 weeks.	PTB	2% (EG) vs 3% (CG) (p=0.64)	No significant differences were observed in the percentage of PTB.	Moderate
Da Silva (2016, Brazil)[29]	Systematic Review and Meta-analysis	17 RCTs, n=4278; 11 cohort studies, n=81595 Pregnant women without contraindications to exercise	**RCTs:** exercise interventions - aerobic exercises, muscle resistance, aquatic exercises, PFMT, balance exercises and stretching. Sessions from 20 to 60 min, at light to moderate intensity, performed 1-5 times/week. Programs started between 6 and 27 weeks, and finished at the end of the 3rd trimester. **Cohort:** exercise was performed during the 1st, 2nd and/or 3rd trimester. Exercise type was not specified.	PTB	**RCTs (gestational age):** MD= -0.07 weeks 95% CI= -0.29 to 0.16 **Cohort studies (PTB):** OR= 0.80 95% CI= 0.70 to 0.91	Exercise during pregnancy was associated with a lower risk of PTB.	**RCTs:** high **Cohort:** low
Da Silva (2017, Brazil)[42]	Randomized Controlled Trial	N=639, Healthy pregnant women, without contraindications to exercise	Supervised exercise intervention - aerobic activities, strength training and stretching exercises. Sessions of 60 min, of moderate intensity, 3 times/week. Program performed during 16 weeks.	PTB	OR= 1.1 95% CI=0.7 to 1.8 (p=0.73)	No significant difference was observed in the incidence of PTB between groups.	Moderate

Muktabhant (2015, Thailand)[35]	Systematic review and Meta-analysis	5 RCTs, n=2320 Pregnant women without contraindications to exercise	Unsupervised and supervised interventions - aerobic and resistance exercises. Sessions of 45-60 min, performed 2-7 times/week, at light to moderate intensity. Programs started between the 6th and 14th weeks, and finished generally at the end of the 3rd trimester.	PTB	**Unsupervised exercise:** RR= 1.17 95% CI= 0.35 to 3.85 (p=0.80) **Supervised exercise:** RR= 1.92 95% CI= 0.75 to 4.93 (p=0.95)	No significant differences were observed in the incidence of PTB between groups.	Very Low
Nascimento (2012, Brazil)[37]	Systematic Review	2 RCTs, n=172 Pregnant women without contraindications to exercise	Supervised exercise interventions - fitness classes, land and aquatic aerobic exercises. Sessions: 2-3 times/week. Exercise programs were performed during 12 weeks or during the entire pregnancy.	PTB	—	No significant differences were observed in the incidence of PTB.	Moderate
Schlüssel (2008, Brazil)[45]	Systematic Review	12 studies, n= 24885 (cross-sectional and cohort)	Exercise interventions including Leisure-time physical activities (the purpose of health promotion or simply for leisure) or occupational physical activities, performed at light-to-vigorous intensity.	PTB	—.	Considering PTB, studies either found no relationship or reported a protective effect.	Very Low
Kahn (2016, USA)[92]	Systematic Review	27 studies, n=193030 (Cohort study designs: n = 13, Case-control: n = 4, Cross-sectional: n = 5, RCT: n=5)	Exercise interventions - aerobic, resistance and balance exercises. Sessions from 30 to 60 min, 2 to 4 times/week, and intensity varied between light and vigorous. Exercise programs were performed during 12 - 31 weeks.	PTB	—	Exercise during pregnancy was not associated with an increased risk of PTB (n=25). Eleven studies related to exercise during pregnancy with a lower risk of PTB.	Very Low

Di Mascio (2016, Italy)[56]	Systematic Review and Meta-analysis	9 RCTs, n=2059 Normal-weight pregnant women with singleton, uncomplicated gestations	Exercise interventions - aerobic exercise, resistance, PFMT, flexibility, and relaxation. Sessions of 35-90 min, 3-4 times/ week, at light to moderate intensity. Exercise programs started in the first or early second trimester (≤22 weeks).	PTB	RR= 1.01 95% CI= 0.68 to 1.50	Exercise interventions in normal-weight women did not increase the risk of PTB.	High
Beetham (2019, Australia) [43]	Systematic Review and Meta-analysis	4 studies (2 cohort studies: n=1242, 2 RCTs: n=296) Pregnant women without contraindications to exercise	Supervised exercise interventions - land and aquatic aerobic exercises. Sessions of 30-50 min; frequency varied from 1-3 times/week. Exercise was performed at vigorous intensity, during the 3rd trimester.	PTB	RR= - 0.20 95% CI= - 0.36 to - 0.03 (p=0.03)	Exercise during pregnancy reduced the risk of PTB.	Low

CI: confidence interval; OR: odds ratio; PFMT: Pelvic Floor Muscle Training; PTB: preterm birth; RR: relative risk.

Table X - Inadequate fetal growth

Author (year, country)	Study design	Population	Intervention	Outcomes	Results	Conclusions	Level of Evidence (GRADE)
Beetham (2019, Australia)[43]	Systematic Review and Meta-analysis	SGA: 5 RCTs, n=623 + 5 Cohort, n=29867 LBW: 5 RCTs, n=623 + 5 Cohort, n=27780 Pregnant women without contraindications to exercise	Exercise interventions - partially supervised walking sessions, supervised aerobic, aquatic activities and resistance training. Sessions duration: 20-180 min; frequency: 2-7 times/week. Exercise was performed at vigorous intensity, during the 3rd trimester.	SGA, LBW	**SGA:** RR= 0.15 95% CI= -0.06 to 0.35 (p=0.13) **LBW:** RR=0.44 95% CI= -0.83 to 1.7 (p=0.35)	Exercise during pregnancy did not increase the incidence of LBW or SGA infants.	**SGA:** Very Low **LBW:** Very Low
Davenport (2018, Canada [7]	Systematic Review and Meta-analysis	IUGR: 1 RCT, n= 334 LBW: 15 RCTs, n=3784 SGA: 15 RCTs, n=5178 Pregnant women without contraindications to exercise	Exercise interventions - aerobic exercises, resistance training, yoga and PFMT. Sessions duration: 10-90 min; intensity ranged from low to vigorous; 1-7 days/week. Exercise programs initiated in the 1st, 2nd or 3rd trimester.	IUGR, LBW,	**LBW:** OR= 0.91 95% CI= 0.70 to 1.20 (p=0.51) **SGA:** OR= 1.20 95% CI= 0.96 to 1.49 **IUGR:** OR= 1.11 95% CI= 0.48 to 2.60	Exercise during pregnancy did not affect the odds of IUGR, LBW or SGA infants.	**LBW:** Moderate **SGA:** Low **IUGR:** High
Ramírez-Vélez (2017, Colombia)[46]	Randomized Controlled Trial (secondary analysis)	N=50 Previously inactive pregnant women, without contraindications to exercise	Supervised exercise interventions - aerobic, resistance and relaxation. Sessions of 60 min, moderate to vigorous intensity, 3 times/week. Exercise program performed during 12 weeks.	LBW	3% (EG) vs 2% (CG) (p=0.75)	No significant differences were observed in the percentage of LBW between exercise and groups.	Moderate

Nascimento (2012, Brazil)[37]	Systematic Review	2 RCTs, n=172 Pregnant women without contraindications to exercise	Supervised exercise interventions - fitness classes, land and aquatic exercises. Sessions 2-3 times/week. Programs were performed during 12 weeks or during the entire pregnancy.	LBW	—	No significant differences were observed in the incidence of LBW.	Moderate
Schlüssel (2008, Brazil)[45]	Systematic Review	15 studies, n= 49127 (cross-sectional and cohort)	Exercise interventions - Leisure-time physical activities (with the purpose of health promotion or simply for leisure) or occupational physical activities, performed at light-to-vigorous intensity.	LBW	—	Exercise during pregnancy was not associated with a higher risk of LBW.	Very Low
Bennett (2018, Australia)[65]	Systematic Review and Meta-analysis	SGA: 2 RCTs, n= 125 LBW: 5 RCTs, n=1977 Studies designed to reduce GWG	Exercise interventions - aerobic, resistance exercises and relaxation. Sessions duration: 30-60 min, 1-5 times/week, and intensity varied between very-light to moderate. Programs were performed during 12 up to 30 weeks.	SGA, LBW	**SGA:** RR= 0.38 95% CI= 0.01 to 15.01 **LBW:** RR=0.88 95% CI= 0.60 to 1.29	Exercise during pregnancy was not associated with increased odds of LBW or SGA.	**SGA:** Low **LBW:** Moderate
Di Mascio (2016, Italy)[56]	Systematic Review and Meta-analysis	5 RCTs, n=1517 Normal-weight pregnant women with singleton, uncomplicated gestations	Exercise interventions - aerobic exercise, resistance, PFMT and stretching. Sessions duration: 50-60 min, 3 times/week, at light to moderate intensity. Programs started before the 20th week.	LBW	RR=1.11 95% CI= 0.72 to 1.73	Exercise interventions in normal-weight women did not increase the risk of LBW.	High

Du (2018, China)[28]	Systematic Review and Meta-analysis	6 RCTs, n=863 Overweight and obese pregnant women	Home-based or supervised programs - aerobic training, stretching, resistance and relaxation exercises. Sessions of 30-60 min, 1-7 times/week. Gestational age at start from 11 to 16 weeks; end of intervention varied between 28 weeks until delivery.	SGA	RR= 1.02 95% CI= 0.54 to 1.91 (p=0.96)	Exercise during pregnancy did not increase the risk of SGA newborns in overweight/obese women.	High
Da Silva (2016, Brazil)[29]	Systematic Review and Meta-analysis	4 RCTs, n=1499; 3 cohort studies, n=2462 Pregnant women without contraindications to exercise	**RCTs:** exercise interventions included aerobic exercises, muscle resistance, PFMT and stretching. Sessions duration: 15-70 min, at light to moderate intensity, and were performed 1-3 times/week. Programs started between 6 and 20 weeks, and finished at the end of the 3rd trimester. **Cohort:** exercise was performed during the 1st, 2nd and/or 3rd trimester. The type of exercise was not specified.	SGA	**RCTs:** RR= 1.08 95% CI= 0.66 to 1.76 **Cohort studies:** OR= 1.03 95% CI= 0.81 to 1.30	There was no significant difference between groups regarding the odds of SGA infants.	**RCTs:** high **Cohort:** low
Han (2012, Australia)[61]	Systematic Review and Meta-analysis	1 RCT, n=84 Pregnant women without contraindications to exercise	Exercise intervention included stationary cycling. Sessions of 40 min; 5 times/week. Program was conducted between 20-40 weeks of gestation.	SGA	RR= 1.05 95% CI= 0.25 to 4.40	No significant differences were observed in the incidence of SGA newborns between exercise and control groups.	Low

Pastorino (2019, UK)[64]	Systematic Review and Meta-analysis	8 population-based studies, n= 75083	Leisure-time physical activity, at low, moderate and vigorous intensity. Exercise was performed in early (8-18 weeks gestation) or late pregnancy (30+ weeks). Session duration varied between 2h to 6,5h per week (early pregnancy) and 1h to 7h (late pregnancy).	SGA	***Early pregnancy (RR (95% CI)):** LTPA: 0.99 (0.98, 1.01) MVPA: 0.99 (0.98, 1.00) VPA: 0.99 (0.98, 1.00) ***Late pregnancy (RR (95% CI)):** LTPA: 0.99 (0.97, 1.01) MVPA: 1.01 (0.97, 1.03) VPA: 1.06 (0.96, 1.17)	Leisure-time physical activity was not associated with increased risk of SGA, in both early and late pregnancy.	Very Low
Mottola (2018, Canada)[97]	Systematic Review	4 studies (2 RCTs, n=917; 1 observational studies, n=26) Pregnant women without contraindications to exercise	**RCTs:** Structured exercise interventions - aerobic and muscular strength exercises, and supine exercises 2-5 min. Sessions duration: 35 to 60min, at moderate intensity, 2-4 times/ week. **Observational:** exercise consisted in static exercises (pelvis raised off the floor) for 5 min. Total sessions time was 35-40 min. All women recovered in the left lateral position for 2–20 min after exercise.	SGA	—	Exercise performed in the supine position was not associated with an increased risk of SGA.	Very Low

Wiebe (2015, Canada)[33]	Systematic Review and Meta-analysis	12 RCTs, n=2183 low-risk pregnant women (n=9), overweight and obese (n=2), women with chronic hypertension, a history of preeclampsia, or both (n=1)	Exercise interventions - aerobic exercise and/or resistance training. Sessions duration: 30-60 min, 1-5 times per week. Exercise programs were performed during 12 to 33 weeks, ending in the mid to late third trimester.	SGA	OR= 1.02 95% CI= 0.72 to 1.46 (p=0.75) **overweight and obese women:** OR=0.90, 95% CI=0.31 to 2.63, p=0.85 **women with GH or PE:** OR=0.75 95% CI=0.28 to 1.98, p=0.56 **low risk women:** OR=1.10 95% CI=0.73 to 1.66, p=0.64	Exercise during pregnancy was not associated with increased risk of SGA.	High

CG: Control Group; CI: Confidence Interval; EG: Exercise Group; IUGR: Intrauterine Growth Restriction; LBW: Low Birth Weight; LTPA: Leisure Time Physical Activity; MVPA: Moderate-to-Vigorous Physical Activity; OR: Odds Ratio; PFMT: Pelvic Floor Muscle Training; RR: Relative Risk; SGA: Small-for-Gestational-Age; VPA: Vigorous Physical Activity;

Table XI – Miscarriage and perinatal mortality

Author (year, country)	Study design	Population	Intervention	Outcomes	Results	Conclusions	Level of Evidence (GRADE)
Schlüssel (2008, Brazil)[45]	Systematic Review	Miscarriage: 4 studies, n=2397 (cross-sectional and cohort)	Exercise interventions including leisure-time physical activities (purpose of health promotion or simply for leisure) performed at light-to-vigorous intensity.	Miscarriage	—	Exercise during pregnancy was not associated with a higher risk of miscarriage.	Very Low
Davenport (2018, Canada)[4]	Systematic Review and Meta-analysis	MC: 10 studies, n=2248 PM: 6 studies, n=1651 Pregnant women without contraindications to exercise	Exercise interventions - aerobic exercise, yoga, resistance training and PFMT. Sessions duration: 10-95min, 1-7 days/week, intensity varied between low to vigorous. Exercise was initiated in the first, second or third trimester, up to 31 weeks' gestation.	Miscarriage, PM	**Miscarriage:** OR= 0.69 95% CI= 0.40 to 1.22 (p=0.20) **PM:** OR= 0.79 95% CI= 0.26 to 2.38 (p=0.68)	Exercise during pregnancy was not associated with increased odds of miscarriage or PM.	**Miscarriage:** Low **PM:** Low

Mottola (2018, Canada)[97]	Systematic Review	1 observational study (n=26) Pregnant women without contraindications to exercise	Exercise consisted in static exercises (pelvis raised off the floor) held for 5 min. Total session time: 35-40 min. After supine exercise, all women recovered in the left lateral position for 2–20 min.	PM	—	Exercise was not related to the recorded stillbirth events.	Very Low

CI: Confidence Interval; FD: Fetal Death; OR: Odds Ratio; PFMT: Pelvic Floor Muscle Training; PM: Perinatal Mortality;

Table XII – Apgar score

Author (year, country)	Study design	Population	Intervention	Outcomes	Results	Conclusions	Level of Evidence (GRADE)
Yu (2017, China) [52]	Systematic Review and Meta-analysis	2 RCTs, n=928 Pregnant women without contraindications to exercise	Exercise interventions including supervised cycling program, 3 times/ week, and exercise programs based on ACOG guidelines. Duration of intervention:12 -14 weeks.	Apgar score <7	OR=0.78 95% CI= 0.21 to 2.91 (p=0.71)	Exercise during pregnancy had no effect on the incidence of Apgar scores <7.	High
Sklempe (2017, Croatia)[58]	Randomized Controlled Trial	N=42 Pregnant women diagnosed with GDM	Supervised exercise intervention (aerobic exercise, resistance, PFMT and relaxation). Sessions of 50-55 min, at moderate intensity, 2 times/week. Women also took 30 min of brisk walking per day. Program started when GDM diagnosis was made. It was conducted throughout pregnancy (minimum total duration of 6 weeks).	Apgar score	**Apgar 1 min (mean±SD):** 9.89±0.47 (EG) vs 9.80±0.70 (CG), p=0.828 **Apgar 5 min (mean±SD):** 10.0±0.00 (EG) vs 10.0±0.00 (CG), p=1.000	Exercise during pregnancy did not change neonatal Apgar scores.	Moderate

Barakat (2018, Spain)[69]	Randomized Controlled Trial	N=508, Healthy pregnant women, with singleton and uncomplicated pregnancies	Supervised exercise intervention, (aerobic resistance, muscle strengthening, balance exercises, PFMT and relaxation). Sessions of 55-60 min, of moderate intensity, 3 times/week. Program from 9^{th}-11^{th} week until the end of the third trimester.	Apgar score	**Apgar 1 min (mean±SD):** 8.77±1.24 (EG) vs 8.68±1.32 (CG), p=0.333 **Apgar 5 min (mean±SD):** 9.79±0.56 (EG) vs 9.92±0.77 (CG), p=0.072	Exercise during pregnancy did not change Apgar scores between intervention and control groups.	Low
Ramírez-Vélez (2017, Colombia)[46]	Randomized Controlled Trial (secondary analysis)	N=64 Previously inactive pregnant women, without contraindications to exercise	Supervised exercise intervention, (aerobic, resistance and relaxation exercises). Sessions of 60 min, of moderate to vigorous intensity, 3 times/week. Exercise program performed during 12 weeks.	Apgar score	**Apgar 1 min (mean (interquartile range)):** 8 (7-9) (EG) vs 8 (7-9) (CG), p=0.36 **Apgar 5 min (mean±SD):** 9.5 (9-10) (EG) vs 10 (9-10) (CG), p=0.25	No significant differences were observed in Apgar scores.	Low
Nascimento (2012, Brazil)[37]	Systematic Review	3 RCTs, n=254 Previously sedentary pregnant women, without contraindications to exercise	Supervised exercise interventions (fitness classes, aerobic exercise, strength training and PFMTs). Sessions were performed 2-3 times/ week, during 40-60 min. Programs were performed during 12 weeks or during the entire pregnancy.	Apgar score	—	No significant differences were observed in neonatal Apgar scores.	Moderate

Han (2012, Australia)[61]	Systematic Review and Meta-analysis	2 RCTs, n= 919 Pregnant women without contraindications to exercise	Exercise interventions - aerobic sessions, aquatic activities, strength training and balance exercises. Sessions extended from 35 to 60 min, 1-3 times/week, and intensity varied between light and moderate. Programs began between weeks 6th and 20th, and finished by the end of the 3rd trimester.	Apgar score <7 at 5 minutes	RR= 1.00 95% CI= 0.27 to 3.65	No significant differences were observed in neonatal Apgar scores <7 at 5 min.	Low

CG: Control Group; CI: Confidence Interval; EG: Exercise Group; OR: Odds Ratio; PFMT: Pelvic Floor Muscle Training; RR: Relative Risk.

Table XIII – Fetal heart rate and uterine blood flow

Author (year, country)	Study design	Population	Intervention	Outcomes	Results	Conclusions	Level of Evidence (GRADE)
Skow (2018, Canada)[69]	Systematic Review and Meta-analysis	91 studies (12 RCTs, 6 non-randomised interventions, 43 cohort, 27 cross-sectional and 3 case–control studies), n=4641 Pregnant women without contraindications to exercise	**Chronic interventions:** aerobic exercises, aquatic activities, yoga and PFMT. Sessions performed 2-7 days/week, low and moderate intensities, 15-60 min/session. Programs started in the 2nd and 3rd trimesters, 7-25 weeks' duration. **Acute sessions:** aerobic exercises, aquatic activities, resistance training and yoga. Sessions duration of 3-60 min, low to high intensity, in the 2nd and 3rd trimesters.	FHR, UBF	**FHR during acute exercise:** MD= 6.35bpm 95% CI= 2.30 to 10.41, (p=0.002) **FHR following acute exercise:** MD= 4.05bpm 95% CI= 2.98 to 5.12, (p<0.00001)	Acute and chronic prenatal exercise were not associated with clinically relevant FHR or uteroplacental responses.	**UBF:** Very Low **FHR:** Very Low

Mottola (2018, Canada)[97]	Systematic Review	FHR: 3 observational studies, n= 53 UBF: 1 observational study, n=14 Pregnant women without contraindications to exercise	Acute exercise consisted on static exercises (pelvis raised off the floor) held for 5 min, abdominal strengthening exercises (pelvic tilts for 5 min), dynamic floor exercise (abdominal exercises - crunches and leg lifts for 10 min), and sets of single leg extensions and double leg extensions. Sessions duration: 35-40 min.	FHR, UBF	—	Observational studies showed a 31% risk of reduced FHR variability and reactivity or fetal bradycardia with exercise programs, including thosein the supine position. Acute supine exercise revealed a 16% reduction on UBF compared with left lateral resting position.	**FHR:** Very Low **UBF:** Very Low

CI: Confidence Interval; FHR: Fetal Heart Rate; MD: Mean Deviation; PFMT: Pelvic Floor Muscle Training; UBF: Uterine Blood Flow.

Table XIV – Maternal core temperature and congenital anomalies

Author (year, country)	Study design	Population	Intervention	Outcomes	Results	Conclusions	Level of Evidence (GRADE)
Ravanelli (2018, Australia)[104]	Systematic Review	12 studies, n=347 Pregnant women without contraindications to exercise	Exercise interventions - aerobics and resistance. Sessions duration: 10-45 min, at a maximum HR between 51 and 90%. Programs were performed at the 7th-40th week.	MCT	Highest Tcore=38.9°C Highest mean end-trial Tcore (land) =38.3°C (95% CI 37.7°C to 38.9°C) Highest mean end-trial Tcore (water) =37.5°C (95% CI 37.3°C to 37.7°C)	Land-based exercise (up to 35 min at 80%–90% of maximum HR in up to 25°C and 45% relative humidity) and water-based exercise (up to 45 min at ≤33.4°C), irrespective of pregnancy stage, is not associated with MCT exceeding the teratogenic threshold (39ºC).	Moderate
Davenport (2018, Canada)[105]	Systematic Review and Meta-analysis	MCT: 15 studies, n=447 CA: 2 studies, n=73966 (1 RCT, n=694 + 1 cohort study, n=73 272) Pregnant women without contraindications to exercise	Exercise was performed at light, moderate and vigorous intensity, and during all trimesters. Exercise exposure could be acute (single exercise session) or regular.	MCT, CA	**CA:** OR= 1.52, 95% CI= 0.54 to 4.32 **MCT:** *pre-exercise to during exercise: MD= 0.26°C 95% CI= 0.12 to 0.40 (p=0.0002) *pre-exercise to after exercise: MD= 0.24°C 95% CI= 0.17 to 0.31 (p<0.00001)	Exercise during pregnancy was not associated with maternal hyperthermia or increased odds of CA.	**CA:** Very Low **MCT:** Very Low

CA: Congenital Anomalies; CI: Confidence Interval; HR: Heart Rate; MCT: Maternal Core Temperature; MD: Mean Deviation; Tcore: core temperature; OR: Odds Ratio;

Table XV – Benefits of exercise, summary of evidence

BENEFITS OF EXERCISE	STUDIES	SUMMARY OF EVIDENCE	LEVEL OF EVIDENCE (GRADE)
GWG, EGWG, PPWR	**Meta-analysis:** Wang, 2019[27]; Du, 2018[28]; Beetham, 2019[43]; Shieh, 2018[44]; Ruchat, 2018[30]; Da Silva, 2016[29]; Sanabria-Martínez, 2015[54]; Muktabhant, 2015[35]; Lamina, 2013[111]; Choi, 2013[38]; Streuling, 2011[31]; Wiebe, 2015[33]; Ming, 2018[32] **RCTs:** Brik, 2019[47]; Nobles, 2018[40]; Bacchi, 2017[41]; Ramírez-Vélez, 2017[46]; Da Silva, 2017[42]; Kong, 2014[48] **Systematic Reviews:** Chan, 2019[34]; Nascimento, 2012[37]; Schlüssel, 2008[45]; Perales, 2016[36]	Exercise had a beneficial impact in all weight-related variables.	**GWG:** low to high **EGWG:** very low to high **PPWR:** low to moderate
GDM, GC	**Meta-analysis:** Du, 2018[28]; Yu, 2017[52]; Ming, 2018[32]; Mijatovic-Vukas, 2018[53]; Davenport, 2018[6]; Davenport, 2018[60]; Da Silva, 2016[29]; Harrison, 2016[59]; Sanabria-Martínez, 2015[54]; Russo, 2015[55]; Di Mascio, 2016[56]; Han, 2012[61] **RCTs:** Sklempe, 2017[58]; Da Silva, 2017 [42]; Cordero, 2015[57] **Systematic Reviews:** Perales, 2016[36];; Schlüssel, 2008[45]; Nascimento, 2012[37]	Exercise reduced GDM risk and improved post-prandial glucose control.	**GDM:** very low to high **GC:** low to moderate
Macrosomia, LGA	**Meta-analysis:** Du, 2018[28]; Davenport, 2018[7]; Da Silva, 2016[29]; Pastorino, 2019[64]; Bennett, 2018[65]; Wiebe, 2015[33]; Muktabhant, 2015[35]; Han, 2012[61] **Systematic Reviews:** Perales, 2016[36];	Exercise was related to a lower risk of macrosomia and LGA newborns.	**Macrosomia:** very low to high **LGA:** very low to high
CD, ID, VD, LD	**Meta-analysis:** Du, 2018[28]; Poyatos-León, 2015[66]; Davenport, 2018[5]; Di Mascio, 2016[56]; Wiebe, 2015[33]; Ming, 2018[32]; Muktabhant, 2015[35]; Han, 2012[61] **RCTs:** Ramírez-Vélez, 2017[46]; Sanda, 2018[67]; Barakat, 2018[69]; Agur, 2007[68] **Systematic Reviews:** Perales, 2016[36]	Exercise did not influence cesarean delivery, labor duration or instrumental delivery. Exercise increased vaginal delivery probability.	**CD:** moderate to high **ID:** moderate to high **VD:** moderate to high **LD:** low to high
GH, PE, BP	**Meta-analysis:** Du, 2018[28]; Davenport, 2018[6]; Meher, 2006[75]; Aune, 2014[73]; Di Mascio, 2016[56] **RCTs:** Haakstad, 2016[74]; Da Silva, 2017[42] **Systematic Reviews:** Schlüssel, 2008[45]	Exercise lowered GH and PE risk and maternal resting systolic BP.	**GH:** very low to high **PE:** very low to moderate **BP:** low
LP	**Systematic Reviews:** Nascimento, 2012[37]; Chan, 2019[34]	Exercise improved LP intensity control.	Very low to low
UI	**Meta-analysis:** Davenport, 2018[80] **RCTs:** Reilly, 2002[81] **Systematic Reviews:** Perales, 2016[36]; Nascimento, 2012[37]	Exercise lowered UI prevalence.	Very low to moderate
PPD, PD, PA	**Meta-analysis:** Davenport, 2018[3] **RCTs:** Coll, 2019[87]; Haakstad, 2015[23]; Mohammadi, 2014[88] **Systematic Reviews:** Chan, 2019[34]; Nascimento, 2012[37]; Shivakumar, 2010[85]	Exercise improved PA and PD prevalence. Exercise did not influence PPD.	**PPD:** low to high **PD:** very low to moderate **PA:** low to moderate

GWG: Gestational Weight Gain; EGWG: Excessive Gestational Weight Gain; PPWR: Postpartum Weight Retention; GDM: Gestational Diabetes Mellitus; GC: Glucose control; LGA: Large for Gestational Age; CD: Cesarean Delivery; ID: instrumental delivery; VD: Vaginal delivery; LD: labor duration; GH: Gestational Hypertension; PE: Preeclampsia; BP: Blood Pressure; LP: Lumbopelvic Pain; UI: Urinary Incontinence; PPD: Postpartum Depression; PD: Perinatal Depression; PA: Perinatal Anxiety

Table XVI – Risks of exercise, summary of evidence

RISKS OF EXERCISE	STUDIES	SUMMARY OF EVIDENCE	LEVEL OF EVIDENCE (GRADE)
PTB	**Meta-analysis:** Du, 2018[28]; Yu, 2017[52]; Davenport, 2018[7]; Da Silva, 2016[29]; Di Mascio, 2016[56]; Beetham, 2019[43]; Muktabhant, 2015[35] **RCTs:** Ramírez-Vélez, 2017[46]; Da Silva, 2017[42] **Systematic Reviews:**; Nascimento, 2012[37]; Schlüssel, 2008[45]; Kahn, 2016[92]	Exercise did not increase PTB risk.	Very low to high
LBW, SGA	**Meta-analysis:** Beetham, 2019[43]; Davenport, 2018[7]; Bennett, 2018[65]; Di Mascio, 2016[56]; Du, 2018[28]; Da Siva, 2016[29]; Pastorino, 2019[64]; Wiebe, 2015[33]; Han, 2012[61] **RCTs:** Ramírez-Vélez, 2017[46] **Systematic Reviews:** Nascimento, 2012[37]; Schlüssel, 2008[45]; Mottola, 2018[97]	Exercise did not change LBW or SGA risk.	**LBW:** very low to moderate **SGA:** very low to high
Miscarriage, PM	**Meta-analysis:** Davenport, 2018[4] **Systematic Reviews:** Schlüssel, 2008[45]; Mottola, 2018[97]	Exercise did not influence PM or miscarriage risk.	**Miscarriage:** very low to low **PM:** very low to low
Apgar score	**Meta-analysis:** Yu, 2017[52]; Han, 2012[61] **RCTs:** Sklempe, 2017[58]; Barakat, 2018[69]; Ramírez-Vélez, 2017[46] **Systematic Reviews:** Nascimento, 2012[37];	Exercise did not influence mean Apgar scores.	Low to high
FHR, UBF	**Meta-analysis:** Skow, 2018[103] **Systematic Reviews:** Mottola, 2018[97]	The effect of exercise on FHR and UBF was not clear.	**FHR:** very low **UBF:** very low
MCT, CA	**Meta-analysis:** Davenport, 2018[105] **Systematic Reviews**: Ravanelli, 2018[104]	Exercise did not rise MCT to dangerous values, nor affected CA risk.	**MCT:** very low to moderate **CA:** very low

PTB: Preterm Birth; LBW: Low Birth Weight; SGA: Small for Gestational Age; PM: Perinatal mortality; FHR: Fetal Heart Rate; UBF: Uterine Blood Flow; MCT: Maternal Core Temperature; CA: Congenital Anomalies

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