CAN GROUP EXERCISE PROGRAMS IMPROVE HEALTH AND FITNESS OUTCOMES IN PREGNANT WOMEN: AN UPDATED SYSTEMATIC REVIEW AND PROTOCOL SUGGESTION

Dissertação de Mestrado

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RESUMO

A literatura científica atual suporta a recomendação de iniciar ou continuar o exercício físico em mulheres grávidas saudáveis. Os programas de exercícios em grupo têm efeitos positivos na melhoria da saúde, bem-estar e apoio social. Em 2015, uma revisão sistemática foi fornecida para avaliar as evidências sobre a eficácia dos programas de exercícios em grupo na melhoriados resultados de saúde de mulheres grávidas e recém-nascidos,e o conteúdo dos programas. Esta revisão visa atualizar esse conhecimento entre 2015 e 2020. Os desenhos dos programas de exercícios foram analisados através do modelo *Consensus of Exercise Reporting Template* (CERT), e a consistência com as diretrizes, identificando limitações nas intervenções que podem ser melhoradas futuramente. Três bases de dados foram usadas para realizar pesquisas na literatura. Trinta e um ensaios clínicos randomizados foram selecionados para análise. Todos os estudos seguiram um programa de exercícios em grupo supervisionado, incluindo fase aeróbica, resistência, treino do pavimento pélvico, alongamento e relaxamento. As intervençõesem grupo durante a gravidez melhoraram os resultados de saúde e condicionamento físico para as mulheres e recém-nascidos, embora algumas lacunas tenham sido identificadas nas intervenções. O monitoramento durante a gravidez deve ser desenvolvido por uma equipa multidisciplinar, e os profissionaisde exercícios e saúde devem transmitir às mulheres grávidas queo exercício em grupo melhora uma ampla gama de resultados de saúde para elas e para os recém-nascidos. Para além disso, os autores reportaram a importância de avaliar, futuramente, a influência do suporte social no bem-estar das gestantes. O apoio social tem sido amplamente estudado como um dos principais determinantes da saúde e bem-estar ao longo do ciclo de vida, sendo um conceito multidimensional, composto por três

dimensões: apoio afetivo/emocional, apoio instrumental/financeiro e apoio informacional. Consequentemente, um segundo estudo/artigo? foi desenvolvido: um protocolo de estudo foi elaborado como solução de avaliação da influência do suporte social (três dimensões) no risco de depressão, na gravidez e no pós-parto. Este desenho de protocolo de estudo irá comparar dois grupos de intervenção com acesso a programa de exercício físico em diferentes formatos (Presencial e Online). O Grupo de Intervenção Presencial, particularmente, terá o apoio de particularmente uma equipa multidisciplinar que oferecerá suporte social nas três dimensões mencionadas anteriormente.

Palavras chave

Exercício Físico; saúde; gravidez; pós-parto; suporte social; bem-estar

ABSTRACT

Current scientific evidence supports the recommendation to initiate or continue physical exercise in healthy pregnant women. Group exercise programs have positive effects in improving health, well-being, and social support. In 2015, a systematic review was provided to evaluate the evidence on the effectiveness of group exercise programs in improving pregnant women's and newborn's health outcomes, and to assess the content of the programs. This review aims to update this knowledge between 2015 and 2020. The exercise program designs were analyzed with the Consensus of Exercise Reporting Template (CERT) model, the consistency with the guidelines, identifying limitations in the interventions that can be improved in the future. Three databases were used to conduct literature searches. Thirty-one randomized control trials were selected for analysis. All studies followed a supervised group exercise program including aerobic, resistance, pelvic floor training, stretching and relaxation sections. Group interventions during pregnancy improved health and fitness outcomes for the women and newborns, although some gaps were identified in the interventions. Monitoring during pregnancy should be developed by a multidisciplinary team and, exercise and health professionals should advise pregnant women that group exercise improves a wide range of health outcomes for them and newborns.

Furthermore, the authors reported the importance to evaluate the influence of social support on well-being of pregnant women, in the future. Social support has been widely studied as a major determinant of health and well-being throughout the life cycle, being a multidimensional concept, which is composed of three dimensions: affective/emotional support, instrumental/financial support, and informational support. Taking into account, a second study/article? was developed: a study protocol was elaborated as a solution to assess the influence of social support (at the three dimensions) on risk of depression during pregnancy and postpartum. This design of study protocol will compare two intervention groups with physical exercise

program assess with different formats (In-person and Online). The In-Person Intervention Group has particularly assess a multidisciplinary team that offers social support on three dimensions mentioned previously.

Keywords

Physical exercise; health; pregnancy; postpartum; social support; well-being

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INTRODUCTION

Regular physical activity in all stages of life, especially in pregnancy, promotes health benefits for mother and newborn (Birsner and Gyamfi-Bannerman, 2020). Furthermore, pregnancy may be a window of opportunity for the adoption of an active and healthy lifestyle (Santos-Rocha, 2019). The guidelines, based on high quality Randomized Controlled Trials (RCT), reported that physical activity during pregnancy is associated with fewer newborn complications, and maternal health benefits, such as: decreased the risk of pre-eclampsia, gestational hypertension, gestational diabetes, caesarean section, instrumental delivery, urinary incontinence, excessive gestational weight gain, and depression; improved blood glucose; decreased severity of depressive symptoms and lumbopelvic pain (Mottola *et al.*, 2019).

During pregnancy, women experience physiology, morphology, and hormonal changes. These changes may affect balance and body stability and can cause discomfort and pain (Santos-Rocha, 2019). Due the specific needs of this special phase, there are recommendations and guidelines for the exercise prescription (Mottola *et al.*, 2019; Birsner and Gyamfi-Bannerman, 2020).

The American College of Obstetricians and Gynaecologists reported that women without complicated pregnancy should be encouraged to engage in aerobic and strength conditioning exercises before, during, and after pregnancy (Santos-Rocha, 2019). World Health Organization claimed a pregnant women without contraindication for practice should, at least, do 150 minutes of moderate intensity physical activity throughout the week, and they can incorporate strength training for other benefits (OMS, 2020). The practice can start at the first trimester of gestation and can be maintained until delivery (as tolerated). Combining aerobic exercise and resistance training during pregnancy is more effective at improving health outcomes than interventions solely focused on aerobic exercise. The strength training consists of low resistance exercises with barbells, dumbbells, and resistance bands (Barakat *et al.*, 2016, 2018; Haakstad, Edvardsen and Bø, 2016; Sánchez-García and Aguilar-Cordero, 2019b; Santos-Rocha, 2019). The Pelvic Floor Muscle Training (PFMT) may be performed to reduce the odds of urinary incontinence (UI) and other pelvic floor dysfunctions (Mørkved and Bø, 2014; Mottola *et al.*, 2019). Despite these recommendations according to the ACOG and Canadian

Guidelines, some physical exercise programs in RCTs did not present this complete training (ACOG, 2015; Mottola *et al.*, 2019).

Relatively to the way of measure exercise intensity, Canadian Guidelines presented the maternal heart rate as a solution. The ACOG refuted it and suggested the use of ratings of perceived exertion (ACOG, 2015; Mottola *et al.*, 2019). In the RCTs did not founded consensus in this variable.

The Guidelines on physical activity during pregnancy provide recommendations for various stakeholders to support the pregnant women. More detailed guidelines for physical activity during pregnancy are available from several countries, with information based on evidence. In 2014 were developed a systematic review that contrasted pregnancy-related physical activity guidelines from around the world. Some discrepancies were founded and the authors suggested more consensus between guidelines (Evenson *et al.*, 2014). A common language to facilitate the communication between the various stakeholders, may help increase the adherence to the physical activity guidelines by both the providers and their patients.

Furthermore, analysing some RCTs were founded discrepancies with the guidelines, some limitations in the design and lack of consensus between them (e.g., method of measured intensity, evaluation of nutrition factor, interventions according with the Consensus of Exercise Reporting Template. Remembering that the RCTs are the base of the guidelines, it is important create consistency on these studies andinterventions.

Considering the contextualization, this Thesis will present at the first place an updated of a Systematic Review that aimed to evaluate the available evidence on the effectiveness of group exercise programs between 2015 and 2020 and given the lack of consensus between the guidelines it was pertinent to contrast the RCTs, which are presented as the evidence base for the guidelines. The authors will present the analyse of physical exercise program design, the consistency with the guidelines, and identified limitations in the interventions that can be improved in the future.

Among the various limitations founded, there were two limitations that impressed the authors and may have a related solution: higher levels of drop-out and

influence of social support on risk of depression. This reasoning will be explained bellow.

Despite the benefits of exercise in pregnancy, the physical exercise program adherence revealed itself as a limitation and as a significant challenge in many RCTs (Coll *et al.*, 2019). Pregnant women tend to be highly motivated to improve unhealthy behaviour when have a support, counselling and supervision of providers, and the gynaecologist/obstetrician encourages her to exercise (Santos-Rocha, 2019). The follow-up during pregnancy from a multidisciplinary team may be relevant.

Not only the physical exercise professionals, but also the others health professionals should support the pregnant women. Social support (not only partner and family, but also health professionals, such as gynaecologist) is a multidimensionalconcept with is composed of three dimensions: affective/emotional support, instrumental/financial support, and informational support (Thoits, 2011; Lima *et al.*, 2018). Social support was identified as a powerful protective factor for decreasing depressive symptoms during pregnancy. This variable could have a preventive impact on pregnant women well-being. More than 70% of pregnant women report symptoms of depression during pregnancy, which can increase the PPD development probability (Becker *et al.*, 2016). Low social support level was identified as a factor that may influence the risk of depression and PPD (Vargas-Terrones *et al.*, 2019).

Considering the possible influence of social support of multidisciplinary team on risk of depression and level of drop-out the authors will present a possible solution. At the second place, this thesis will present a Study Protocol that will evaluate the influence of multidisciplinary team (In-Person Intervention) on risk of depression during pregnancy and postpartum, and level of drop-out. Considering that the benefits of the physical exercise for the pregnant women and newborn are already strongly supported by the evidence, the second group just will be excluded of the social support from this multidisciplinary team. The physical exercise intervention will be developedin online format. An also relevant reason for choosing the online format was thedevelopment of this work in a time of pandemic (Covid-19), which inherently forcedthe continuity of many tasks in online mode.

STUDY 1 - CAN GROUP EXERCISE PROGRAMS IMPROVE HEALTH AND FITNESS OUTCOMES IN PREGNANT WOMEN: AN UPDATED SYSTEMATIC REVIEW

Can Group Exercise Programs Improve Health and Fitness Outcomes in Pregnant Women? An Updated Systematic Review

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Abstract: Current scientific evidence supports the recommendation to initiate or continue physical exercise in healthy pregnant women. Group exercise programs have positive effects in improving health, well-being, and social support. In 2015, a systematic review was provided to evaluate the evidence on the effectiveness of group exercise programs in improving pregnant women's and newborn's health outcomes, andto assess the content of the programs. This review aims to update this knowledge between 2015 and 2020. The exercise program designs were analysed with the Consensus of Exercise Reporting Template (CERT) model, the consistency with the guidelines, identifying limitations in the interventions that can be improved in thefuture. Three databases were used to conduct literature searches. Thirty-one randomizedcontrol trials were selected for analysis. All studies followed a supervised group exercise program including aerobic, resistance, pelvic floor training, stretching and relaxation sections. Group interventions during pregnancy improved health and fitness outcomes for the women and newborns, although some gaps were identified in the interventions. Monitoring during pregnancy should be developed by a multidisciplinary team and, exercise and health professionals should advise pregnant women that group exercise improves a wide range of health outcomes for them and newborns.

Keywords: physical activity; exercise; health; fitness; pregnancy; postpartum

INTRODUCTION

Regular physical activity in all stages of life, including pregnancy, promotes health benefits, such as maintaining and improving cardiorespiratory fitness, promotes physical fitness, and reduces the risk of obesity and associated comorbidities (Evenson *et al.*, 2014; Mottola *et al.*, 2019; Birsner and Gyamfi-Bannerman, 2020). Pregnancy is a special moment where lifestyle behaviors, including physical activity, can significantly affect maternal and fetal health (Haakstad, Edvardsen and Bø, 2016). The American College of Obstetricians and Gynecologists (ACOG) reports that women whobegins their pregnancy without a healthy lifestyle should be encouraged to adopt it in pre-pregnancy and pregnancy periods and should follow a more gradual progression of exercise intensity.

For pregnant women who want to adopt the practice of physical exercise during pregnancy, exercise intensity should be adjusted according to their physical activity and exercise levels. Moderate-intensity physical exercise has the most scientific evidence and the strongest recommendation. The guidelines suggest that pregnant women without contraindications should accumulate at least 150 min/week of moderate-intensity aerobic exercise spread across, at least, 3 days per week. The sessions should be of 30-60 minutes. The practice can start at the first trimester of gestation and can be maintained until delivery (as tolerated). They should incorporate a variety of aerobic exercise, resistance training, yoga, and stretching.

Combining aerobic exercise and resistance training during pregnancy is more effective at improving health outcomes than interventions solely focused on aerobic exercise. It is important to note that, for some outcomes, lower intensity physicalactivity also imparts benefits, although accumulating more physical activity over the week was associated with greater benefits. Some examples of safe aerobic activities to do during pregnancy are walking, stationary cycling, dancing, aerobic, step, and water aerobic exercises (Haakstad, Edvardsen and Bø, 2016; Sánchez-García and Aguilar- Cordero, 2019b; Santos-Rocha, 2019). The strength training consists of low resistance exercises with barbells, dumbbells, and resistance bands (Barakat *et al.*, 2016, 2018). The Pelvic Floor Muscle Training (PFMT) may be performed to reduce the odds of urinary incontinence (UI) and other pelvic floor dysfunctions (Mørkved and Bø, 2014; Mottola *et al.*, 2019).

For pregnant women who performed regular high-intensity exercise before pregnancy and who have an uncomplicated and healthy pregnancy, should be able to maintain the practice of high-intensity exercise; while being flexible for possible adjustments according to their condition or type of exercise (ACOG, 2015; Birsner and Gyamfi-Bannerman, 2020).

The Canadian Guidelines presented the maternal heart rate as a measure of exercise intensity (Mottola *et al.*, 2019). The ACOG Guidelines refuted it, outlining that due to blunted heart rate responses to exercise reported in pregnant women, the use of ratings of perceived exertion may be a more effective means to monitor exercise intensity. The 6-20 Borg's Scale can be used, between 13-14 values for moderate- intensity. The talk-test is another valid way of gauging exercise intensity (Birsner and Gyamfi-Bannerman, 2020). These recommendations are intended for pregnant women without contraindications for physical exercise practice.

ACOG reports that exercise during pregnancy can: control the gestational weight gain, gestational diabetes mellitus, and gestational hypertensive disorders; increase the vaginal delivery probability; and control the birth weight. The evidence reported a 50% and 35% reduction in prenatal and postnatal urinary incontinence, respectively. However, the recommendation level is weak with low quality evidence (Mørkved and Bø, 2014; Mottola *et al.*, 2019). Despite the benefits of exercise in pregnancy the physical exercise program adherence revealed itself as a limitation and as a significant challenge in many RCTs (Coll *et al.*, 2019).

Comparing and updating the guidelines, ACOG (Birsner and Gyamfi-Bannerman, 2020), contrary to the Canadian Guidelines (Mottola *et al.*, 2019), states that the contraindications for exercise (absolute and relative) should only be considered in aerobic exercise. Thus, a pregnant woman with obstetric or medical complications should maintain strength or pelvic floor training. Furthermore, ACOG in 2015 reported that the evidence of the benefits of aerobic training was limited. However, the same article was recently revised and redacted this fact (Birsner and Gyamfi- Bannerman, 2020).

Obstetric care and exercise professionals must carefully consider the potential costs and perceived barriers to prenatal physical activity to facilitate participation. The

guidelines suggest the use of The Five A's (Ask, Advise, Assess, Assist, and Arrange) to promote consistent exercise practice. Monitoring a pregnancy intervention requires a multidisciplinary team, which not only includes health professionals but also exercise physiologists. Hence, it is necessary that the language, ideas, and recommendations be clear and consensual among the various stakeholders (Mottola *et al.*, 2019).

In 2014, Evenson et al. compared pregnancy-related physical activity guidelines from around the world. The authors suggested that there should be more consensus between the guidelines to enable proper cooperation between health professionals, exercise professionals, and pregnant women (Evenson *et al.*, 2014). Furthermore, to facilitate the use of guidelines in practice, the Physical Activity Readiness Medical Examination (PARmed-X) for Pregnancy tool was developed in 2013, and recently, it was replaced by the Get Active Questionnaire for Pregnancy. These tools are available at the CSEP's website. The authors support that the creation of a common language to facilitate the communication between the various stakeholders, may help increase the adherence to the physical activity guidelines by both the providers and their patients (Evenson *et al.*, 2014).

In 2015, a systematic review was provided to evaluate the available evidence on the effectiveness of group exercise programs in improving women's health outcomes during pregnancy, as well as newborn's health outcomes, and to 88 assess the content of the programs (Jorge, Rocha and Bento, 2015). The present systematic review aims to update the knowledge about the effectiveness of exercise in a group context during pregnancy between 2015 and 2020. Additionally, given the lack of consensus between the guidelines it was pertinent to contrast the RCTs, which are presented as the evidence base for guidelines. The authors analyzed the physical exercise program design, the consistency with the guidelines, identifying limitations in the interventions that can be improved in the future.

MATERIALS AND METHODS

The authors followed the methodological approach described by PRISMA 2009 (Moher *et al.*, 2009). The PRISMA Statement consists of 27-item checklist and a four-phase flow diagram, and it is aimed at helping authors improve the reporting of systematic reviews.

CRITERIA FOR CONSIDERING STUDIES FOR THIS REVIEW

TYPE OF STUDIES

This review included RCT studies published in the English, Portuguese, and Spanish languages, between 2015 and 2020, to find the most recent data.

PARTICIPANTS

This review included studies that recruited adult pregnant women without known pregnancy-related medical conditions.

TYPE OF INTERVENTIONS

The articles included in this review were based in prenatal exercise interventions with a minimum duration of 12 weeks, supervised by physical exercise specialists or exercise physiologists. Interventions designed explicitly for underweight, overweight, and obese pregnant women, or other pregnancy-related medical conditions were excluded.

OUTCOMES MEASURES

Considering the aims of this systematic review, the studied outcome variables were related to pregnant women's health, physical activity, quality of life, and fitness.

SEARCH STRATEGY

Studies were identified by searching three databases: PubMed, Scopus, andScielo, from October 2020 to January 2021. The following search terms were conjoined so as to be identified in the title or abstract of the article or the Medical Subject Headings terms: “pregnancy / gestation / pregnant” AND “physical activity / exercise / group exercise”. PubMed allowed the search of RCT studies, “female”, and “humans”.

STUDY SELECTION

The study selection was conducted in three phases: the first phase was the screening of the articles by their titles 118 against the inclusion criteria; the second phase was the screening of the abstracts; and the third phase was the full screening of the article. During the first and second phases, in the case of doubts about including any article, the screening was delayed for the next phase. On this point, all team members participated in the discussion to resolve it. In the case of duplicated studies, the authors randomly picked one from the three databases.

DATA EXTRACTION

The following data was extracted from each selected article:

- author and year of publication;
- sample size, characteristics of participants, country and location where the study was performed, and gestational week;
- purpose of study, study design including type, frequency and duration of intervention, exercise intensity, equipment, exercise and health specialists leading the program, and the number of participants on each session;
- maternal and fetal health and fitness outcomes measured;
- results of outcomes measured.

QUALITY ASSESSMENT OF THE STUDIES

Version 2 of the Cochrane risk-of-bias tool for randomized trials (RoB 2) was used to assess quality and risk of bias of each study, in order to reduce bias and check internal and statistical validity of each study. It is structured in different domainsfocused on the study's design, conduct, and analysis. Each domain has some questions that collect information relevant to the risk of bias. The proposed judgment on the riskof bias arising from each domain is generated by an algorithm based on the answers to the questions. The judgment may be 'Low' or 'High' risk of bias or express 'Some concerns'. If the author disagrees with the algorithmic answer, the final judgment can be changed, always prevailing as the final decision. Two of the researchers independently assessed risk of bias and the results were compared and consensus reached for each study.

THE CONSENSUS OF EXERCISE REPORTING TEMPLATE (CERT)

In addition to the previous systematic review (Jorge, Rocha and Bento, 2015), this article evaluated intervention design and reported its limitations. The CERT model evaluated the physical exercise program design through key items considered essential to report replicable capacity of intervention. The CERT model comprises 19 questions (refer to 16 items) organized in 7 sections/domains: what (materials and equipment); who (provider); how (delivery); where (location); when, how much (dosage); tailoring (what, how); and how well (compliance/planned and actual). The possible answers are "YES" and "NOT". Each answer with "YES" offers 1 point to study. The studies with higher scores have higher quality interventions. The higher the score the more easily the intervention can be understood and replicated. No study was excluded by the CERT score (Slade and Dionne, 2016).

RESULTS

STUDY SELECTION

Initially 580 articles were identified in the databases search. Sixteen articles were removed, because they were duplicated. Considering the inclusion and exclusion criteria, in the screening based on title or abstract 484 articles were excluded. In the eligibility phase 80 articles were assessed. After a full text review of these articles, just thirty-one were selected for analysis as presented in Figure 1.

CHARACTERISTICS OF THE STUDIES

Table 1 provides the quality assessment of the studies using the RoB2, as well as the total score of each study.

Table 3 provides the characteristics of the studies, which were described according to sample size, location, duration, aims of the study, type and description of the intervention, primary and secondary outcome variables, and results.

This review contains 31 studies including a total 7.560 pregnant women. The sample size across studies ranged from 36 to 840 pregnant women. All studies present a RCT design. Concerning the span of intervention, most studies assessed the influence of a physical exercise program on the 210 outcome variables, during the second and third trimesters of pregnancy (Barakat *et al.*, 2016; Haakstad, Edvardsen and Bø, 2016; Cordero J *et al.*, 2017; L. R. Sagedal, Øverby, *et al.*, 2017; Linda R. Sagedal *et al.*, 2017; Aguilar-Cordero *et al.*, 2019; Coll *et al.*, 2019; Sánchez-García and Aguilar- Cordero, 2019b)(Gustafsson *et al.*, 2016; Haakstad, Torset and Bø, 2016; Perales *et al.*, 2016; Pawalia *et al.*, 2017; Rodriguez-Blanque *et al.*, 2018; Sanda *et al.*, 2018; Dias *et al.*, 2018; Awad *et al.*, 2019; Brik *et al.*, 2019; Rodríguez-Blanque, Sanchez-Garcia, *et al.*, 2019; Rodríguez-Blanque, Sánchez-García, *et al.*, 2019; Roldan-Reoyo *et al.*, 2019; Vargas-Terrones *et al.*, 2019; Charkamyani *et al.*, 2019; Clark *et al.*, 2019; Rodríguez- Blanque, Aguilar-Cordero, Marín-Jiménez, Menor-Rodríguez, *et al.*, 2020; Rodríguez- Blanque, Aguilar-Cordero, Marín-Jiménez, Núñez-Negrillo, *et al.*, 2020; Haakstad and Bø, 2020), but also during the entire pregnancy (Cordero *et al.*, 2015; Bacchi *et al.*, 2018; Barakat *et al.*, 2018, 2019; Pelaez *et al.*, 2019). All interventions lasted at least 12weeks. The studies were conducted in the following countries: Spain (Cordero *et al.*, 2015; Perales *et al.*, 2016; Barakat *et al.*, 2016; Cordero J *et al.*, 2017; Barakat *et al.*,

2018; Rodriguez-Blanque *et al.*, 2018; Rodríguez-Blanque, Sanchez-Garcia, *et al.*, 2019; Aguilar-Cordero *et al.*, 2019; Barakat *et al.*, 2019; Rodríguez-Blanque, Sánchez- García, *et al.*, 2019; Roldan-Reoyo *et al.*, 2019; Sánchez-García and Aguilar-Cordero, 2019b; Vargas-Terrones *et al.*, 2019; Brik *et al.*, 2019; Pelaez *et al.*, 2019; Rodríguez- Blanque, Aguilar-Cordero, Marín-Jiménez, Menor-Rodríguez, *et al.*, 2020; Rodríguez- Blanque, Aguilar-Cordero, Marín-Jiménez, Núñez-Negrillo, *et al.*, 2020), Argentina(Bacchi *et al.*, 2018), Norway (Gustafsson *et al.*, 2016; Haakstad, Edvardsen and Bø, 2016; L. R. Sagedal, Øverby, *et al.*, 2017; Linda R. Sagedal *et al.*, 2017; Dias *et al.*, 2018; Sanda *et al.*, 2018; Haakstad and Bø, 2020), Brazil (Dias *et al.*, 2018; Coll *et al.*, 2019), Iran (Charkamyani *et al.*, 2019), USA (Clark *et al.*, 2019), Egypt (Awad *et al.*, 2019), India (Pawalia *et al.*, 2017).

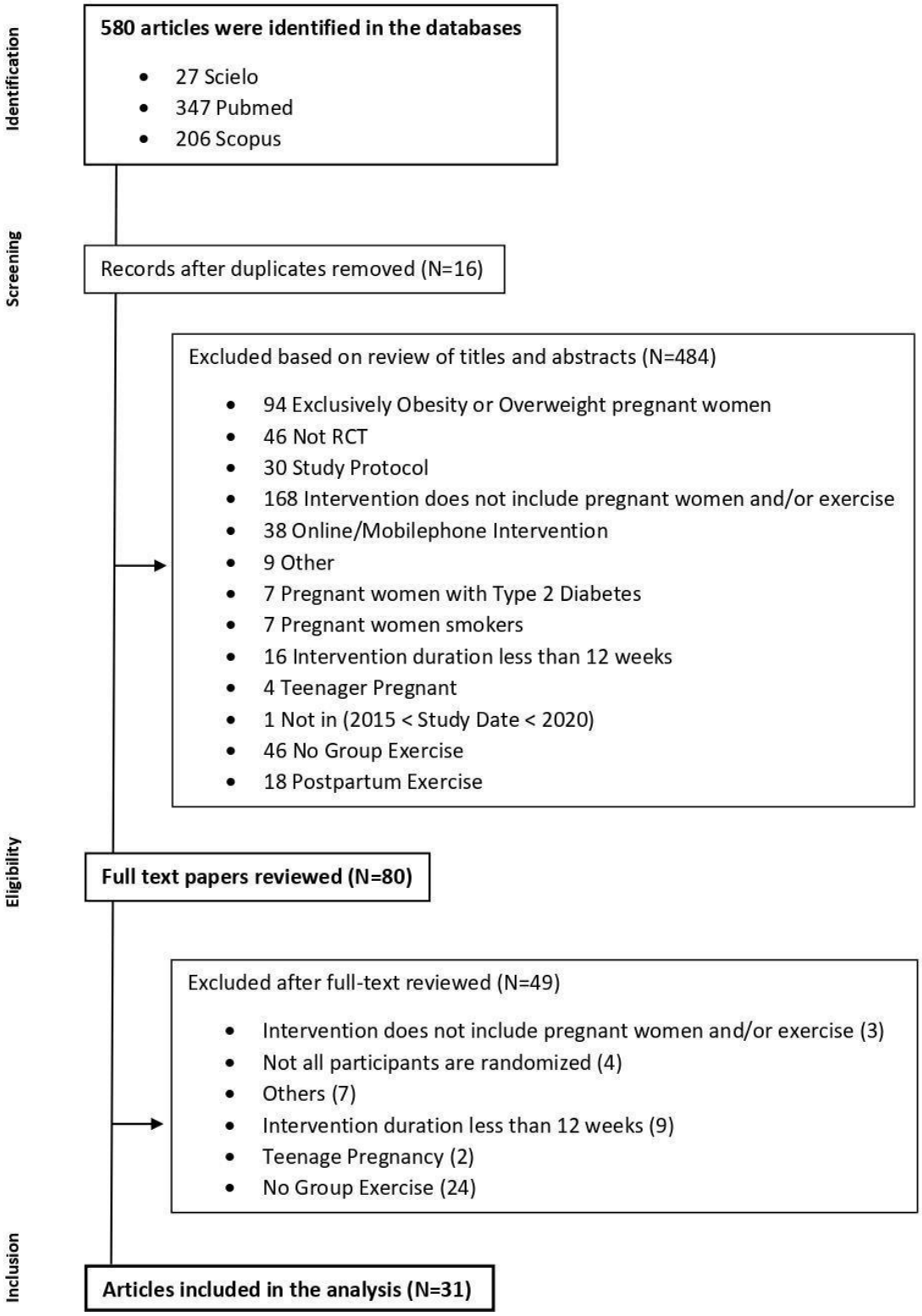

Figure 1: Flow diagram of literature search for group exercise interventions in pregnancy.

Table 1: Quality assessment and RoB2 score.

Authors	D1	D2	D3	D4	D5	Overall
Sánchez-García, J. (2019) [6]	+	+	+	+	+	+
Blanque, R. (2017) (Cordero J *et al.*, 2017)	+	+	+	+	+	+
Bacchi, M. (2017) (Bacchi *et al.*, 2018)	+	+	+	+	+	+
Haakstad, L. (2016) [4]	+	+	+	+	+	+
Sagedal, LR. (2017) (L. R. Sagedal, Øverby, *et al.*, 2017)	+	+	+	+	+	+
Sagedal, LR. (2017) (Linda R. Sagedal *et al.*, 2017)	+	+	+	!	+	!
A-Cordero, M. (2018) (Aguilar-Cordero *et al.*, 2019)	+	+	+	+	+	+
Barakat, R. (2018) (Barakat *et al.*, 2019)	+	+	+	+	+	+
Sanda, B. (2018) (Sanda *et al.*, 2018)	!	+	!	+	+	!
Terrones, M. (2018) (Vargas-Terrones *et al.*, 2019)	+	+	+	+	!	!
23Blanque, R. (2017) (Rodriguez-Blanque *et al.*, 2018)	+	+	+	+	+	+
Dias, N. (2017) (Dias *et al.*, 2018)	+	+	+	+	+	+
Haakstad, L. (2015) (Haakstad, Torset and Bø, 2016)	+	+	!	+	+	!
Gustafsson, MK. (2015) (Gustafsson *et al.*, 2016)	+	+	+	+	+	+
Charkamyani, F. (2019) (Charkamyani *et al.*, 2019)	+	+	+	+	+	+
Perales, M. (2015) (Perales *et al.*, 2016)	+	+	+	+	+	+
Palaez, M. (2019) (Pelaez *et al.*, 2019)	+	+	+	+	+	+
Clark, E. (2019) (Clark *et al.*, 2019)	+	+	+	+	!	!
Haakstad, L. 2020) (Haakstad and Bø, 2020)	+	+	+	+	+	+
Blanque, R. (2020) (Rodríguez-Blanque, Aguilar-Cordero, Marín-Jiménez, Menor-Rodríguez, *et al.*, 2020)	+	+	+	+	+	+
Blanque, R. (2020) (Rodríguez-Blanque, Aguilar-Cordero, Marín-Jiménez, Núñez-Negrillo, *et al.*, 2020)	+	+	+	+	+	+
Reoyo, O. (2019) (Roldan-Reoyo *et al.*, 2019)	+	+	+	+	+	+
Blanque, R. (2019) (Rodríguez-Blanque, Sanchez-Garcia, *et al.*, 2019)	+	+	+	+	+	+
Brik, M. (2018) (Brik *et al.*, 2019)	+	+	+	+	+	+
Coll, C. (2019) (Coll *et al.*, 2019)	+	+	+	+	+	+
Blanque, R. (2019) (Rodríguez-Blanque, Sánchez-García, *et al.*, 2019)	+	+	+	+	+	+
Awad, E. (2019) (Awad *et al.*, 2019)	+	+	-	+	!	-
Barakat, R. (2017) (Barakat *et al.*, 2018)	+	+	+	+	+	+

Pawalia, A. (2017) (Pawalia *et al.*, 2017)	-	!	!	+	+	-
Barakat, R. (2016) (Barakat *et al.*, 2016)	+	+	+	+	+	+
Cordero, Y. (2015) (Cordero *et al.*, 2015)	!	+	+	+	+	!

Note 1: D1 – Randomisation Process; D2 – Deviations from the intended interventions; D3 – Missing outcome 218 data; D4 – Measurement of the outcome; D5 – Selection of the reported result; Low Risk (+); Some Concerns 219 (!); High Risk (-).

CHARACTERISTICS OF THE INTERVENTIONS

All studies aimed to evaluate the effectiveness of a group exercise program on maternal and foetal health outcomes. The interventions had between 24 to 90 group sessions of an average of 8-13 women. The sessions had a frequency of at least one to four times per week and an average duration of 60 minutes. Only one study presented sessions with a duration between 60 and 90 minutes. The intensity of the intervention was measured with Borg's scale remaining between 12 and 14, or with heart rate remaining at maximum values of 60% (Barakat *et al.*, 2018; Brik *et al.*, 2019; Roldan- Reoyo *et al.*, 2019) or 70% (Barakat *et al.*, 2016). Some studies used heart rate with women who reported a value higher than 14 on Borg's Scale (Rodríguez-Blanque, Aguilar-Cordero, Marín-Jiménez, Menor-Rodríguez, *et al.*, 2020).

The structure of interventions developed out of water consisted of a warm-up period with low-impact aerobic exercises such as walking and dancing, the main phase with resistance training, pelvic floor muscle training, and ended with relaxation, stretching, flexibility, and mobility. Nine studies used aquatic intervention with the Study Water Exercise Pregnant (SWEP) method (Aguilar-Cordero, 2015). Specifically, this method consisted of three sessions of 60 minutes per week. Each session had one day of recovery. Nutrition and hydration were essential before sessions. The temperature of the water was between 28- 30 degrees Celsius. Each session was divided into three phases: the warm-up phase (in and out of water); the aim phase, first in 1,8 m (or 5ft) and after in 1,2 m (or 3ft) m pools, that consisted of resistance training using the four swimming techniques and pelvic floor muscle training, respectively; finally, the women had a relaxation phase.The intensity is measured with Borg's scale (14), heart rate with a maximum of 140bpm or talk-test. The level of training was calculated with: IPAQ – international physical activity questionnaire, using an accelerometer for seven days, and by themastery of the swimming techniques.

Only one study used both methods and women had two sessions in the gym hall and one session in the pool. In the gym, the intervention was structured like in the previously mentioned studies. In the pool, the intervention was focused on each of the swimming techniques (excluding butterfly technique). The pelvic floor muscle training was mentioned only in the gym hall sessions (Cordero *et al.*, 2015).

In the studies that used the NFFD method, the intervention group received an initial telephone consultation with a doctor, clinical nutritionist, or graduate student in public health. A follow-up consultation took place 4-6 weeks after initial consultation. They had other nutrition initiatives during pregnancy.

The physical exercise interventions were supervised and led by certified aerobic/fitness instructors or by physiotherapists. The control groups included pregnant women receiving standard antenatal care and were neither encouraged nor discouraged from exercising. Some studies reported that the control group had additional written information and recommendations about diet, pelvic floor muscle exercises, and pregnancy-related pelvic girdle pain (Gustafsson *et al.*, 2016).

CERT MODEL

On analysis of the intervention's design with the CERT Model a total score was assigned by summing all responses, as presented in Table 2.

Briefly, 9 articles had 12 or more on total score. The maximum score was 15 and the minimum score was 5. Only one study recorded the minimum score.

Table 2: CERT Model

Authors	Total	Authors	Total	Authors	Total
Sánchez-García, J. (2019) [6]	14	Dias, N. (2017) (Dias *et al.*, 2018)	7	Blanque, R. (2019) (Rodríguez-Blanque, Sanchez-Garcia, *et al.*, 2019)	15
Blanque, R. (2017) (Cordero J *et al.*, 2017)	14	Haakstad, L. (2015) (Haakstad, Torset and Bø, 2016)	8	Brik, M. (2018) (Brik *et al.*, 2019)	5
Bacchi, M. (2017) (Bacchi *et al.*, 2018)	8	Gustafsson, MK. (2015) (Gustafsson *et al.*, 2016)	10	Coll, C. (2019) [11]	10
Haakstad, L. (2016) [4]	9	Charkamyani, F. (2019) (Charkamyani *et al.*, 2019)	5	Blanque, R. (2019) (Rodríguez-Blanque, Sánchez-García, *et al.*, 2019)	13
Sagedal, LR. (2017) (L. R. Sagedal, Øverby, *et al.*, 2017)	10	Perales, M. (2015) (Perales *et al.*, 2016)	9	Awad, E. (2019) (Awad *et al.*, 2019)	10
Sagedal, LR. (2017) (Linda R. Sagedal *et al.*, 2017)	10	Palaez, M. (2019) (Pelaez *et al.*, 2019)	8	Barakat, R. (2017) [8]	9
A-Cordero, M. (2018) (Aguilar-Cordero *et al.*, 2019)	15	Clark, E. (2019) (Clark *et al.*, 2019)	8	Pawalia, A. (2017) (Pawalia *et al.*, 2017)	7
Barakat, R. (2018) (Barakat *et al.*, 2019)	9	Haakstad, L. 2020) (Haakstad and Bø, 2020)	7	Barakat, R. (2016) [7]	9
Sanda, B. (2018) (Sanda *et al.*, 2018)	6	Blanque, R. (2020) (Rodríguez-Blanque, Aguilar-Cordero, Marín-Jiménez, Menor-Rodríguez, *et al.*, 2020)	15	Cordero, Y. (2015) (Cordero *et al.*, 2015)	9
Terrones, M. (2018) (Vargas-Terrones *et al.*, 2019)	11	Blanque, R. (2020) (Rodríguez-Blanque, Aguilar-Cordero, Marín-Jiménez, Núñez-Negrillo, *et al.*, 2020)	15		
Blanque, R. (2017) (Rodriguez-Blanque *et al.*, 2018)	14	Reoyo, O. (2019) (Roldan-Reoyo *et al.*, 2019)	6		

Table 3: Caractheristics of the Studies

Authors and Year of Publication	Participants and Location	Objetives	Study Design	Measures	Results
Juan Carlos Sánchez-García et al. (2018) (Sánchez-García and Aguilar-Cordero, 2019b)	**N=**129 IG=65 + CG=64 Healthy PW without contraindications for practice ACOG (2015). **Gestational week:** 20th **Location:** Granada, Spain	To examine the gestational weight gain and postpartum on pregnant women who realized moderate physical exercise on aquatic environment.	**Type of Intervention:** RCT (CG x IG) **Description:** The IG had access to moderate intensity physical exercise program in water with SWEP method. The intervention was supervised by an exercise specialist. The CG received usual care and general advice on the benefits of exercise. **Intensity Measurement:** Borg Scale or Heart Rate **Time of session:** 60' **Frequency:** 3x/week **Duration of Intervention:** 17 weeks	**Primary:** GWG, weight retention (16th and 18th postpartum week) and newborn weight. **Secondary:** The level of physical activity (GPAQ at 12th gestational week) and baseline maternal characteristics.	The study showed that the variables of GWG, weight retention (4 and 7 months) and newborn weight presented lower values on IG.
Raquel Rodríguez-Blanque et al. (2017) (Cordero J *et al.*, 2017)	**N=** 140 IG=70 + CG=70 Healthy PW without contraindications for practice (ACOG 2015). **Gestational Week:** 20th **Location:** Granada, Spain	To examine the Effect of physical exercise program with moderate intensity during pregnancy in water on newborn weight.	**Type of Intervention:** RCT (CG x IG) **Description:** The IG had access to moderate intensity physical exercise program in water with SWEP method. The intervention was supervised by an exercise specialist. The CG received usual care and general advice on the benefits of exercise. **Intensity Measurement:** Borg Scale or Heart Rate **Time of session:** 60' **Frequency:** 3x/week **Duration of Intervention:** 17 weeks	**Primary:** Days of gestation and newborn weight. **Secondary:** maternal weight (1st and 3rd trimesters) and baseline maternal characteristics.	Lower values of newborn weight in IG. However, these differences did not represent clinical trends because both groups are on normal state of weight.

Mariano Bacchi et al. (2017) (Bacchi *et al.*, 2018)	**N=** 111 IG=49 + CG=62 Healthy PW without contraindications for practice (ACOG 2002). **Gestational Week:** 10th **Location:** Buenos Aires, Argentina.	To examine the influence of supervision and regular water activities program during pregnancy on maternal weight gain and birth weight.	**Type of Intervention:** RCT (CG x IG) **Description:** Moderate physical exercise intervention in water. Sessions included aerobic, strength and aquatic activities, on standing, supine and ventral position. Relax phase included relaxing, stretching, and breathing exercises. The intervention was supervised by an exercise specialist. The CG received usual care and did not report any physical exercise during pregnancy. **Water Temperature:** 28.5º to 29º **Intensity Measurement:** BORG Scale **Time of session:** 55 to 60 minutes **Frequency:** 3 per/week **Duration of Intervention:** 26 weeks	**Primary:** GWG and birth weight. **Secondary:** baseline maternal characteristics.	Higher percentage of women with excessive maternal weight gain in CG No differences between groups on birth weight variable.
Lene A. H. Haakstad et al. (2015) (Haakstad, Edvardsen and Bø, 2016)	**N=** 61 IG=35 + CG=26 Healthy PW without contraindications for practice (ACOG 2002). **Gestational Week:** 24th **Location:** Oslo, Norway.	To evaluate the effect of regular exercise on maternal arterial blood pressure at rest and during uphill walking.	**Type of Intervention:** RCT (CG x IG) **Description:** Moderate intensity physical exercise program. Each session included warm-up, aerobic, strength (general and pelvic) and relax phases. The participants were advised to do at least 30' of moderate physical exercise on rest of days. The CG received usual care and recommendations for maintain the physical activity without received some incentive for physical exercise practice. **Intensity Measurement:** Borg Scale **Time of session:** 60 minutes **Frequency:** 2 x/week **Duration of Intervention:** 12 weeks	**Primary:** Resting systolic and diastolic blood pressure (three times by auscultatory techniques) and walking systolic and diastolic blood Pressure (during monitoring walking). This was performed before and after the intervention.	Lower values of blood pressure in rest in IG. The values of blood pressure during exercise were lower on IG.

Linda R. Sagedal et al. (2016) (L. R. Sagedal, Øverby, *et al.*, 2017)	**N=** 591 IG=296 + CG=295 Healthy PW without contraindications for practice (ACOG 2002). **Gestational Week:** ≤20th **Location:** Kristiansand and Mandal, Norway.	To examine whether a lifestyle intervention on nutrition and physical exercise in pregnancy limits GWG and provides measurable health benefits for mother and newborn.	**Type of Intervention:** RCT (CG x IG) **Description:** Dietary and physical exercise intervention. The intervention was designed by NFFD method. The group was encouraged to engage in 30' of moderate-intensity physical activity on three additional days per week. Counselling dietary was performed by phone. The sessions were supervised by the therapists or students in sports science, trained and quality controlled by the NFFD team. The CG received routine prenatal care in accordance with Norwegian standards. They received too a booklet with advice on prenatal nutrition and physical activity. **Intensity Measurement:** Borg Scale **Time of session:** 60 min **Frequency:** 2 x/week **Duration:** 12 weeks	**Primary:** GWG, birthweigh, the proportion of infants weighing >4000 g and the incidence of operative deliveries. **Secondary:** the proportion of newborns of birthweight ≥90th percentile, the incidence of delivery complications.	Statistically significant decrease in GWG in the IG. The intervention did not decrease the incidence of pregnancy complications or operative delivery and had no effect on fetal weight or neonatal outcomes.
Linda R. Sagedal et al. (2017) (Linda R. Sagedal *et al.*, 2017)	**N=** 591 IG=296 + CG=295 Healthy PW without contraindications for practice (ACOG 2002). **Gestational Week:** ≤20th **Location:** Kristiansand and Mandal, Norway.	To examine the effect of the NFFD intervention on glucose metabolism, including an assessment of the subgroups of normal-weight and overweight/obese participants	**Intervention:** RCT (CG x IG) **Description:** Dietary and physical exercise intervention. The intervention was designed by NFFD method. The group was encouraged to engage in 30' of moderate-intensity physical activity on three additional days per week. Counselling dietary was performed by phone. The sessions were supervised by the therapists or students in sports science, trained and quality controlled by the NFFD team. The CG received routine prenatal care in accordance with Norwegian standards. They received too a booklet with advice on prenatal nutrition and physical activity. **Intensity Measurement:** Borg Scale **Time of session:** 60 min **Frequency:** 2 x/week **Duration:** 12 weeks	**Primary:** GWG, birth weight of term infants, the proportion of term infants >4000g, maternal fat percent at 36 gestational-weeks, and the incidence of operative deliveries. **Secondary:** proportion of women with elevated 2-h glucose tolerance tests and measurement of hormones related to glucose metabolism.	Statistically significant reduction of GWG. In variables of infants there were not differences. The levels of insulin were statistically significant lower in IG. In the normal weight sub-group there was reduction on levels of insulin and leptin. In the obesity sub-group the only was difference in fasted glucose values.
María José Aguilar-Cordero et	**N=** 129	To determine whether physical activity during	**Type of Intervention:** RCT (CG x IG) **Description:** The IG had access to moderate intensity physical exercise	**Primary:** Prevalence of PPD (EDPS).	In the normal weight category, for PPD evaluation there was statistically significant differences between groups.

al. (2019) (Aguilar-Cordero *et al.*, 2019)	GI=65 + GC=64 Healthy PW without contraindications for practice (ACOG 2015). **Gestational Week:** $12^{th}/20^{th}$ **Location:** Granada, Spain.	pregnancy alleviates Postpartum Depression	program in water with SWEP method. The intervention was supervised by an exercise specialist. The CG received usual care and general advice on the benefits of exercise. **Intensity Measurement:** Borg Scale or Heart Rate **Time of session:** 60' **Frequency:** 3x /week **Duration of Intervention:** 17 weeks	**Secondary:** Baseline maternal characteristics and GWG.	However, none of the groups were in high risk of postpartum depression. For overweight and obesity categories there were statistically significant differences. Contrary to category of normal weight, the CG showed values of high risk of postpartum depression. Lower weight gain in IG.
Ruben Barakat et al. (2018) (Barakat *et al.*, 2019)	**N=** 456 GI=234 + GC=222 Healthy PW without contraindications for practice (ACOG 2015). **Gestational Week:** $8^{th}/10^{th}$ **Location:** Madrid, Spain.	Examine the effects of an exercise program throughout pregnancy on maternal weight gain and prevalence of gestational diabetes	**Type of Intervention:** RCT (CG x IG) **Description:** Moderate intensity physical exercise intervention. Each session included warm-up, aerobic, light muscle strengthening, coordination, and balance and stretching exercises. All sessions were accompanied by music and the room had appropriated conditions to practice (altitude 600 m; temperature 19-21◦C; humidity 50-60%). The CG attended regular scheduled visits to their obstetricians and midwives, usually every 4-5 weeks until the 36-38th week of gestation and then weekly until delivery. They received general nutrition and physical activity counselling from their health-care provider. **Intensity Measurement:** Borg Scale (12-14) **Time of session:** 55 to 60 min **Frequency:** 3x/week **Duration:** 30 weeks	**Primary:** GWG, excessive gestational weight gain (yes/no), gestational diabetes and 1h OGTT. **Secondary:** maternal gestational age at delivery, type of delivery and birth weight	IG presented lower GWG compared with CG. The ratio of women that gained excessively weight was higher in the CG than the IG. IG presented statistically significant lower values of OGTT results compared with CG. The ratio of women diagnosed with GDM was higher in the CG than the IG, with statistically significant differences. The results just showed that the ratio of neonate macrosomia was slightly higher in CG than in the IG.

Birgitte Sanda et al. (2018) (Sanda *et al.*, 2018)	**N=** 606 GI=295 + GC=294 Healthy PW without contraindications for practice (ACOG 2022). **Gestational Week:** 18th **Location:** Norway.	Examine the effect of a lifestyle intervention including group exercise classes, as well as the possible influence of physical activity level in late pregnancy, on labor outcomes.	**Type of Intervention:** RCT (CG x IG) **Description:** Dietary and physical activity intervention. The intervention was designed by NFFD method. The group was encouraged to engage in 30' of moderate-intensity physical activity on three additional days per week. Counselling dietary was performed by phone. The sessions were supervised by the therapists or students in sports science, trained and quality controlled by the NFFD team. The CG received routine prenatal care in accordance with Norwegian standards. They also received a booklet with advice on prenatal nutrition and physical activity. **Intensity Measurement:** Borg Scale (12-14) **Time of session:** 60 min **Frequency:** 2 per/week **Duration:** 30 weeks	**Primary:** The duration and type of labor. **Secondary:** Baseline maternal characteristics, other information of labor.	IG experienced a longer 1st stage of labor with statistically significant difference compared with CG. PW with high level of PA levels in late pregnancy had lower odds for acute caesarean delivery compared to women with low levels. Epidural analgesia was more common among in the low active group compared to women in high active group.
Marina Vargas-Terrones et al. (2018) (Vargas-Terrones *et al.*, 2019)	**N=** 124 GI=70 + GC=54 Healthy PW without contraindications for practice (ACOG 2015). **Gestational Week:** <16th **Location:** Madrid, Spain.	To examine the effect of an exercise programme during pregnancy on the risk of perinatal depression.	**Type of Intervention:** RCT (CG x IG) **Description:** Moderate intensity physical exercise intervention. Each session included warm-up, aerobic, strength exercises and stretching and relaxation. The sessions were supervised by a qualified fitness specialist. Both groups received usual care from health professionals of the hospital and the general recommendations of nutrition and exercise. **Intensity Measurement**: Borg Scale (12-14) or heart rate (55-60%) **Time of session:** 60 min **Frequency:** 3 per/week **Duration:** 30 weeks	**Primary:** Risk of depression (CES-D scale) was measured at the beginning of the study (12-16 weeks), at gestational week 38 and at 6th week postpartum. **Secondary:** Baseline maternal characteristics.	The prevalence of women with depression was lower in IG. These differences were showed at gestational week 38 and week 6 postpartum.

R. Rodriguez Blanque et al. (2017) (Rodriguez-Blanque *et al.*, 2018)	**N=** 134 GI=67 + GC=67 Healthy PW without contraindications for practice (ACOG 2015). **Gestational Week:** $12^{th}/20^{th}$ **Location:** Granada, Spain.	To determine whether, in pregnant women, there is an association between moderate-intensity physical activity in an aquatic environment and sleep quality.	**Type of Intervention:** RCT (CG x IG) **Description:** The IG had access to moderate intensity physical exercise program in water with SWEP method. The intervention was supervised by an exercise specialist. The CG received usual care and general advice on the benefits of exercise. **Intensity Measurement:** Borg Scale or Heart Rate **Time of session:** 60' **Frequency:** 3x /week **Duration of Intervention:** 17 weeks	**Primary:** Sleep quality (PSQI-Questionnaire) was evaluated in the 1^{st} and 3^{rd} trimesters. **Secondary:** Baseline maternal characteristics.	This study showed that IG had better results in quality, duration, latency and regular efficiency of sleep, compared with CG.
Naiara T. Dias et al. (2017) (Dias *et al.*, 2018)	**N=** 50 GI=25 + GC=25 Healthy PW without contraindications for practice (ACOG 2015). **Gestational Week:** $14^{th}/16^{th}$ **Location:** Uberlândia, Brazil.	Evaluate the effectiveness of a Pilates exercise program with PFM contraction compared to a conventional intervention in pregnant women.	**Intervention:** RCT (CG x IG) **Description:** Pilates exercise intervention. The intervention intensity increased after an adaptation period of 4 weeks. Mats, therapeutic balls and elastic bands were used. The intervention was supervised by an exercise specialist. The CG underwent walking for 10' and strengthening exercises of the lower libs, upper limbs, and trunk with elastic band and body weight resistance. At the end of each session, the women performed stretching and relaxation exercises. No type of instruction or verbal command was given regarding the PFM and abdominal muscle contraction. **Intensity Measurement:** Borg Scale (13-14) **Time of session:** 60 min **Frequency:** 2 x/week **Duration:** 18 weeks	**Primary:** PFM strength (manometer) measured at 14^{th} and 16^{th} weeks and, again between the 32^{nd} and 34^{th} weeks of gestation. **Secondary:** digital palpation variables – PFM strength using Oxford Scale, PFM endurance and PFM repeatability.	There were no significant differences between groups for the PFM strength assessed by manometer. The IG presented significantly better results on PFM strength measured through Oxford scale, PFM endurance, and PFM repeatability, compared to CG.

Lene A.H. Haakstad et al. (2016) (Haakstad, Torset and Bø, 2016)	**N=** 105 GI=52 + GC=53 Healthy PW without contraindications for practice (ACOG 2002). **Gestational Week:** <24th **Location:** Oslo, Norway.	To examine the effects of supervised group exercise on maternal psychological outcomes and commonly reported pregnancy complaints.	**Type of Intervention:** RCT (CG x IG) **Description:** Moderate intensity physical exercise intervention. Each session included warm-up, cardiovascular training, strength (core muscles) and stretch and relaxation phase. The intervention was supervised by an exercise specialist. The CG were asked to continue their usual physical activity habits and were neither encouraged no discouraged from exercising. **Intensity Measurement:** Borg Scale (12-14) **Time of session:** 60 min **Frequency:** 2 x/week **Duration:** At least 12 weeks	**Primary:** well-being, QOL, body-image and negative mood symptoms/maternal depression (WHOQOL-bref and SF-36). **Secondary:** pregnancy complaints, pelvic girdle pain and LBP.	IG presented significant lower values in fatigue variable compared with CG. IG presented higher values in health satisfaction compared with CG. The IG presented lower values in variables of nausea/vomiting and numbness/reduced circulation compared with CG.
MK Gustafsson et al. (2015) (Gustafsson *et al.*, 2016)	**N=** 761 GI=396 + GC=365 Healthy PW without contraindications for practice (ACOG 2002). **Gestational Week:** 18th/22th **Location:** Trondheim, Norway.	To investigate whether a customised exercise programme influences pregnant women's psychological wellbeing and general health perception reflecting health-related quality of life (HRQoL) in late pregnancy.	**Type of Intervention:** RCT (CG x IG) **Description:** Moderate intensity physical exercise programme. Each session included aerobic and strength phases. The participants were also encouraged to exercise three times a week. The intervention was supervised by an exercise specialist. CG received standard antenatal care and the customary information, and they were not discouraged from exercise. Women in both groups received written standardised information and recommendations on diet, pelvic floor muscle exercises and pregnancy-related pelvic girdle pain. **Intensity Measurement:** Borg Scale (12-14) **Time of session:** **Frequency:** 1 x/week **Duration:** At least 12 weeks	**Primary** self-perceived general health and psychological wellbeing (PGWBI) before and after the intervention.	The study did not show significant differences in general health perception and psychological wellbeing in the third trimester between IG and CG.

Forouzan Charkamyani et al. (2019) (Charkamyani *et al.*, 2019)	**N=** 170 GI=85 + GC=85 Healthy PW IVF with no contraindications for practice (ACOG 2002). **Gestational Week:** $12^{th}/16^{th}$ **Location:** Tehran, Iran.	The role of a structured program of exercise training on the low-risk pregnancy in Iranian women undergoing in vitro fertilization (IVF) based on the reduction of gestational diabetes was examined.	**Type of Intervention:** RCT (CG x IG) **Description:** Moderate intensity physical exercise programme. Each session included walking, aerobic, strength and relaxation exercises. The intervention was supervised by an exercise specialist. A similar number of classes (1 weekly session for 90 days) for both the groups were held to present routine and general cares in pregnancy period relevant to significant impacts of physical activity on the maternal and fetal health. **Intensity Measurement:** Borg Scale (12-14) **Time of session:** 60 min **Frequency:** 3 x/week **Duration:** 12 weeks	**Primary:** LSQ, GDM (OGTT) at the 24-28 and 34 gestation weeks. Gestational hypertension was measured in three distinct analyses after 20 week's gestation.	The present study showed significant differences in the suitability of physical activity between after and before intervention in IG. CG did not present differences. IG had significant reduction in GDM. The physical exercise intervention can highly decrease the risk of developing Pre-Eclampsia.
María Perales et al. (2016) (Perales *et al.*, 2016)	**N=** 241 GI=120 + GC=121 Healthy PW without contraindications for practice (ACOG 2002). **Gestational Week:** $<16^{th}$ **Location:** Madrid, Spain.	Investigate the effects of pregnancy exercise on echocardiographic indicators of hemodynamics, cardiac remodeling, left ventricular (LV) function, and cardiovascular disease risk factors.	**Type of Intervention:** RCT (CG x IG) **Description:** Moderate intensity physical exercise intervention. Each session included warm-up, aerobic, strength and stretch exercises. The intervention was supervised by an exercise specialist. The duration of the aerobic and strength training component was kept constant. During the first trimester, more importance was given to improve body awareness, in the second trimester, the priority was to improve balance, in the third trimester, more emphasis was given to improve pelvis mobility. **Intensity Measurement:** Borg Scale **Time of session:** 55 to 60 min **Frequency:** 3 x/week **Duration:** 18 weeks	**Secondary:** Baseline maternal characteristics, hypertension was measured at 20^{th} and 34^{th} gestational weeks. GDM was measured at 24^{th} to 28^{th} gestational weeks. GWG and Depression level (CES-D) were measured at the end of intervention. Pregnancy outcomes were identified at the delivery.	The proportion of women with excessive GWG at the end of pregnancy in the IG compared with the CG was significant lower. The values of the CES-D scale were lower in IG compared with CG.
Mireia Pelaez et al. (2019)	**N=** 345 GI=115 + GC=230 Healthy PW without	To investigate the effect of supervised moderate to vigorous exercise on gestational weight	**Type of Intervention:** RCT (CG x IG) **Description:** Moderate intensity physical exercise intervention. Each session included warm-up, core exercises, major muscles groups resistance training and relaxation phase. The intervention was	**Primary:** GWG was measured at the first and the last prenatal visit. **Secondary:** GDM, macrosomia,	The study showed that IG gained less weight than CG with a significant difference. IG were less likely to exceed 2009 IOM recommendations

(Pelaez *et al.*, 2019)	contraindications for practice (ACOG 2002). **Gestational Week:** 8th/10th **Location:** Arroyo, Spain.	gain, its related risks (gestational diabetes), macrosomia, and type of delivery), and the preventive effects on women who exceed the weight gain recommendations.	supervised by an exercise specialist. Supine position, ballistic movements, and high-impact exercises were avoided. Group dynamics were used to enhance motivation and adherence (games, exercises in pairs or groups, social networks such as Facebook and WhatsApp). The CG received standard care and physical activity counselling from health care professionals. They were not discouraged from exercising on their own. **Intensity Measurement:** Borg Scale (12-14) **Time of session:** 60 to 65 min **Frequency:** 3 x/ week **Duration:** 24 weeks	and type of delivery.	than CG. The values of macrosomia were lower in IG than CG. More normal vaginal deliveries were found in the IG than in the CG. In this study, the relationship between excessive GWG and the risks mentioned existed only in the CG and not in the IG, which leads us to hypothesize that exercise provides some level of protection against the risks associated with excessive GWG.
Erin Clark et al. (2018) (Clark *et al.*, 2019)	**N=** 36 GI=14 + GC=22 Healthy PW without contraindications for practice (ACSM 2010). **Gestational Week:** ≤ 16th **Location:** United States of America.	To determine the influence of exercise on maternal lipid levels and infant body size.	**Type of Intervention:** RCT (CG x IG) **Description:** Moderate intensity physical exercise intervention. Each session included warm-up, aerobic and relaxation phases. The intervention was supervised by an exercise specialist. The CG did not receive an exercise intervention period. **Intensity Measurement:** Borg Scale (12-14) **Time of session:** 60 min **Frequency:** 3 x/week **Duration:** 22 weeks	**Primary:** GWG, Non-fasting lipid profiles, blood samples, serum samples, total cholesterol, HDL, and triglycerides were calculated at 16th and 36th weeks gestation. **Secondary:** Infant measures included gestational age at birth, delivery mode, sex, Apgar score at 1 and 5 min, birth weight, birth length, head and abdominal circumferences.	The study showed that IG presented lower values of triglycerides compared with CG. The Head Circumference at birth has positive relationship with exercise during pregnancy. Improved infant outcomes are associated with lower pre-pregnancy BMI, along with increased physical exercise level during pregnancy and late pregnancy LDL levels. Birth weight and length are associated with amount of aerobic exercise during pregnancy and maternal lipid levels. No differences in Apgar score between groups.

Lene A. H Haakstad et al. (2020) (Haakstad and Bø, 2020)	**N=** 105 GI=52 + GC=53 Healthy PW without contraindications for practice (ACOG 2002). **Gestational Week:** ≤12th **Location:** Olso, Norway.	To investigate the sole effect of supervised group exercise, including pelvic floor muscle training on course of labor and mode of delivery.	**Type of Intervention:** RCT (CG x IG) **Description:** Moderate physical exercise intervention. Each session included warm-up, cardiovascular, strength and relaxation phases. The intervention was supervised by an exercise specialist. **Intensity Measurement:** Borg Scale (12-14) **Time of session:** 60 min **Frequency:** **Duration:** At least 12 weeks. (36 sessions)	**Primary:** The course of labor and mode of delivery. **Secondary:** Baseline maternal characteristics.	In mode of delivery, IG had more caesarean sections compared with the CG, without significant differences.
Raquel Rodríguez-Blanque et al. (2020) (Rodríguez-Blanque, Aguilar-Cordero, Marín-Jiménez, Menor-Rodríguez, *et al.*, 2020)	**N=** 129 GI=65 + GC=64 Healthy PW without contraindications for practice (ACOG 2015). **Gestational Week:** 20th **Location:** Granada, Spain.	To analyse the quality of life in pregnancy for women who complete a programme of moderate physical activity in water, following a designed method that the woman can perform physical exercise safely during pregnancy called the SWEP.	**Type of Intervention:** RCT (CG x IG) **Description:** The intervention group had access to moderate physical exercise program in water with SWEP method. The intervention was supervised by an exercise specialist. The CG received usual care and general advice on the benefits of exercise. Both groups received verbal and written dietary advice during pregnancy. **Intensity Measurement:** Borg Scale or Heart Rate **Time of session:** 60' **Frequency:** 3x /week **Duration of Intervention:** 17 weeks	**Primary:** HRQol (SF36v2), at the beginning and at the end of intervention. **Secondary:** Sociodemographic and Anthropometric Variables were measured in the first and third trimesters and parity. Body weight was measured at weeks 12 and 36 of pregnancy. Perinatal results were identified after delivery. The level of physical activity was measured with Questionnaire at the beginning of the study.	The decrease in mean HRQol scores was significantly higher in the CG compared with IG. CG presented higher risk of depression compared with IG.

Raquel Rodríguez-Blanque et al. (2020) (Rodríguez-Blanque, Aguilar-Cordero, Marín-Jiménez, Núñez-Negrillo, *et al.*, 2020)	**N=** 129 GI=65 + GC=64 Healthy PW without contraindications for practice (ACOG 2015). **Gestational Week:** $12^{th}/20^{th}$ **Location:** Granada, Spain.	To evaluate the prevalence of spontaneous birth among women who participated in a water-based physical exercise program.	**Type of Intervention:** RCT (CG x IG) **Description:** The intervention group had access to moderate physical exercise program in water with SWEP method. The intervention was supervised by an exercise specialist. The CG received usual care and general advice on the benefits of exercise. Both groups received verbal and written dietary advice during pregnancy. **Intensity Measurement:** Borg Scale or Heart Rate **Time of session:** 60' **Frequency:** 3x /week **Duration of Intervention:** 17 weeks	**Primary:** Intrapartum and neonatal outcomes (gestational age, reason for hospital admission, birth weight, and Apgar test). **Secondary:** sociodemographic and anthropometric variables were measured at the beginning and at the end of the intervention.	IG presented better control of GWG and higher rate of spontaneous birth and a lower rate of instrumental deliveries and of caesarean sections. GWG is related with APGAR score. PW with BMI is in the normal-weight range had more probably to have a baby with an APGAR score of 10 at five minutes. PW whose BMI is in the normal-weight range at the start of pregnancy are more likely to give birth spontaneously than those with overweight or obesity before pregnancy. An appropriate GWG is related with a physiological birth, while PW who present a higher GWG are more likely to require instrumental birth.
O. Roldan-Reoyo et al. (2019) (Roldan-Reoyo *et al.*, 2019)	**N=** 131 GI=64 + GC=67 Healthy PW without contraindications for practice (ACOG 2002). **Gestational Week:** $10^{th}/12^{th}$ **Location:** Madrid, Spain.	To determine if regular maternal physical activity leads to measurable adaptations of the fetal ANS measured by FHR response recovery time.	**Intervention:** RCT (CG x IG) **Description:** Moderate intensity physical exercise intervention. Each session included warm-up, aerobic, strength, pelvic floor and stretching exercises. The intervention was supervised by an exercise specialist. **Intensity Measurement:** heart rate (40-60% of RHR) **Time of session:** 60 min **Frequency:** 3 x/week **Duration:** 28 weeks	**Primary:** FHR recovery time was measured between 34^{th} and 36^{th} gestational weeks (at 40% and 60% maternal HRR). **Secondary**: MHR recovery time, FHR at rest, FHR after exercise, and difference between these timepoints.	This study showed that supervised moderate intensity exercise during pregnancy is associated with quicker FHR recovery time.

Raquel Rodríguez-Blanque et al. (2019) (Rodríguez-Blanque, Sanchez-Garcia, *et al.*, 2019)	**N=** 129 GI=65 + GC=64 Healthy PW without contraindications for practice (ACOG 2015). **Gestational Week:** 12th **Location:** Granada, Spain.	To determine the effect of an aquatic physical exercise program performed during pregnancy on rate of intact perineum after childbirth.	**Type of Intervention:** RCT (CG x IG) **Description:** The intervention group had access to moderate intensity physical exercise program in water with SWEP method. The intervention was supervised by an exercise specialist. The CG received usual care and general advice on the benefits of exercise. Both groups received verbal and written dietary advice during pregnancy. **Intensity Measurement:** Borg Scale or Heart Rate **Time of session:** 60' **Frequency:** 3x/week **Duration of Intervention:** 17 weeks	**Primary:** Reason for admission, mode of labor, integrity of the perineum (intact, lacerations, episiotomy), gestation time, birth weight, and analgesia during labor. **Secondary:** Baseline maternal characteristics, GWG, level of physical activity (GPAQ).	The study showed that the IG presented lower values in birth weight compared with the CG, with a significant difference. In a variable of Integrity of the perineum, the IG had significant more incidences compared with the CG. The CG had more cases of lacerations and episiotomies, but without significant differences.
M. Brik et al. (2019) (Brik *et al.*, 2019)	**N=** 120 GI=75 + GC=45 Healthy PW without contraindications for practice (no guidelines). **Gestational Week:** 9th **Location:** Madrid, Spain.	To evaluate the association between physical exercise during pregnancy and maternal gestational weight gain and fetal cardiac function.	**Type of Intervention:** RCT (CG x IG) **Description:** Moderate intensity physical exercise intervention. Each session included warm-up, cardiovascular, strength, coordination and balance, pelvic floor and stretching exercises. The intervention was supervised by an exercise specialist. The CG were advised not to attend during pregnancy any supervised exercise program involving exercise for more than 30' three times per week. However, they were not discouraged from exercising on their own. **Intensity Measurement:** 55 to 60% of Maximum Heart Rate **Time of session:** 60 min **Frequency:** 3x/week **Duration:** 29 weeks	**Primary:** GWG, fetal cardiac function parameters. **Secondary:** Baseline maternal characteristics and labor outcomes.	The physical exercise intervention did not control GWG but increases maternal weight loss after delivery. The physical exercise intervention did not affect fetal cardiac function.

Carolina de Vargas Nunes Coll et al. (2019) (Coll *et al.*, 2019)	**N=** 639 GI=75 + GC=45 Healthy PW without contraindications for practice (ACOG 2015). **Gestational Week:** $16^{th}/20^{th}$ **Location:** Rio Grande, Brazil.	To assess the efficacy of regular exercise during pregnancy of the prevention of postpartum Depression.	**Type of Intervention:** RCT (CG x IG) **Description:** Moderate intensity physical exercise intervention. Each session included warm-up, aerobic, strength and relaxation exercises. The intensity was managed with the evolution of pregnancy. The intervention was supervised by an exercise specialist. The CG were advised to maintain their usual daily activities. **Intensity Measurement:** Borg Scale (12-14) **Time of session:** 60 min **Frequency:** 3 x/week **Duration:** At least 16 weeks	**Primary:** Self-reported postpartum depressive symptoms (EPDS). **Secondary:** Baseline maternal characteristics.	The study did not show significant differences between groups in Postpartum depression. In Antenatal EPDS CG presented higher risk of depression compared with IG.
Raquel Rodríguez-Blanque et al. (2019) (Rodríguez-Blanque, Sánchez-García, *et al.*, 2019)	**N=** 140 GI=70 + GC=70 Healthy PW without contraindications for practice (ACOG 2015). **Gestational Week:** 20^{th} **Location:** Granada, Spain.	To determine the duration of labor in pregnant women who completed a program of moderate physical exercise in water and subsequently presented eutocic birth.	**Type of Intervention:** RCT (CG x IG) **Description:** The intervention group had access to moderate physical exercise program in water with SWEP method. The intervention was supervised by an exercise specialist. The CG received usual care and general advice on the benefits of exercise. Both groups received verbal and written dietary advice during pregnancy. **Intensity Measurement:** Borg Scale or Heart Rate **Time of session:** 60' **Frequency:** 3x /week **Duration of Intervention:** 17 weeks	**Primary:** birthweight, and duration of 1^{st}, 2^{nd}, and 3^{rd} stages of labor, and the type of labor. **Secondary:** Baseline maternal characteristics.	The study showed that neonatal birth weight was significantly lower in IG than in CG. The study presented that the 1^{st} and 2^{nd} stages of labor were shorter for PW who performed intervention. The total delivery time for IG was almost 3 hours less than in CG.

Eman Awad et al. (2019) (Awad *et al.*, 2019)	**N=** 60 GI=30 + GC=30 Healthy PW without contraindications for practice (ACOG 2002). **Gestational Week:** 24th **Location:** Cairo, Egypt.	To determine the effect of an exercise program on the mode of delivery in gestational diabetic females	**Type of Intervention:** RCT (CG x IG) **Description:** Moderate intensity physical exercise intervention. Each session included warm-up, aerobic, strength and relaxation exercises. Both groups received the same diet with insulin therapy. **Intensity Measurement:** **Time of session:** 60 min **Frequency:** 3 /week **Duration:** 12 weeks	**Primary:** Mode of delivery and Apgar score. **Secondary:** Baseline maternal characteristics.	The study showed a significant decrease in the number of caesarean deliveries in the IG compared with the CG. The neonates of IG had Apgar score at 1st and 5th minutes after delivery better compared with CG.
Ruben Barakat et al. (2017) (Barakat *et al.*, 2018)	**N=** 65 GI=33 + GC=32 Healthy PW without contraindications for practice (ACOG 2015). **Gestational Week:** 8th/11th **Location:** Madrid, Spain.	To examine the influence of an aerobic exercise program throughout pregnancy on PW among healthy pregnant women.	**Type of Intervention:** RCT (CG x IG) **Description:** Moderate intensity physical exercise intervention. Each session included warm-up, aerobic dance, strength exercises, pelvic floor muscle training and relaxation exercises. All sessions were supervised by a qualified fitness specialist and with an obstetrician's assistance. The CG received general advice about the positive effects of physical activity. **Intensity Measurement:** Borg Scale (12-14) and Heart Rate (55-60% of Heart ate reserve) **Time of session:** 55 to 60 min **Frequency:** 3 x/week **Duration:** 28 weeks. (84 sessions)	**Primary:** The placental weight was measured during the first 30' after delivery. **Secondary:** Gestational age, type of delivery, BW, Apgar score, gestational diabetes, and hypertension.	The study did not presented differences between both groups in variables. The study showed that supervised moderate exercise training during pregnancy did not affect negatively Placental Weight, the overall health status of the newborn and Apgar score.

Alka Pawalia et al. (2017) (Pawalia *et al.*, 2017)	**N=** 36 GI=12 + GC=12 Healthy PW without contraindications for practice (ACOG 2015). **Gestational Week:** 16th **Location:** Haryana, India.	To investigate the effect of physical activity and diet during prenatal period and its effect on gestational weight gain (GWG), BMI, waist circumference (WC), hip circumference (HC) and postpartum weight retention (PPWR).	**Type of Intervention:** RCT (CG x IG x IDG) **Description:** Moderate intensity physical exercise intervention. Each session included warm-up, pelvic floor and Kegal's exercises, abdominal and back care exercises and, relaxation and meditation exercises. The IG was asked to do the same exercises at home for at least 3 day/week apart from the supervised session and were also encouraged to walk daily for a minimum duration of 30 minutes and to do so at least 4 days/week throughout pregnancy. The IDG received timely telephonic messages emphasizing the need for adequate and healthy food choices to be followed during pregnancy. The CG was advised once at recruitment for following a proper diet care and explained about the importance of being physically active during pregnancy. The intervention was extended to 2 months after delivery. **Intensity Measurement:** Borg Scale (12-14) **Time of session:** 60 to 90 min **Frequency:** 2 x/week **Duration:** 30 weeks	**Primary:** GWG, BW, fetal waist circumference, hip circumference, waist to hip ratio, and maternal weight retention at postpartum. **Secondary:** Baseline maternal characteristics.	The study showed birth weight was significant lower in IG and IDG compared with CG. The IG presented lower values on the waist circumference, that has a direct relation with lifestyle diseases. There were not significant differences in GWG and Maternal weight retention at postpartum between groups.
Ruben Barakat et al. (2016) (Barakat *et al.*, 2016)	**N=** 840 GI=420 + GC=420 Healthy PW without contraindications for practice (ACOG 2002). **Gestational Week:** 9th/11th **Location:** Madrid, Spain.	To examine the impact of a program of supervised exercise throughout pregnancy on the incidence of pregnancy-induced hypertension.	**Type of Intervention:** RCT (CG x IG) **Description:** Moderate intensity physical exercise intervention. Each session included warm-up, strength exercises and relaxation phase. The CG received general advice about the positive effects of physical activity. The CG were asked by telephone about their exercise during pregnancy with a questionnaire. If they were active during pregnancy, they were excluded. **Intensity Measurement:** Borg Scale (12-14) and Heart rate (70% of MHR) **Time of session:** 50 to 55 min	**Primary:** Number of women who developed hypertension during pregnancy, diastolic and systolic arterial BP (every visit) and BW. **Secondary:** Baseline maternal characteristics and GWG.	Significant lower values on the incidence of hypertension in IG. Excessive GWG, gestational diabetes and preeclampsia significant prevention in IG. Physical exercise intervention also reduced the incidence of macrosomia and protected against low-birthweight infants.

			Frequency: 3 x/week **Duration:** 28 weeks		
Yaiza Cordero et al. (2015) (Cordero *et al.*, 2015)	**N=** 257 GI=101 + GC=156 Healthy PW without contraindications for practice (no guidelines). **Gestational Week:** $10^{th}/12^{th}$ **Location:** Madrid, Spain.	To assess the effectiveness of a maternal exercise program (land/aquatic activities, both aerobic and muscular conditioning) in preventing gestational diabetes mellitus (GDM).	**Type of Intervention:** RCT (CG x IG) **Description:** Moderate intensity physical exercise intervention in and out of water. Each land session (2x) included activation, physical and psychological preparation, aerobic choreography, strength exercise, pelvic floor muscle training and stretching. Each water session (1x) included warm-up, core and strength exercises and stretching exercises. Water Temperature: 28.5º - 29º **Intensity Measurement:** Borg Scale (12-14) **Time of session:** 50 to 60 min **Frequency:** 3 x/week **Duration:** 10-12 weeks to the end of the pregnancy.	**Primary:** GDM **Secondary:** Baseline maternal characteristics, GWG, gestational age at delivery, type of delivery, BW and length.	The study showed that physical exercise intervention was strongly associated with a decrease in GWG, and preserved glucose tolerance.

MATERNAL AND FETAL PHYSICAL ACTIVITY AND HEALTH OUTCOMES

The following effects of the exercise intervention on maternal and fetal health and fitness outcomes were analysed:

Maternal Outcomes (Primary)

- Gestational Weight Gain (GWG) (Perales *et al.*, 2016; Linda R. Sagedal *et al.*, 2017; Pawalia *et al.*, 2017; L. R. Sagedal, Øverby, *et al.*, 2017; Bacchi *et al.*, 2018; Barakat *et al.*, 2018; Aguilar-Cordero *et al.*, 2019; Brik *et al.*, 2019; Clark *et al.*, 2019; Pelaez *et al.*, 2019; Rodríguez-Blanque, Aguilar-Cordero, Marín- Jiménez, Núñez-Negrillo, *et al.*, 2020)
- Fat percentage at 36 gestational weeks (Linda R. Sagedal *et al.*, 2017; Clark *et al.*, 2019)
- Non-fasting lipid profiles, blood samples, serum samples, total cholesterol, HDL, triglycerides (Clark *et al.*, 2019)
- Gestational diabetes and/or 1h Oral Glucose Tolerance Test (Cordero *et al.*, 2015; Barakat *et al.*, 2019; Charkamyani *et al.*, 2019)
- Gestational Hypertension and Pre-eclampsia (Barakat *et al.*, 2016)
- Resting and walking systolic and diastolic Blood pressure (Haakstad, Edvardsen and Bø, 2016)
- Maternal heart rate recovery (Roldan-Reoyo *et al.*, 2019)
- Pelvic Floor Muscle strength (Dias *et al.*, 2018)
- Perineal status after birth (Rodríguez-Blanque, Sanchez-Garcia, *et al.*, 2019)
- Quality of life (Gustafsson *et al.*, 2016; Haakstad, Torset and Bø, 2016; Rodríguez-Blanque, Aguilar-Cordero, Marín-Jiménez, Menor-Rodríguez, *et al.*, 2020)
- Sleep quality (Rodriguez-Blanque *et al.*, 2018)
- Incidence of operative deliveries (L. R. Sagedal, Øverby, *et al.*, 2017)

- Type and duration of labor (Sanda *et al.*, 2018; Awad *et al.*, 2019; Rodríguez-Blanque, Sanchez-Garcia, *et al.*, 2019; Rodríguez-Blanque, Sánchez-García, *et al.*, 2019; Haakstad and Bø, 2020; Rodríguez-Blanque, Aguilar-Cordero, Marín-Jiménez, Núñez-Negrillo, *et al.*, 2020)

- Weight retention at postpartum (Pawalia *et al.*, 2017; Sánchez-García and Aguilar-Cordero, 2019b)

- Prevalence of Postpartum Depression (PPD), Depression (Gustafsson *et al.*,2016; Haakstad, Torset and Bø, 2016; Perales *et al.*, 2016; Aguilar-Cordero *et al.*, 2019; Coll *et al.*, 2019; Vargas-Terrones *et al.*, 2019; Rodríguez-Blanque, Aguilar-Cordero, Marín-Jiménez, Menor-Rodríguez, *et al.*, 2020)

Fetal Outcomes (Primary)

- Head Circumference (Clark *et al.*, 2019)

- Newborn weight (Cordero J *et al.*, 2017; Bacchi *et al.*, 2018; Barakat *et al.*, 2018; Rodríguez-Blanque, Sanchez-Garcia, *et al.*, 2019; Rodríguez-Blanque,Sánchez-García, *et al.*, 2019; Sánchez-García and Aguilar-Cordero, 2019b; Rodríguez-Blanque, Aguilar-Cordero, Marín-Jiménez, Núñez-Negrillo, *et al.*,2020)

- Neonate with Macrosomia (Barakat *et al.*, 2019; Pelaez *et al.*, 2019)

- Apgar Score (Awad *et al.*, 2019; Rodríguez-Blanque, Aguilar-Cordero, Marín-Jiménez, Núñez-Negrillo, *et al.*, 2020)

- Fetal Heart Rate recovery time (Roldan-Reoyo *et al.*, 2019).

EFFECTIVENESS OF THE INTERVENTIONS

The studies reported the following main and significant effects on maternal outcomes of the interventions:

- The control group reported higher gestational weight gain (Cordero *et al.*, 2015; Perales *et al.*, 2016; Barakat *et al.*, 2016; Linda R. Sagedal *et al.*, 2017; L. R. Sagedal, Øverby, *et al.*, 2017; Bacchi *et al.*, 2018; Barakat *et al.*, 2019; Aguilar-Cordero *et al.*, 2019; Sánchez-García and Aguilar-Cordero, 2019b; Pelaez *et al.*,

2019; Rodríguez-Blanque, Aguilar-Cordero, Marín-Jiménez, Núñez-Negrillo, *et al.*, 2020); and higher values of triglycerides at 16 and 36 weeks (Clark *et al.*, 2019)

- Faster maternal heart rate recovery in the intervention group (Roldan-Reoyo *et al.*, 2019)
- The intervention group presented lower weight retention at four and seven months of postpartum (Sánchez-García and Aguilar-Cordero, 2019b)
- Physical activity during pregnancy increases weight loss after delivery (Brik *et al.*, 2019)
- The ratio of women diagnosed with gestational diabetes mellitus was higher in the control group (Cordero *et al.*, 2015; Barakat *et al.*, 2016, 2019; Charkamyani *et al.*, 2019); and results of 1h oral glucose tolerance test were lower in the intervention group (Barakat *et al.*, 2019)
- Blood pressure at rest and during exercise were lower in the intervention group (Haakstad, Edvardsen and Bø, 2016); and incidence of preeclampsia and hypertension was higher in the control group (Barakat *et al.*, 2016; Charkamyani *et al.*, 2019)
- Strength, endurance, and repeatability of pelvic floor muscle were higher in the intervention group (Dias *et al.*, 2018); furthermore, the intervention group presented fewer lacerations and episiotomies (Rodríguez-Blanque, Sanchez-Garcia, *et al.*, 2019)
- Physical activity intervention decreased the levels of depression duringpregnancy (Perales *et al.*, 2016; Rodríguez-Blanque, Aguilar-Cordero, Marín- Jiménez, Menor-Rodríguez, *et al.*, 2020; Rodríguez-Blanque, Aguilar-Cordero, Marín-Jiménez, Núñez-Negrillo, *et al.*, 2020), and is linked with a lower incidence of PPD (Vargas-Terrones *et al.*, 2019); with significant differences in the overweight and obesity categories (Aguilar-Cordero *et al.*, 2019)
- Higher rate of spontaneous birth (Pelaez *et al.*, 2019; Haakstad and Bø, 2020; Rodríguez-Blanque, Aguilar-Cordero, Marín-Jiménez, Núñez-Negrillo, *et al.*, 2020); and a lower rate of instrumental deliveries and caesarean sections in the

intervention group (Rodríguez-Blanque, Aguilar-Cordero, Marín-Jiménez, Núñez-Negrillo, *et al.*, 2020)

- The intervention group presented shorter first and second stages of labor (Sanda *et al.*, 2018; Rodríguez-Blanque, Sánchez-García, *et al.*, 2019); and physical activity was associated with lower odds of acute caesarean delivery (Awad *et al.*, 2019; Barakat *et al.*, 2019; Rodríguez-Blanque, Aguilar-Cordero, Marín-Jiménez, Núñez-Negrillo, *et al.*, 2020)

- Levels of fatigue, nausea/vomiting, and numbness/reduced circulation were higher in the control group (Haakstad, Torset and Bø, 2016); additionally, the control group reported worse values for quality, duration, latency, and regular efficiency of sleep (Rodriguez-Blanque *et al.*, 2018)

- Decreased quality of life was higher in the control group (Rodríguez-Blanque, Aguilar-Cordero, Marín-Jiménez, Menor-Rodríguez, *et al.*, 2020).

Significant effects on newborn outcomes of the interventions were reported by the studies too:

- Newborn weight was lower in the intervention group (Barakat *et al.*, 2016; Pawalia *et al.*, 2017; Rodríguez-Blanque, Sanchez-Garcia, *et al.*, 2019;Rodríguez-Blanque, Sánchez-García, *et al.*, 2019; Sánchez-García and Aguilar- Cordero, 2019b). However, one study reported that despite the differences, both groups were in a normal state of weight (Cordero J *et al.*, 2017); The ratio of neonate macrosomia was higher in the control group (Barakat *et al.*, 2018, 2019;Pelaez *et al.*, 2019)

- The head circumference at birth has a positive relationship with exercise during pregnancy (Clark *et al.*, 2019)

- Better results of Apgar Score were associated with women who practiced physical activity or that had normal weight during pregnancy (Awad *et al.*, 2019; Rodríguez-Blanque, Aguilar-Cordero, Marín-Jiménez, Núñez-Negrillo, *et al.*, 2020)

- The foetal heart rate recovery time is associated with moderate-intensity exercise during pregnancy (Roldan-Reoyo *et al.*, 2019).

DISCUSSION

The present systematic review aims to update the knowledge about the effectiveness of group exercise during pregnancy analysed in a previous systematic review (Jorge, Rocha and Bento, 2015). Additionally, the authors analysed the physical exercise program design, the consistency with the guidelines, identifying limitations in the interventions that can be improved in the future.

The RCT studies were analysed, and the authors investigated if the studies followed the ACOG (ACOG, 2002, 2015; Birsner and Gyamfi-Bannerman, 2020), Canadian (Mottola *et al.*, 2019) or ACSM (Thompson *et al.*, 2013) guidelines, remembering the need for consistency between practical interventions. Six studies did not present the updated guidelines (Bacchi *et al.*, 2018; Awad *et al.*, 2019; Charkamyani*et al.*, 2019; Pelaez *et al.*, 2019; Roldan-Reoyo *et al.*, 2019; Haakstad and Bø, 2020),and three studies do not even refer to the guidelines as the basis of their interventions (Cordero *et al.*, 2015; Brik *et al.*, 2019; Clark *et al.*, 2019).

In accordance with the guidelines (ACOG, 2015), all the studies reported that certified fitness instructors supervised the exercise program, and some studies presented the qualifications of the physical exercise specialists. Most of the exercise programs were structured with: a warm-up (low impact aerobic exercise); a main phase (aerobic and resistance training); a pelvic floor muscle training phase; and, a stretching and relaxation phase. Although the literature suggests that combining aerobic exercise and resistance training during pregnancy is more effective at improving health outcomes than interventions focused on aerobic exercise alone, one study had only aerobic exercise. This study also presented significant results in some variables (Clark *et al.*, 2019).

Most studies compared the variables between the intervention group that received supervised exercise program and the control group that received usual care. Only one study used three groups to evaluate the nutrition variable (Intervention and Dietary Group) (Pawalia *et al.*, 2017).

The results of most of the studies were in line with the literature, with physical exercise contributing to the improvement of maternal and fetal health. Regarding maternal outcomes, the intervention groups reported more control of maternal weight

gain, lower risk of GDM, lower risk of preeclampsia and hypertension, lower blood pressure in rest and during exercise, lower levels of depression, less caesarean deliveries, shorter first and second stages of labor and better quality of life. On fetal outcomes, the intervention groups presented better control of newborn weight gain anda lower ratio of neonate macrosomia, better results on Apgar score and faster recovery fetal heart rate. Maternal weight was often associated with other complications inpregnancy.

In the following, the results of the main variables will be presented and discussed, as well as possible failures in the analysis of some of these or limitations in the literature.

MATERNAL WEIGHT GAIN

Gestational weight gain can occur due to maternal fat accumulation, fluid expansion, and foetus, placenta, and uterus growth. Gestational weight gain is necessary to give health to the foetus, but this should be controlled, not reporting other adverse outcomes (Voerman *et al.*, 2019).

It is important to remember that overweight, obese, or underweight before delivery is associated with many risks for mother and newborn. Excessive weight gain increases the risk of GDM, hypertension, and preeclampsia (Peggie L. Williamson, 2019). So, maternal weight can be a great indicator of maternal health in pregnancy. Most of studies on this systematic review 365 reported significant impact of exercise intervention on control of weight gain (Barakat *et al.*, 2016; Sánchez-García and Aguilar-Cordero, 2019; Cordero *et al.*, 2015; Perales *et al.*, 2016; L. R. Sagedal,Øverby, *et al.*, 2017; Linda R. Sagedal *et al.*, 2017; Barakat *et al.*, 2019; Pelaez *et al.*, 2019; Rodríguez-Blanque, Aguilar-Cordero, Marín-Jiménez, Núñez-Negrillo, *et al.*, 2020).

It is important to mention that the Maternal Weight Gain was the variable that presented the most significant results in the studies included in this systematic review.

GESTATIONAL DIABETES

It is known that the placenta produces hormones responsible for the growth and development of the newborn. However, these hormones may promote insulin resistance

in the mother's cells, and it can consequently influence the GDM emergence. GDM is associated with adverse outcomes for the mother and the newborn (Awad *et al.*, 2019). Diet and exercise are used to prevent or manage it once it occurs (Peggie L. Williamson, 2019). In this review, the studies focused on the prevention of GDM, and just manipulate the physical exercise variable. The four studies that evaluated the impact of physical exercise programs reported a lower risk of GDM on the Intervention Group compared with the Control Group with statistically significant differences (Cordero *et al.*, 2015; Barakat *et al.*, 2016, 2019; Charkamyani *et al.*, 2019).

Cordero et al. reflected at the end of the RCT the possible importance of the relationship between the timing of the beginning of intervention and the efficacy of GDM prevention, reporting that the earlier the intervention starts, the lower the risk of GDM (Cordero *et al.*, 2015). Every study of the present RCT began the intervention during the first trimester. In this trimester, the levels of the hormones change and increase dramatically (Peggie L. Williamson, 2019). So, in this period, the control of insulin is relevant. It can be relevant to understand the influence of this timing in the future.

Furthermore, it is known that the history of glucose intolerance, past gestational diabetes or having first degree relatives with diabetes are also associated with a higher risk of developing GDM. Some studies, specifically those that study the GDM variable, did not consider some of these factors that can influence the results (Cordero *et al.*, 2015; Barakat *et al.*, 2016, 2019; Charkamyani *et al.*, 2019).

It is important to refer, too, that the nutrition variable can be relevant on GDM results. Some studies reported the lack of nutritional monitoring as a limitation (Barakat *et al.*, 2018; Barakat *et al.*, 2019). Spaight et al. exposed some studies that evaluated the association between nutrition in pre-pregnancy and the risk of GDM. Interestingly, the findings suggested that the animal protein intake is associated with lower risk of GDM and inversely associated with vegetal protein. The diets with low fibre and high glycaemic load, and high intake of animal fat and cholesterol were associated too. If the pre-pregnancy habits can influence the risk of GDM in the future, controlling this variable on physical exercise intervention will be necessary (Spaight *et al.*, 2016).

The ACOG warned of the risk of hypoglycaemia (glucose level less than 45 mg/dL) on high-intensity or prolonged exercise of more than 45 to 60 minutes at 55% of their VO2max (ACOG, 2015). This means that, the intensity and duration have a

relevant role in the ability to maintain glucose levels. Also, pregnant women are less likely to maintain stable glucose levels where compared with non-pregnant women. Therefore, pregnant women should be advised to adequate caloric intake before exercise or limit the intensity to minimize this risk. All the interventions must have available these recommendations (Soultanakis *et al.*, 1996).

PRE-ECLAMPSIA AND HYPERTENSION

The relationship between hypertensive disorders and physical exercise is unclear. In 2017, Gregg and Ferguson presented an unclear view with some reviews thatreported any significant impact of moderate-intensity physical exercise duringpregnancy on the risk of hypertension, and other reviews that inversely presentedpositive impact (Gregg, Ii and Ii, 2017). In the present review, two studies reported a significant reduction in the risk of hypertension (Barakat *et al.*, 2016; Charkamyani *et al.*, 2019). One study presented lower values of blood pressure in the InterventionGroup compared to the Control Group, between, before and after the intervention, although without significant differences (Santos-Rocha, 2019). The ACOG reported reduction of hypertensive disorders as a benefit of physical exercise, despite presenting some studies without significant results in this variable (ACOG, 2015). Considering thissystematic review, more studies are needed to clarify the relationship between exercise and hypertension.

DEPRESSION

The PPD (Warburton *et al.*, 2011; Aguilar-Cordero *et al.*, 2019; Vargas- Terrones *et al.*, 2019) and/or depression (Perales *et al.*, 2016; Vargas-Terrones *et al.*, 2019) variables were evaluated in four studies. Most studies reported a positive association between physical exercise and the prevention of PPD and depression. Assaid before, maternal weight can trigger other risks for pregnancy. Aguilar-Cordero etal. evaluated the prevalence of PPD through EPDS. The study concluded that all obese or overweight women in the third trimester are at higher risk of PPD, but this risk is lower among those who follow a physical exercise program (Aguilar-Cordero *et al.*, 2019).

Although the results reported were positive, the evaluation of this variable can be biased. The sessions were in a group setting, and this factor could have a preventive impact on depressive symptomatology, whereas these classes promote socialization (Vargas-Terrones *et al.*, 2019). The difference of the impact of social factor and physical exercise in the risk of depression should be clarified. In the future, it is

convenient the analysis of the impact of the socialization variable in physical exercise programs on the prevention of PPD.

TYPE AND DURATION OF DELIVERY

The type of labour was evaluated, and the studies reported a higher rate of spontaneous birth and a lower rate of instrumental deliveries and caesarean sections on the intervention group (Sanda *et al.*, 2018; Awad *et al.*, 2019; Pelaez *et al.*, 2019; Haakstad and Bø, 2020; Rodríguez-Blanque, Aguilar-Cordero, Marín-Jiménez, Núñez-Negrillo, *et al.*, 2020). The studies that evaluated the duration of labour revealed that the intervention group had shorter first and second stages of labour (Sanda *et al.*, 2018; Rodríguez-Blanque, Sánchez-García, *et al.*, 2019).

QUALITY OF LIFE

The World Health Organization (WHO) had a broad and multidimensional definition of quality of life that incorporates physical, psychological, social and environmental aspects of life. On this systematic review, the three studies that evaluated this variable used different questionnaires that enable the assessment of the impact of mental and physical health status on different areas in a person's life: General Health Questionnaire (GHQ) (Goldberg and Hillier, 1979), SF-36 (Jenkinson, Coulter and Wright, 1993) and Psychological General Well-being Index (PGWBI) (Lundgren-Nilsson *et al.*, 2013). Two studies reported better results in the Intervention Group compared with the Control Group. Gustafsson et al. (Gustafsson *et al.*, 2016) did not report differences between groups. It is important to note that this intervention was performed with a considerably lower training frequency compared to the other studies in the systematic review (1x/week). Comparing the variable evaluation method between studies, in addition to the discrepancy between the questionnaires used, there is no questionnaire measuring this outcome specifically in pregnancy. In the future, it is relevant to adapt these questionnaires to this type of population (Haakstad, Torset and Bø, 2016; Gustafsson *et al.*, 2016; Rodríguez-Blanque, Aguilar-Cordero, Marín- Jiménez, Menor-Rodríguez, *et al.*, 2020).

NEWBORN WEIGHT GAIN AND MACROSOMIA

The present systematic review presented five studies with statistically significant differences between both groups on the birth weight variable (Barakat *et al.*, 2016; Cordero J *et al.*, 2017; Pawalia *et al.*, 2017; Rodríguez-Blanque, Sanchez-Garcia, *et al.*, 2019; Rodríguez-Blanque, Sánchez-García, *et al.*, 2019; Sánchez-García and Aguilar-Cordero, 2019). The moderate physical exercise program positively impacted birth weight and any adverse effects on foetal health. Furthermore, one study reported higher significant values of macrosomia on the control group (Barakat *et al.*, 2016).

APGAR SCORE

The Apgar score provides an accepted and convenient method for reporting the status of the newborn infant immediately after birth and adaptation to extrauterine life (Watterberg *et al.*, 2015). The variables were measured at 1 min and 5 min afterdelivery. The test score ranges from 0-10. The normal maternal weight gain was associated to score 10 at 5 min (Rodríguez-Blanque, Aguilar-Cordero, Marín-Jiménez, Núñez-Negrillo, *et al.*, 2020). The intervention group presented a significantly better score at both minutes, but any group presented low values on Apgar Test (Awad *et al.*, 2019). Moderate-intensity physical exercise is associated with a better Apgar score, although the research does not associate the low score (<7) to sedentarism on pregnancy.

FETAL HEART RATE RECOVERY

Roldan-Reoyo et al. (Roldan-Reoyo *et al.*, 2019) evaluated the Foetal Heart Rate recovery variable. The participants performed two walking tests (40% and 60% of Maternal Heart Rate Reserve), and it was measured at the beginning and after 20 minutes of the maternal walking test. On both intensities, the foetuses of the Intervention Group were quicker to recovery heart rate. Additionally, after the 60% intensity walking test, the difference of foetuses that recovered within 20 minutes between both groups was statistically significant (100% of foetuses of Intervention Group recovered within the time). Although the literature is scarce, it presents a positiverelationship between exercise and foetal heart rate recovery.

PELVIC FLOOR MUSCLE TRAINING (PFMT)

In pregnancy, due to hormonal changes, it is possible to have a PFM strength reduction that may result in pelvic floor dysfunction. Preventive strategies such as PFM training during pregnancy can be the solution for possible disorders (the most commonly is urinary incontinence) (Dias *et al.*, 2018). The Canadian Guidelines reported the importance of pelvic floor muscle training to reduce the risk of urinary incontinence, although still supported by weak recommendations and low-quality evidence (Mottola *et al.*, 2019).

Pires evaluated the effectiveness of PFM supervised training and another PFM unsupervised at home. The intervention began at the 28th gestational week and it used digital palpation, the Oxford Grading Scale to evaluate the muscle contractility, and the Pad test to quantify the urine loss. This study did not use the manometer evaluation. The study reported significant improvements in pregnant women (Pires *et al.*, 2020). A systematic review evaluated the effectiveness of PFM training on the risk of urinary incontinence, and the results reported that PFM training decreased the risk of urinary incontinence (Woodley *et al.*, 2020).

In this systematic review, only one study evaluated the pelvic floor muscles strength through manometer and digital palpation. The physical exercise intervention finished on the 32-34th gestational week. The results did not report differences in strength pelvic floor muscles on manometer evaluation, but it presented improvement ofdigital palpation variables (PFM strength, PFM endurance and PFM repeatability) with significant differences between intervention and control groups (Dias *et al.*, 2018).

It is already known that the Pilates Method improves control over the core muscles, strengthening them. Due to the great popularity of this method throughout the world over the last decade, it may be relevant more literature that corroborate the benefits of pelvic strength work associated with it.

LEVEL OF PHYSICAL ACTIVITY

The ACOG affirmed that pregnancy is an ideal time for behaviour modification and adoption of a healthy lifestyle (Birsner and Gyamfi-Bannerman, 2020). Evaluating the physical activity level (excluding the exercise program) before, during, and after pregnancy can be a way to evaluate the impact of a physical exercise intervention on

lifestyle habits. All studies that reported this evaluation presented increasing physical activity levels in the exercise group and inversely in the control group (Charkamyani *et al.*, 2019). Some studies counselled the participants to do some physical exercise (e.g.: 3 days/week of moderate-intensity physical exercise) at home to complement the supervised program, but this variable was not considered in the analysis (Santos-Rocha, 2019; Linda R. Sagedal *et al.*, 2017). Due to the lack of consensus in studying this variable, the effectiveness of the home program/physical activity combined with supervised physical exercise and its influence on the results is unclear. It is important to perform other intervention studies that analyse this variable.

ADHERENCE OF PROGRAM

The program's adherence revealed itself as a limitation and a significant challenge in many RCTs (Coll *et al.*, 2019). Some studies reported that this is due to poor follow-up of the control group compared to the intervention group. Other studies presented some adverse events of pregnancy as reasons for dropout. One group reportedhigh adherence to the program justifying with supervision of the programs carried out by qualified exercise professionals ensuring safety to the participants. If the adverse events and poor follow-up are reasons for the dropout of participants, it is important thatinterventions had a multidisciplinary team to accompany the participants to guarantee safety and motivation. Barakat et al. reported that an obstetrician accompanied the physical exercise intervention. This study had >85% adherence, justified by the authors by the variety of exercises. However, it is important to note that there was no dropout due to pregnancy related complications, probably due to the presence of a multidisciplinary team (Barakat *et al.*, 2018). Rodríguez-Blanque et al. (Rodríguez- Blanque, Aguilar-Cordero, Marín-Jiménez, Menor-Rodríguez, *et al.*, 2020) reported thatthe difficulty in recruiting sufficient participants were due to, in part, the health services involved did not 488 provide sufficient, appropriate information to respond to doubts raised by some pregnant women regarding physical exercise during pregnancy. This problem reminds us of the need for a common language between the various stakeholders. Furthermore, the ACOG reported that if the pregnant woman had an absolute or relative contraindication for exercise, she should continue to perform, at least, some resistance training (Birsner and Gyamfi-Bannerman, 2020). The lack of compliance may be related to the lack of a multidisciplinary team.

RATING OF PERCEIVED EXERTION VS HEART RATE

Due to blunted and normal heart rate responses to exercise reported in pregnant women, the guidelines suggested that ratings of perceived exertion may be a more effective means to monitor exercise intensity than heart rate parameters (ACOG, 2015). Nonetheless, some studies have used the heart rate method (Barakat *et al.*, 2016, 2018; Cordero J *et al.*, 2017; Rodriguez-Blanque *et al.*, 2018; Aguilar-Cordero *et al.*, 2019; Sánchez-García and Aguilar-Cordero, 2019a; Vargas-Terrones *et al.*, 2019; Brik *et al.*, 2019; Rodríguez-Blanque, Sanchez-Garcia, *et al.*, 2019; Rodríguez-Blanque, Sánchez-García, *et al.*, 2019; Roldan-Reoyo *et al.*, 2019; Rodríguez-Blanque, Aguilar-Cordero, Marín-Jiménez, Núñez-Negrillo, *et al.*, 2020). This adaptation should be further studied and clarified in future research.

CERT EVALUATION

The CERT model evaluated the report of the exercise intervention design. The main limitations found in the evaluated interventions, which can compromise their clarity and replication, are reported as follows:

- Few studies present motivation strategies. Conversely, they present a high dropout of participants
- Few studies report a final reflection of the intervention and the fulfilment of the initial planning
- Few studies have controlled the physical activity performed beyond the exercise intervention. Two problems can arise from this limitation: difficulty in evaluating the effectiveness of a program performed at home and the impossibility of evaluating its influence on the progress of pregnancy
- Few studies present the program in detail, reporting intensity monitoring, frequency, duration, and detailed description of the type of exercises, making it difficult to replicate the exercise program in future interventions
- Few studies assess the initial level of participants to adapt the intervention to each pregnant woman

- Few studies clarified the monitoring and evaluation of other components than exercise that can influence the results, such as nutrition.

FUTURE RESEARCH

Due to the limitations mentioned above, a few proposals for future studies were discussed as follows.

There is a lack of studies examining the effectiveness of different exercise programs on the levels of maternal 514 physical fitness parameters, such as muscular fitness, balance, and coordination.

The Canadian Guidelines state that, as well as the pregnant woman's weight, diabetes, and age, a pregnant woman's level of physical activity before pregnancy can also be a risk factor. In the future, studies that assess the influence of the level of physical activity and the practice of physical exercise during pre-pregnancy on the quality of life of pregnant women will be convenient.

The literature argues that pregnancy can be a time for adopting healthy practices. In the future, it would be of serious interest to analyse if previously inactive pregnant women who participate in intervention programs maintain exercise levels after pregnancy.

The social factor can also be determinant for depression levels during and after pregnancy. In this systematic review, most studies showed a positive influence between the exercise program and depression levels. However, all studies included group interventions, which can bias the results. It would be interesting to compare group and individualized interventions in future research, as well as in-person versus virtual interventions. Trials comparing the effectiveness of in-person with online interventions, that were substantially increased after the COVID-19 pandemic in 2020 (Thompson, 2022; Zheng *et al.*, 2022), would be of particular interest.

As mentioned before, the ACOG states that the relative and absolute contraindications may not justify stopping the practice of exercise, namely the strength training and pelvic floor. No study presented an alternative intervention plan for these hypotheses to promote the continuation of physical exercise in women with pregnancy-related complications. In the future, it would be convenient a multidisciplinary follow-

up to supervise these groups and ensure more safety and confidence (e.g., gestational diabetes, depression, among other medical conditions), promoting a high adherence.

The authors suggest creating or adapting existing questionnaires that assess the quality of life and well-being during pregnancy. This validation will, consequently, bring more accuracy to the results presented.

The strict non-compliance with the CERT model by all articles is presented as a limitation for their replication and accuracy. In the future, the authors consider relevant that exercise programs comply with the CERT model. Moreover, it would be interesting to develop and evaluate prenatal exercise interventions included in trials, as complex interventions (Möhler, Köpke and Meyer, 2015; Skivington *et al.*, 2021).

The main strengths of this systematic review are that there were included only RCT studies with a high level of quality. The CERT model that assessed the intervention program allowed us to perceive some gaps in the interventions. The main limitations are that even using important databases, there is a possibility that other relevant studies were not included.

CONCLUSION

The present systematic review reported significant effects of the group exercise programs on maternal health status, specifically, lower maternal weight gain, faster heart rate recovery, improved glucose tolerance, lower blood pressure, better performance of pelvic floor muscles, decreased risk of depression, higher rate of spontaneous birth, lower complications during labour, lower newborn weight, less neonate macrosomia, faster foetal heart rate recovery time and better results on Apgar score. These results are in line with the results of the original systematic review and support the positive relationship between physical exercise and pregnancy, helping to dispel some myths. Nevertheless, there should be more consistency between the variables of physical exercise used in the different interventions, according to the current guidelines. Some suggestions were presented for future studies or improvementsregarding prenatal exercise interventions. Exercise and health professionals should inform pregnant women about the benefits for maternal and foetal health and should advise pregnant women regarding the practice of physical exercise in group during pregnancy, in compliance with the guidelines, and that preferably, that practice should be accompanied by a multidisciplinary team to convey more confidence to the pregnant woman.

STUDY 2 - EXERCISE IN PREGNANCY: CAN SOCIAL SUPPORT INFLUENCE THE WELLBEING AND DEPRESSION IN PREGNANCY ANDPOSTPARTUM? STUDY PROTOCOL FOR A RANDOMIZED CONTROLLED TRIAL

Exercise in Pregnancy: Can Social Support influence the Wellbeing and Depression in Pregnancy and Postpartum? Study Protocol for a Randomized Controlled Trial

INTRODUCTION

BACKGROUND

Depression is the most prevalent psychiatric disorder in the general population and debilitating healthcare problem worldwide, with dire consequences for individuals, families, and society. (Heinzel *et al.*, 2015; Murri *et al.*, 2018). During pregnancy depression symptoms are common and may increase the risk of poor health outcomes in mother and child (Vargas-Terrones *et al.*, 2019). Taking into account the higher prevalence of this disorder during pregnancy and its negative effects, it is urgent to identify predictors of perinatal depression to assist with prevention mechanisms (Racine *et al.*, 2020).

More than 70% of pregnant women report symptoms of depression during pregnancy, and 10-16% fulfil criteria for major depressive disorders (Becker *et al.*, 2016). The prevalence of maternal depression during pregnancy has been reported as 7.4% in the first trimester, 12.0 to 12.8% in the second and third trimesters, and higher rates in the first year after delivery (Howdeshell and Ornoy, 2017). Mottola et al. rated the pregnancy outcomes as 'Critical' or 'Important', considering maternal mental health(depression and anxiety during and following pregnancy) as a 'Critical' outcome in pregnancy (Mottola *et al.*, 2019). Perinatal depression has been associated with complications for the physical and emotional wellbeing of the mother, both during pregnancy and postpartum: hypertension, preeclampsia, gestational diabetes, and postpartum depression; and for fetus health: premature birth, low birth weight and fetal growth restriction (Racine *et al.*, 2020). Furthermore, infants of mothers with postpartum depression have higher risk of failure to thrive, attachment disorders, developmental delays, and other negative effects on cognitive development, social- emotional development, and behaviour. Postpartum depression (PPD) is the most complication after the childbirth, occurring in 10-19% of women (Vargas-Terrones *et al.*, 2019). Some factors that influence the prevalence of PPD are depression during pregnancy, experiencing stressful life events during pregnancy, previous history of

depression and low levels of social support (Vargas-Terrones *et al.*, 2019; Robertson *et al.*, 2004). The strongest risk for depression during pregnancy is a prior history of major depressive disorders (Becker *et al.*, 2016). Overweight or obesity might be a risk factor for developing depression, as well (Aguilar-Cordero *et al.*, 2019; Becofsky *et al.*, 2015). During pregnancy, to identify depressive disorders, health professionals may use suitable instruments for screening depressive symptoms of pregnant women.

Some questionnaires are used to screen depressive symptoms during pregnancy and consequently risk of PPD, such as the self-report Edinburgh Postnatal Depression Scale (EPDS), the Patient Health Questionnaire (PHQ-9), Centre for Epidemiologic Studies Depression Scale (CES-D), World Health Organization Quality of Life Instruments – Bref (WHOQOL-bref), Short Form Health Survey 36 (SF-36) and Psychological General Well-Being Index (PGWBI). Nonetheless, the diagnosis of depression in the pregnant women can be complicated due to the overlap of pregnancy-related symptoms (e.g., sleep changes, appetite change, and fatigue) (Pearlstein, 2015).

When a pregnant woman is diagnosed with depressive disorder, pharmacological treatment is one of the most frequently used options. Howdeshell et al. reported the importance of balancing the risks and benefits of antidepressant medications, and untreated depression. Antidepressant medications exposure have been associated with preterm birth, reductions in birth weight, persistent pulmonary hypertension, and postnatal adaptation syndrome (PNAS) as well as a possible connection with autism spectrum disorder (Howdeshell and Ornoy, 2017). In this regard, some studies (Haakstad, Torset and Bø, 2016; Aguilar-Cordero *et al.*, 2019; Coll *et al.*, 2019; Vargas-Terrones *et al.*, 2019) have evaluated the treatment and prevention of depression during pregnancy and postpartum through alternatives of pharmacological treatment, such as: physical exercise.

Several systematic reviews support the promotion of moderate-to-vigorous prenatal physical activity for maternal health benefits (Nascimento, Surita and Cecatti, 2012; Jorge, Rocha and Bento, 2015; Magro-Malosso *et al.*, 2017; Davenport *et al.*, 2019; Mørkved and Bø, 2014; Dipietro *et al.*, 2019). Indeed, the maternal well-beingand quality of life are improved when women participate in regular group exercise during pregnancy, as shown by large RCT's (Stafne *et al.*, 2012; Ruiz *et al.*, 2013;

Haakstad, Torset and Bø, 2016; L. R. Sagedal, Sanda, *et al.*, 2017; Barakat *et al.*, 2016, 2019).

The relationship between physical exercise and depression has been studiedsince the early 1900s has been recognized. The Australia's government included the services of a physical exercise physiologist under the nation's Medicare program, including the treatment of depression. In 2005, the Mental Health Foundation (in UK), encourage general practitioners to use physical exercise as a frontline treatment for mildto moderate depression (Rethorst, Wipfli and Landers, 2009). The physical exercise in pregnancy guidelines have been updated, and some randomized clinical trials (RCT's) have been developed, and the benefits of physical exercise in pregnancy are supported scientific evidence.

The literature report a positive association between physical exercise and lower risk of depression and PPD (Heinz, 2013; Mottola *et al.*, 2019; Birsner and Gyamfi-Bannerman, 2020; Perales *et al.*, 2016; Rodríguez-Blanque, Aguilar-Cordero, Marín-Jiménez, Menor-Rodríguez, *et al.*, 2020; Rodríguez-Blanque, Aguilar-Cordero, Marín-Jiménez, Núñez-Negrillo, *et al.*, 2020; Vargas-Terrones *et al.*, 2019).

All studies mentioned above presented group interventions, with higher social support. Social support has been widely studied as a major determinant of health and well-being throughout the life cycle (Thoits, 2011). Social support is a multidimensional concept, which is composed of three dimensions: affective/emotional support (demonstrations of love and caring, esteem and value, encouragement, and sympathy), instrumental/financial support (offering or supplying behavioural or material assistance with practical tasks or problems), and informational support (the provision of facts or advice that may help a person solve problems) (Thoits, 2011; Lima *et al.*, 2018).

The social support (partner and family) was identified as a powerful protective factor for decreasing depressive symptoms across the perinatal period (Racine *et al.*, 2020). This phenomenon was also observed in other studies (Vargas-Terrones *et al.*, 2019; Robertson *et al.*, 2004). Vargas reported that this factor could has a preventive impact on depressive symptomatology, whereas these classes promote socialization (Vargas-Terrones *et al.*, 2019). Despite the affective/emotional support dimension being

more related with the partner and family, it is relevant to understand the influence of other dimensions of social support on well-being of pregnant women.

The "Exercise in Pregnancy: Can Social Factor influence the Risk of Depression in Pregnancy and Postpartum?" is a Randomized Controlled Trial including a supervised physical exercise programme in group, in-person and online, three times a week for 12 weeks. This duration was reported as the more effective in the outcomes (Rethorst, Wipfli and Landers, 2009). The in-person intervention group will have a higher social support by a multidisciplinary team. This support will be delivered on the three dimensions: supervision and follow-up of various specialists (exercise physiologist, obstetric and gynaecologist, psychologist, nutritionist); availability of several lectures of interest to the pregnant women; and sharing experiences, knowledge, frustrations, and daily problems with other pregnant women.

OBJETIVES

The aim of this paper is to describe the protocol for a RCT evaluating the influence of social support in prenatal exercise on risk of depression during pregnancy and postpartum.

MATERIAL AND METHODS

STUDY DESIGN

The present study is a RCT designed to evaluate the effect of in-person supervised exercise in group on risk of depression and PPD with and without previous history of depression. This study was designed in accordance with the Consolidated Standards of Reporting Trials (CONSORT) recommendation for RCTs and with the Standard Protocol Items: Recommendations for Interventional Trials (SPIRIT) guidelines for reporting trial protocol (Chan *et al.*, 2017). The exercise intervention was developed in accordance with Consensus on Exercise Reporting Template (CERT)(Slade and Dionne, 2016). The physical intervention prescription follows therecommendations described in the chapter "Exercise Testing and Prescription for Pregnant Women" of the book Exercise and Sporting Activity During Pregnancy (Santos-Rocha, 2019).

STUDY SETTING

Participants will be recruited among pregnant women attending antenatal care in a Clinic of Leiria District. It is relevant that this clinic does not make available the physical exercise service. The presential physical exercise intervention will take place at Polytechnic of Leiria, School of Education and Social Sciences.

ELIGIBILITY CRITERIA

Eligible participants will be pregnant women ≥18 years old, non-practitioners of a physical exercise programme, without diagnosed clinical depression or depression history, single foetus, without medical complication for practice of physical exercise.

RECRUITMENT PROCEDURE

Initially, two health professionals of the Clinic will contact all the pregnant women, by telephone, showing the opportunity to participate in the study. During the next week, in the Polytechnic of Leiria, it will be made a second face-to-face contact to explain more information about the intervention with the physical exercise professional (researcher). At this meeting the participants will have opportunity to ask questions. At the same week, the women decide to participate will be required to sign a written informed consent, to complete the baseline questionnaire, and randomization will be realized. The participants will be randomly assigned to either the presential intervention or the online intervention group in a ratio of 1:1. In this session, a WhatsApp group will be created for each group. This group will facilitate contact between the various stakeholders and the exchange of relevant information about the intervention.

In the same week there will be a meeting with the exercise physiologist to carry out the first evaluations of the outcomes: baseline, and primary and secondary outcomes. The process is presented in Figure 2.

RANDOMISATION/ASSIGNEMENT

Simple randomization will be performed on the second contact by study research. The investigator will provide one envelope for each participant. The participants, without knowing the contents of each envelope, will choose one. The randomization will be at Polytechnic of Leiria.

BLIDING

Because of the nature of the intervention in this RCT, double-blinding is not possible. Only the statistician that will perform the statistical analyses will be blinded to presential intervention or the online group allocation. The exercise physiologists will know the participants and the progress of intervention.

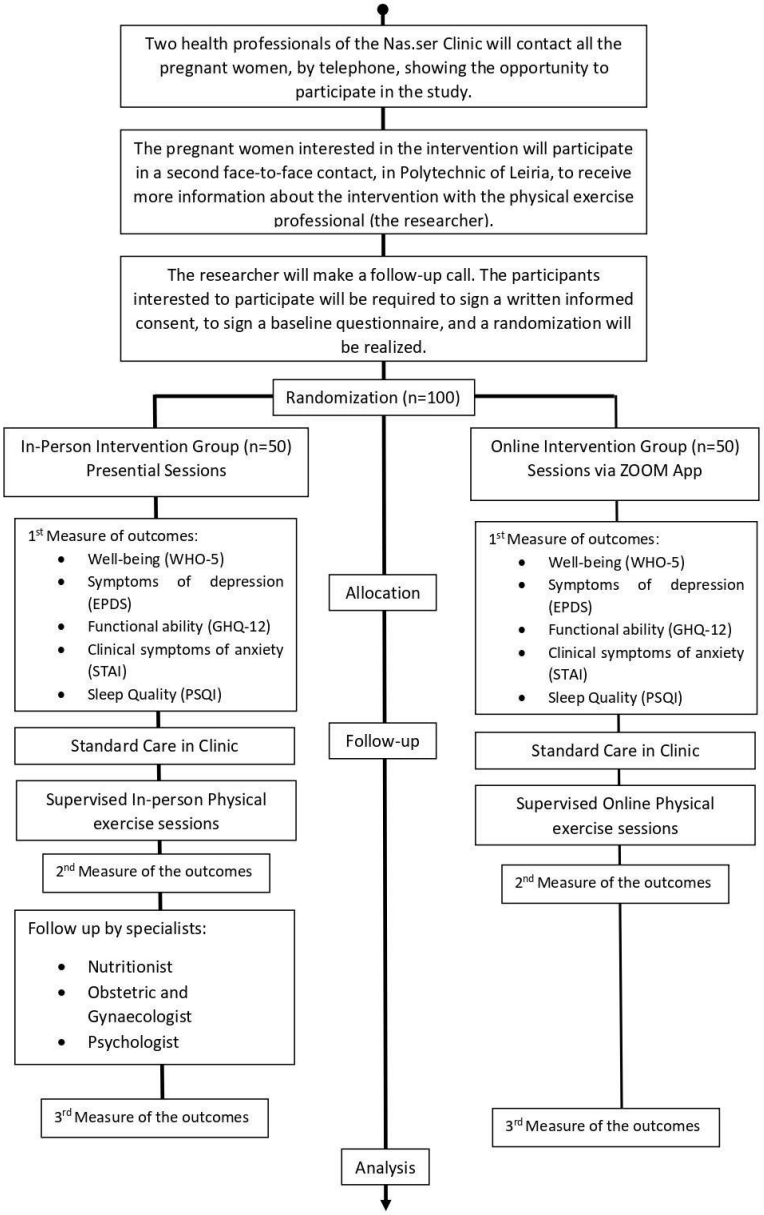

Figure 2: Recruitment Process Flow diagram

SAMPLE SIZE ESTIMATION

For the processing of the data collected we will use the computer program Statistical Package for the Social Sciences – SPSS (V.27.0). A significance level adopted will be $p<0.05$, and for the characterization of our sample, a descriptive analysis of the data will be performed, using measures of central tendency (mean and median), measures of dispersion (standard deviation and interquartile range), including the 95% confidence interval.

For the comparison between groups (In-person Intervention Group and Online Intervention Group) will be used the T-test (if the assumptions for the use of parametric statistics are confirmed). For the comparison between pre and post intervention will be used the T-test for paired samples (if the assumptions for the use of parametric statistics are confirmed).

The effect size will be calculated, considering variables starting from the value Z, according to the equation proposed by Fritz et al., (2012): $r=Z/\sqrt{n}$. The effect size will be analysed according to the limits of correlation suggested by Cohen (1998): trivial $r < 0.1$; small > 0.1 $r < 0.3$; moderate > 0.3 $r < 0.5$; large > 0.5 $r < 0.7$; very large > 0.7 $r < 0.9$; almost perfect > 0.9 $r < 1$; perfect $r = 1$.

IN-PERSON INTERVENTION GROUP

The intervention group will perform a presential physical exercise program delivered to groups of 10-12 pregnant women at the Sports Hall of Polytechnic of Leiria, three times per week from baseline (17-22 weeks of gestation) with duration of 12 weeks. The physical exercise programme (Table 4) will be in accordance with the American College of Obstetricians and Gynecologists recommendations for exercise during pregnancy (Birsner and Gyamfi-Bannerman, 2020) and developed by an exercise physiologist (clinical exercise physiologist with master degree of exercise science), who will supervise the exercise sessions.

The duration of session will be 60 minutes. Consider the changes on each trimester, the structure of session will change throughout pregnancy. Each session will include 10 minutes of warm-up; 20 minutes of aerobic training such as aerobic step, dancing, or cycling (Borg scale 4-7); 15 minutes of strength training (quadriceps, back,

glutes, pectoral, shoulders); 5 minutes of Abdominal and Pelvic Floor Muscle training (Borg scale 6-7); and 10 minutes of Stretching and Relaxation. In the third trimester, the pelvic mobility training is done at the beginning and at the end of session, due the necessity of preparation for birth.

The supine position will be used cautiously, for a short time, to prevent compression of the vena cava, and the Valsalva manoeuvre will be avoided. As a strategy of motivation, the classes will be accompanied by music, and the rhythm willbe accordance with the type of exercise and intensity of each phase of session.

ONLINE INTERVENTION GROUP

The online intervention group will participate in the same of intervention, although, online format. The sessions are realized via ZOOM App, and the session link will be allowed by WhatsApp group. The equipment will be adapted to the material available at home. There will be no music so that the exercise professional can be heard. All sessions will be supervised by an exercise physiologist.

NUTRITION FOLLOW-UP

The nutrition follow-up will be available for presential intervention group. Every week the pregnant women will receive a nutrition consultation with a nutritionist, in Polytechnic of Leiria. This consultation will aim to help the pregnant women to chose health alimentation, and adequate intake of calories taking account the physical exercise programme and pregnancy necessities. If the pregnant woman has any questions during the intervention, she can contact the nutrition professional free of charge.

As a complement to the online intervention program, there will be, throughout the intervention, free webinars about nutrition. These sessions will be via Zoom App and it will have a non-mandatory character.

PSYCHOLOGICAL FOLLOW-UP

The psychological follow-up will be available for presential intervention group. Every week the pregnant women will receive a psychological consultation with a psychologist, in Polytechnic of Leiria. This consultation will aim to help the pregnant women to deal with possible stresses that arise in pregnancy. If the pregnant woman has

any questions during the intervention, she can contact the psychological professional free of charge.

As a complement to the online intervention program, there will be, throughout the intervention, free webinars about psychology. These sessions will be via ZOOM App and it will have a non-mandatory character.

GYNECOLOGIST FOLLOW-UP

The standard care will be available for both groups. As a complement to the in-person intervention group, an obstetric and gynaecologist will give a lecture about healthcare during pregnancy.

Table 4: Exercise Intervention

Duration	Intervention	Description of exercise	Load BORG Scale (1-10)	Material
10 minutes	Initial talk Warm-up (Mobilization of shoulder, back, and pelvis)	Exercises are performed in group circle: 1. Walking (forward, backward, sideways) 2. Neck rotations 3. Shoulder elevations 4. Shoulder rotation (single + both) 5. Trunk rotation 6. Lateral trunk flexes 7. Pelvic Tits (anterior, posterior, bilateral) 8. Bird Dog		
20 minutes	Aerobic training	Exercises are performed in group or in pairs: 1. Aerobic Step 2. Dancing 3. Indoor Cycling	Borg Scale 4-6	Step or Bicycle
15 minutes	Strength training	The strength training starts with large muscular groups. The supine position (more in 3rd trimester) and the Valsalva Maneuver are avoided. 1. Squat 2. Bench press with dumbbells 3. Stiff with dumbbells 4. Row with dumbells 5. Single leg Glute bridge	Each exercise: 3 sets x 12 repetitions Borg Scale 6-7	Dumbbells (2/3/4/5 kg) Elastic Bands (varied resistances)

		6. Lateral thigh raise		
5 minutes	Abdominal Training Pelvic Floor Training	1. Plank 2. Bird dog 3. Kegel exercises	Each exercise: 3 sets x 40'' Borg Scale 6-7	
10 minutes	Stretching and relaxation Pelvic Mobility (3rd Trimester) Final talk	The Stretching training is accompaniedby breathing work: 1. Walking with arms elevation 2. Pectoralis major 3. Quadriceps 4. Gluteus maximus 5. Femoral The pelvic mobility training at the end of the session is only done in the 3rdtrimester: 1. Pelvic Tits (anterior, posterior, bilateral) 2. Bird Dog The class ends with a final talk about some questions and sharing of daily experiences from pregnant women.		

OUTCOMES MEASURED

Maternal data will be obtained at the beginning of the intervention. This information will filter participants through eligibility criteria and identify possible significant differences between groups. The Maternal Weight will be measured before, during and after the intervention. This information will be measured the Gestational Weight Gain (GWG). The questionnaires of primary and secondary outcomes will be asked at the beginning of intervention and, after the intervention, and after 2 months postpartum.

PRIMARY OUTCOMES

World Health Organization Well-Being Index (WHO-5)

The primary outcome, psychological well-being, will be measured by the WHO-5 score. The 5-item World Health Organization Well-Being Index (WHO-5) is a short and generic global rating scale measuring subjective well-being. The WHO-5 contains five positively phrased items: (1) ”I have felt cheerful and in good spirits”, (2) “I have felt calm and relaxed”, (3) “I have felt active and vigorous”, (4) “I woke up feeling freshand rested” and (5) “My daily life has been filled with things that interest me”. The pregnant woman will be asked to rate how well each of the 5 statement applies to her when considering the last 14 days. Each of the 5 items will be scored from 5 (all of the time) to 0 (none of the time). The score will range from 0 (absence of well-being) to 25 (maximal well-being). The WHO-5 has high clinimetric validity, and it can be used to measure outcomes in clinical trials. Furthermore, it can be used as a clinical screening tool for depression (Topp *et al.*, 2015). In this intervention will be used the Portuguese Version of WHO-5 (OMS, 1998).

Physical Activity (PPAQ)

The Pregnancy Physical Activity Questionnaire (PPAQ) (Chasan-Taber *et al.*, 2004) is a widely used tool for the assessment and measurement of physical activity levels amongst pregnant women.

SECONDARY OUTCOMES

Symptoms of depression (EPDS)

The symptoms of depression will be measured by the Edinburgh Postnatal Depression Scale (EPDS). This questionnaire consists of 10 short statements of common depressive symptoms. The pregnant women will be asked to rate each question considering the last 7 days. Each of the 10 items will be scored from 0 (absence of depressed mood) to 3 (the worst mood). The EPDS has been validated for the depression measure in antenatal and postpartum depression (Cox, Holden and Sagovsky, 1987; Glaze and Cox, 1991; Tendais *et al.*, 2014). In this intervention will be used the Portuguese Version of EPDS (Augusto, Kumar, Calheiros, Matos and Figueiredo, 1996).

Functional ability (GHQ-12)

The 12-item General Health Questionnaire (GHQ-12) is a standardized self-reported questionnaire used to screen for common mental disorders. This questionnaire consists of 12 questions. The pregnant women will be asked to rate each question from 1 (less than usual) to 4 (much more than usual) (Goldberg and Hillier, 1979). In this intervention will be used the Portuguese Version of GHQ-12 (Laranjeira, 2008).

Sleep Quality (PSQI)

The Pittsburgh Sleep Quality Index (PSQI) is a self-rated questionnaire which assesses sleep quality and disturbances. This questionnaire consists of 19 self-rated questions. These questions are related with sleep quality, including duration, latency, and frequency and severity of specific sleep related problems. Sleep quality is measuredby means of 19 questions, and the total score is based on 7 "component" scores. The pregnant women will be asked to rate each question from 0 (no difficulty) to 3 (severe difficulty). The global score has a range of 0-21. Higher score indicates worse sleep quality (Buysse *et al.*, 1989). In this intervention will be used the Portuguese Version of PSQI (Del Rio João *et al.*, 2017).

Pregnancy and delivery Outcomes

These outcomes are measured since the beginning of hospitalization of pregnant women: hospitalization (day and reason for), labour onset (spontaneous or induced), use of epidural anaesthesia during delivery (yes or no), duration of labour (hours), mode of delivery (percentage of participants with spontaneous delivery, vacuum extraction, or caesarean section), birthweight (kilograms), and birth length (centimetres). This information will be obtained in the hospital.

TIMELINE

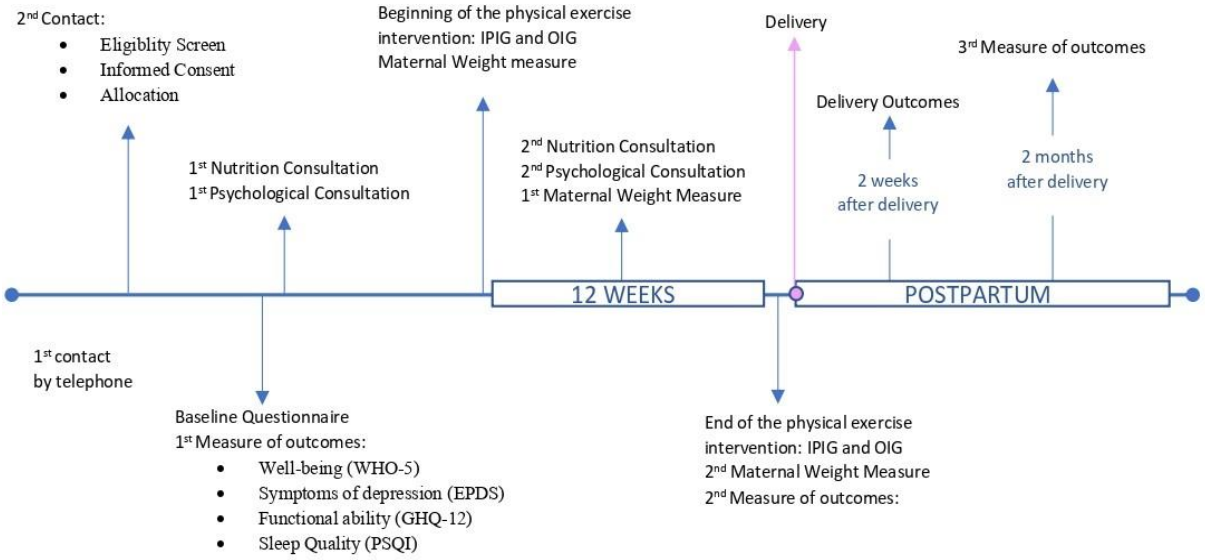

Figure 3: Intervention Timeline

DISCUSSION

Maternal depression and anxiety are the most common psychiatric disorders during pregnancy and postpartum with more prevalence in third trimester and postpartum (Howdeshell and Ornoy, 2017; Broberg *et al.*, 2017). The physical exercise has been identified as a treatment and prevention for depression. Furthermore, not only in the context of exercise, social support has been recognized as a powerful protective factor for decreasing depressive symptoms across perinatal period (Racine *et al.*, 2020). However, as verified in some studies, little importance is given to this variable in data analysis. This protocol comes as a solution for this lack, aiming evaluate the influence of social support on risk of depression during pregnancy and postpartum. The multidisciplinary team will be a strong point for follow-up of pregnant women on various dimensions. The eligibility criteria will be in line with risk factors for depression, and other factors that may influence practice. This RCT will consider the CERT model. Complying with the points of the CERT model was a gap identified in some RCTs. This will allow easier replication of the intervention and clarifications of possible biases. The authors expect a low drop-out from the participants due to the closefollow-up by the team of professionals.

This protocol of RCT aimed to evaluate if a supervised exercise in group for pregnant women with high social support will influence the risk of depression during pregnancy and postpartum. These results will provide evidence on the importance of social support in pregnancy and the relevance of a multidisciplinary team in the intervention program for pregnant women.

ETHICS AND DISSEMINATION

The study was approved by the ethics committee of the higher education institution (#ESDRM), and all procedures will be carried out in accordance with the Declaration of Helsinki.

Personal data processing complies with the Act on Processing of Personal Data. Data are owned by the research team of the Polytechnic Institute of Santarém. The use of data generated in the ActivePregnancy RCT in new contexts must be agreed upon and approved by the Steering group. Researchers from other participating universities

and hospitals must have access to the data they have collected and are free to use it in new contexts.

The exercise intervention is designed based on recommendations of appropriate PA during pregnancy and although anatomic and physiological changes occur during pregnancy, PA during an uncomplicated pregnancy is safe (Santos-Rocha, 2019; Birsner and Gyamfi-Bannerman, 2020).

The program was delivered by qualified and certified exercise physiologists with a degree (bachelor's and/or master's) in Exercise and Sport Science with expertise in pregnancy and postpartum exercise. Those exercise physiologists represent key providers of structured training for pregnant participants with knowledge and skills to report and refer to healthcare providers during the course of pregnancy, if necessary.

A non-exercise control group either receiving “standard care“, or being included in a “waiting list” will not be enrolled in the study, as in a typical RCT study, due to ethical reasons. Namely, there is plenty of evidence supporting the benefits of physical activity during pregnancy. It is health and exercise professionals’ responsibility toadvise and encourage women towards physical activity. Standard care, unfortunately, is not focused on physical activity promotion. On the other hand, it does not make sense totell a pregnant woman that she is in a waiting list for 12 weeks, since she might no longer be pregnant.

Participation in the ActivePregnancy program is free of charge.

All participants consent in written form before inclusion and are informed that participation in the study is voluntary.

Participants are informed that they may withdraw from the study at any time and that withdrawal of consent will not affect any subsequent pregnancy and delivery processes at the hospital. The participant has time to ask questions and is allowed 24 hours to deliberate on study participation before the obtainment of written informed consent.

All information about adverse events and serious adverse events are documented consecutively and will be reported. Participants will be discontinued from the intervention if serious obstetric or medical complications occur.

The study will provide evidence-based knowledge that can contribute to improving national and international recommendations of PA during pregnancy and to new, effective and simple guidance to implement health technology-supported exercise programs for pregnant women.

Findings will be disseminated via peer-reviewed publications and at national and international conferences for exercise and health professionals.

Based on the results and process evaluation, the knowledge and tools from the ActivePregnancy study can be transformed into initiatives in municipalities and hospitals to improve the health and quality of life for both mother and child and can be used for preventing the development of lifestyle-related diseases across generations.

CONCLUSION

This dissertation aimed to: updated the knowledge about the effectiveness of exercise in a group context during pregnancy between 2015 and 2020; analysed the exercise programme design, the consistency with the guidelines, identifying limitations in the interventions that can be improved in the future; and developed a possiblesolution for issues identified.

Related to the Systematic Review, the authors highlighted three limitations: high level of drop-out; influence of social support on risk of depression; and few studies having a high score on CERT model.

Considering the factors mentioned above, the authors presented a protocol of exercise intervention that evaluated the influence of Social Support from multidisciplinary team on risk of depression during pregnancy and postpartum. The level of drop-out was considered an outcome with expected correlation with high follow-up of multidisciplinary team. This exercise intervention was developedaccording to the CERT model.

The authors believe that this study is an important element of intervention with this population, not only by updating the scientific evidence, but also by the intervention proposal. The study protocol aimed to respond to the problems identified in the Systematic Review. The authors believe that further studies are needed to assess the reasons for dropping out or the main motivations for the practice during pregnancy. A multidisciplinary team that supports the pregnant woman is essential for her to feel confident in the practice of exercise in this special phase.

REFERENCES

ACOG (2002) ‘Commitee on Obstetric Practice - Exercise During Pregnancy and the Postpartum Period’, *Obstetric and Gynecology*, 99(1), pp. 171–173. doi: 10.1016/S0029-7844(01)01749-5.

ACOG (2015) ‘Committee Opinion - Physical Activity and Exercise During Pregnancy and the Postpartum Period’, *Obstetrics and Gynecology*, 701. doi: 10.1016/S0140-6736(16)31898-0.

Aguilar-Cordero, M. J. (2015) ‘Influencia del programa SWEP (Study Water Exercise Pregnant) en los resultados perinatales: protocolo de estudio’, *Nutrición Hospitalaria*, 33, pp. 162–176. doi: 10.20960/nh.02870.

Aguilar-Cordero, M. J. *et al.* (2019) ‘Moderate Physical Activity in an Aquatic Environment During Pregnancy (SWEP Study) and Its Influence in Preventing Postpartum Depression’, *Journal of the American Psychiatric Nurses Association*, 25(2), pp. 112–121. doi: 10.1177/1078390317753675.

Awad, E. *et al.* (2019) ‘Effect of antenatal exercise on mode of delivery in gestational diabetic females: A single-blind randomized controlled trial’, *Physiotherapy Quarterly*, 27(2), pp. 1–5. doi: 10.5114/pq.2019.84270.

Augusto, A, Kumar, R, Calheiros, JM, Matos, E. (1996) ‘Postnatal depression in na urban área of Portugal: comparison of childbearing women and matched controls’, Psychol Med, 26 (1):135-41.

Bacchi, M. *et al.* (2018) ‘Aquatic Activities During Pregnancy Prevent Excessive Maternal Weight Gain and Preserve Birth Weight: A Randomized Clinical Trial’, *American Journal of Health Promotion*, 32(3), pp. 729–735. doi: 10.1177/0890117117697520.

Barakat, R. *et al.* (2016) ‘Exercise during pregnancy protects against hypertension and macrosomia: Randomized clinical trial’, *American Journal of Obstetrics and Gynecology*. Elsevier Inc., 214(5), pp. 649.e1-649.e8. doi: 10.1016/j.ajog.2015.11.039.

Barakat, R. *et al.* (2018) ‘Does Exercise During Pregnancy Affect Placental Weight?: A Randomized Clinical Trial’, *Evaluation and the Health Professions*, 41(3), pp. 400–414. doi: 10.1177/0163278717706235.

Barakat, R. *et al.* (2019) ‘Exercise during pregnancy has a preventative effect onexcessive maternal weight gain and gestational diabetes. A randomized controlled trial’,*Brazilian Journal of Physical Therapy*. Associação Brasileira de Pesquisa e Pós- Graduação em Fisioterapia, 23(2), pp. 148–155. doi: 10.1016/j.bjpt.2018.11.005.

Becker, M. *et al.* (2016) ‘Depression During Pregnancy and Postpartum’, *Current Psychiatry Reports*, 18(3), pp. 1–9. doi: 10.1007/s11920-016-0664-7.

Becofsky, K. M. *et al.* (2015) ‘A prospective study of fitness, fatness, and depressive symptoms’, *American Journal of Epidemiology*, 181(5), pp. 311–320. doi: 10.1093/aje/kwu330.

Birsner, M. L. and Gyamfi-Bannerman, C. (2020) ‘ACOG 2020’, *Obstetrics and Gynecology*, 135(4). Available at: http://journals.lww.com/greenjournal.

Brik, M. *et al.* (2019) ‘Does exercise during pregnancy impact on maternal weight gain and fetal cardiac function? A randomized controlled trial’, *Ultrasound in Obstetrics and*

Gynecology, 53(5), pp. 583–589. doi: 10.1002/uog.20147.

Broberg, L. *et al.* (2017) 'Effect of supervised exercise in groups on psychological well-being among pregnant women at risk of depression (the EWE Study): Study protocol for a randomized controlled trial', *Trials*. Trials, 18(1), pp. 1–10. doi: 10.1186/s13063-017-1938-z.

Buysse, D. J. *et al.* (1989) 'Buysse DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. Psychiatry Res. 1989;28:193–213.'

Cepêda, T, Brito I, Heitor MJ (2005) 'Promoção da Saúde Mental na Gravidez e Primeira Infância – Manual de Orientação para profissionais de saúde: DGS, pp. 7-8'

Chan, A. W. *et al.* (2017) 'SPIRIT 2013 statement: Defining standard protocol items for clinical trials', *Japanese Pharmacology and Therapeutics*, 45(12), pp. 1895–1904.

Charkamyani, F. *et al.* (2019) 'Reducing the Adverse Maternal and Fetal Outcomes in IVF Women by Exercise Interventions During Pregnancy', *Research Quarterly for Exercise and Sport*. Routledge, 90(4), pp. 589–599. doi: 10.1080/02701367.2019.1639601.

Chasan-Taber, L. *et al.* (2004) 'Development and validation of a pregnancy physical activity questionnaire', *Medicine and Science in Sports and Exercise*, 36(10), pp. 1750–1760. doi: 10.1249/01.MSS.0000142303.49306.0D.

Clark, E. *et al.* (2019) 'Influence of aerobic exercise on maternal lipid levels and offspring morphometrics', *International Journal of Obesity*. Springer US, 43(3), pp. 594–602. doi: 10.1038/s41366-018-0258-z.

Coll, C. de V. N. *et al.* (2019) 'Efficacy of Regular Exercise During Pregnancy on the Prevention of Postpartum Depression: The PAMELA Randomized Clinical Trial', *JAMA network open*, 2(1), p. e186861. doi: 10.1001/jamanetworkopen.2018.6861.

Cordero J, A. M. *et al.* (2017) 'Influencia del ejercicio físico durante el embarazo sobre el peso del recién nacido: un ensayo clínico aleatorizado', *Nutrición Hospitalaria*,34(4), pp. 834–840. doi: 10.20960/nh.1095.

Cordero, Y. *et al.* (2015) 'Exercise is associated with a reduction in gestational diabetes mellitus', *Medicine and Science in Sports and Exercise*, 47(7), pp. 1328–1333. doi: 10.1249/MSS.0000000000000547.

Cox, J. L., Holden, J. M. and Sagovsky, R. (1987) 'Edinburgh Postnatal Depression', *British Journal of Psychiatry*, 150(JUNE), pp. 782–786. doi: 10.1192/bjp.150.6.782.

Davenport, M. H. *et al.* (2019) 'Exercise for the prevention and treatment of low back, pelvic girdle and lumbopelvic pain during pregnancy: A systematic review and meta-analysis', *British Journal of Sports Medicine*, 53(2), pp. 90–98. doi: 10.1136/bjsports-2018-099400.

Dias, N. T. *et al.* (2018) 'A Pilates exercise program with pelvic floor muscle contraction: Is it effective for pregnant women? A randomized controlled trial', *Neurourology and Urodynamics*, 37(1), pp. 379–384. doi: 10.1002/nau.23308.

Dipietro, L. *et al.* (2019) 'Benefits of Physical Activity during Pregnancy and Postpartum: An Umbrella Review', *Medicine and Science in Sports and Exercise*,51(6), pp. 1292–1302. doi: 10.1249/MSS.0000000000001941.

Evenson, K. R. *et al.* (2014) 'Guidelines for Physical Activity During Pregnancy: Comparisons From Around the World', *American Journal of Lifestyle Medicine*, 8(2), pp. 102–121. doi: 10.1177/1559827613498204.

Glaze, R. and Cox, J. L. (1991) 'Validation of a computerized version of the 10-item (self-rating) Edinburgh postnatal depression scale', *Journal of Affective Disorders*, 22(1–2), pp. 73–77. doi: 10.1016/0165-0327(91)90086-8.

Goldberg, D. P. and Hillier, V. F. (1979) 'A scaled version of the General Health Questionnaire', *Psychological Medicine*, 9(1), pp. 139–145. doi: 10.1017/S0033291700021644.

Gregg, V. H., Ii, J. E. F. and Ii, F. (2017) 'Exercise in Pregnancy', *Clinics in Sports Medicine*. Elsevier Inc, 36(4), pp. 741–752. doi: 10.1016/j.csm.2017.05.005.

Gustafsson, M. K. *et al.* (2016) 'The effects of an exercise programme during pregnancy on health-related quality of life in pregnant women: a Norwegian randomisedcontrolled trial', *BJOG: An International Journal of Obstetrics and Gynaecology*, 123(7), pp. 1152–1160. doi: 10.1111/1471-0528.13570.

Haakstad, L. A. H. and Bø, K. (2020) 'The marathon of labour—Does regular exercise training influence course of labour and mode of delivery?: Secondary analysis from a randomized controlled trial', *European Journal of Obstetrics and Gynecology and Reproductive Biology*. Elsevier Ireland Ltd, 251, pp. 8–13. doi: 10.1016/j.ejogrb.2020.05.014.

Haakstad, L. A. H., Edvardsen, E. and Bø, K. (2016) 'Effect of regular exercise on blood pressure in normotensive pregnant women. A randomized controlled trial', *Hypertension in Pregnancy*, 35(2), pp. 170–180. doi: 10.3109/10641955.2015.1122036.

Haakstad, L. A. H., Torset, B. and Bø, K. (2016) 'What is the effect of regular group exercise on maternal psychological outcomes and common pregnancy complaints? An assessor blinded RCT', *Midwifery*. Elsevier, 32, pp. 81–86. doi: 10.1016/j.midw.2015.10.008.

Heinz, H. C. M. G. H. R. (2013) *ACSM's Guidelines forExercise Testing and Prescription, Persepsi Masyarakat Terhadap Perawatan Ortodontik Yang Dilakukan Oleh Pihak Non Profesional*.

Heinzel, S. *et al.* (2015) 'Using exercise to fight depression in older adults: A systematic review and meta-analysis', *GeroPsych: The Journal of Gerontopsychology and Geriatric Psychiatry*, 28(4), pp. 149–162. doi: 10.1024/1662-9647/a000133.

Howdeshell, K. L. and Ornoy, A. (2017) 'Depression and Its Treatment During Pregnancy: Overview and Highlights', *Birth Defects Research*, 109(12), pp. 877–878. doi: 10.1002/bdr2.1080.

Jenkinson, C., Coulter, A. and Wright, L. (1993) 'Short form 36 (SF 36) health survey questionnaire: Normative data for adults of working age', *British Medical Journal*, 306(6890), pp. 1437–1440. doi: 10.1136/bmj.306.6890.1437.

Jorge, C., Rocha, R. S. and Bento, T. (2015) 'Can Group Exercise Programs Improve Health Outcomes in Pregnant Women? A Systematic Review', *Current Women's Health Reviews*, 11(1), pp. 75–87. doi: 1875-6581/15 $58.00+.00.

Laranjeira, C. A. (2008) 'General Health Questionnaire-12 items: Adaptation study to the Portuguese population', *Epidemiologia e Psichiatria Sociale*, 17(2), pp. 148–151. doi: 10.1017/s1121189x00002840.

Lima, L. *et al.* (2018) 'Adaptation and validation of the instrumental expressive social support scale in portuguese older individuals', *Revista Latino-Americana de Enfermagem*, 26. doi: 10.1590/1518-8345.2647.3096.

Lundgren-Nilsson, Å. *et al.* (2013) 'Construct validity of the Psychological General Well Being Index (PGWBI) in a sample of patients undergoing treatment for stress- related exhaustion: a Rasch analysis.', *Health and quality of life outcomes*, 11, pp. 1–9. doi: 10.1186/1477-7525-11-2.

Magro-Malosso, E. R. *et al.* (2017) 'Exercise during pregnancy and risk of gestational hypertensive disorders: a systematic review and meta-analysis', *Acta Obstetricia et Gynecologica Scandinavica*, 96(8), pp. 921–931. doi: 10.1111/aogs.13151.

Moher, D. *et al.* (2009) 'Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement.', *PLoS medicine*, 6(7). doi: 10.1371/journal.pmed.1000097.

Möhler, R., Köpke, S. and Meyer, G. (2015) 'Criteria for Reporting the Development and Evaluation of Complex Interventions in healthcare: revised guideline (CReDECI2)', *Trials*. doi: 10.1186/s13063-015-0709-y.

Mørkved, S. and Bø, K. (2014) 'Effect of pelvic floor muscle training during pregnancy and after childbirth on prevention and treatment of urinary incontinence: A systematic review', *British Journal of Sports Medicine*, 48(4), pp. 299–310. doi: 10.1136/bjsports-2012-091758.

Mottola, M. F. *et al.* (2019) 'Canadian Guideline for Physical Activity throughout Pregnancy - 2019', *Journal of Obstetrics and Gynaecology Canada*, 40(11), pp. 1528–1537. doi: 10.1016/j.jogc.2018.07.001.

Murri, M. B. *et al.* (2018) 'Physical exercise for late-life depression: Effects on symptom dimensions and time course', *Journal of Affective Disorders*, 230(October 2017), pp. 65–70. doi: 10.1016/j.jad.2018.01.004.

Nascimento, S. L., Surita, F. G. and Cecatti, J. G. (2012) 'Physical exercise during pregnancy: A systematic review', *Current Opinion in Obstetrics and Gynecology*, 24(6), pp. 387–394. doi: 10.1097/GCO.0b013e328359f131.

OMS (1998) 'Índice de bem-estar OMS (cinco) (WHO-5), versão de 1998', *Mental Health Services*, pp. 1–2.

OMS (2020) 'Recomendações da OMS para atividade física e comportamento sedentário', *World Health Organization*, p. 24.

Pawalia, A. *et al.* (2017) 'Exercise in pregnancy: Effect on obesity parameters in indian women - A randomized controlled trial', *Romanian Journal of Diabetes, Nutrition and*

Metabolic Diseases, 24(4), pp. 315–323. doi: 10.1515/rjdnmd-2017-0037.

Pearlstein, T. (2015) 'Depression during Pregnancy', *Best Practice and Research: Clinical Obstetrics and Gynaecology*. Elsevier Ltd, 29(5), pp. 754–764. doi: 10.1016/j.bpobgyn.2015.04.004.

Peggie L. Williamson (2019) *Exercise for Special Populations*. 2nd edn. Killeen, Texas: Wolters Kluwer.

Pelaez, M. *et al.* (2019) 'Protective Effect of Exercise in Pregnant Women Including Those Who Exceed Weight Gain Recommendations: A Randomized Controlled Trial', *Mayo Clinic Proceedings*. Mayo Foundation for Medical Education and Research,94(10), pp. 1951–1959. doi: 10.1016/j.mayocp.2019.01.050.

Perales, M. *et al.* (2016) 'Maternal cardiac adaptations to a physical exercise program during pregnancy', *Medicine and Science in Sports and Exercise*, 48(5), pp. 896–906. doi: 10.1249/MSS.0000000000000837.

Pires, T. F. *et al.* (2020) 'Effects of pelvic floor muscle training in pregnant women', *Porto Biomedical Journal*, 5(5). doi: 10.1097/j.pbj.0000000000000077.

Racine, N. *et al.* (2020) 'Perinatal depression: The role of maternal adverse childhood experiences and social support', *Journal of Affective Disorders*. Elsevier B.V., 263, pp. 576–581. doi: 10.1016/j.jad.2019.11.030.

Rethorst, C. D., Wipfli, B. M. and Landers, D. M. (2009) 'The antidepressive effects of exercise: A meta-analysis of randomized trials', *Sports Medicine*, 39(6), pp. 491–511. doi: 10.2165/00007256-200939060-00004.

Del Rio João, K. A. *et al.* (2017) 'Validation of the Portuguese version of the Pittsburgh Sleep Quality Index (PSQI-PT)', *Psychiatry Research*. Elsevier, 247, pp. 225–229. doi: 10.1016/j.psychres.2016.11.042.

Robertson, E. *et al.* (2004) 'Antenatal risk factors for postpartum depression: A synthesis of recent literature', *General Hospital Psychiatry*, 26(4), pp. 289–295. doi: 10.1016/j.genhosppsych.2004.02.006.

Rodriguez-Blanque, R. *et al.* (2018) 'The influence of physical activity in water on sleep quality in pregnant women: A randomised trial', *Women and Birth*. Australian College of Midwives, 31(1), pp. e51–e58. doi: 10.1016/j.wombi.2017.06.018.

Rodríguez-Blanque, R., Sánchez-García, J. C., *et al.* (2019) 'Physical activity during pregnancy and its influence on delivery time: A randomized clinical trial', *PeerJ*,2019(2), pp. 1–14. doi: 10.7717/peerj.6370.

Rodríguez-Blanque, R., Sanchez-Garcia, J. C., *et al.* (2019) 'Randomized Clinical Trial of an Aquatic Physical Exercise Program During Pregnancy', *JOGNN - Journal of Obstetric, Gynecologic, and Neonatal Nursing*. Elsevier Inc, 48(3), pp. 321–331. doi: 10.1016/j.jogn.2019.02.003.

Rodríguez-Blanque, R., Aguilar-Cordero, M. J., Marín-Jiménez, A. E., Núñez-Negrillo, A. M., *et al.* (2020) 'Influence of a Water-Based Exercise Program in the Rate of Spontaneous Birth: A Randomized Clinical Trial', *International journal of environmental research and public health*, 17(3), pp. 1–12. doi:

10.3390/ijerph17030795.

Rodríguez-Blanque, R., Aguilar-Cordero, M. J., Marín-Jiménez, A. E., Menor-Rodríguez, M. J., *et al.* (2020) 'Water exercise and quality of life in pregnancy: A randomised clinical trial', *International Journal of Environmental Research and Public Health*, 17(4), pp. 1–12. doi: 10.3390/ijerph17041288.

Roldan-Reoyo, O. *et al.* (2019) 'Influence of maternal physical exercise on fetal and maternal heart rate responses', *German Journal of Exercise and Sport Research*, 49(4), pp. 446–453. doi: 10.1007/s12662-019-00582-5.

Ruiz, J. R. *et al.* (2013) 'Supervised exercise-based intervention to prevent excessive gestational weight gain: A randomized controlled trial', *Mayo Clinic Proceedings*. Elsevier Inc, 88(12), pp. 1388–1397. doi: 10.1016/j.mayocp.2013.07.020.

Sagedal, L. R., Øverby, N. C., *et al.* (2017) 'Lifestyle intervention to limit gestational weight gain: the Norwegian Fit for Delivery randomised controlled trial', *BJOG: An International Journal of Obstetrics and Gynaecology*, 124(1), pp. 97–109. doi: 10.1111/1471-0528.13862.

Sagedal, Linda R. *et al.* (2017) 'The effect of a prenatal lifestyle intervention on glucose metabolism: Results of the Norwegian Fit for Delivery randomized controlled trial', *BMC Pregnancy and Childbirth*. BMC Pregnancy and Childbirth, 17(1), pp. 1–12. doi: 10.1186/s12884-017-1340-6.

Sagedal, L. R., Sanda, B., *et al.* (2017) 'The effect of prenatal lifestyle intervention on weight retention 12 months postpartum: results of the Norwegian Fit for Delivery randomised controlled trial', *BJOG: An International Journal of Obstetrics and Gynaecology*, 124(1), pp. 111–121. doi: 10.1111/1471-0528.13863.

Sánchez-García, J. C. and Aguilar-Cordero, M. J. (2019a) 'Influencia del ejercicio físico en la evolución del peso gestacional y posparto. Ensayo clínico aleatorizado', *Nutrición Hospitalaria*, 36(4), pp. 931–938. doi: 10.20960/nh.02456.

Sánchez-García, J. C. and Aguilar-Cordero, M. J. (2019b) 'Influencia del ejerciciofísico en la evolución del peso gestacional y posparto', *Nutrición Hospitalaria*, 36(4), pp. 3–7. doi: 10.20960/nh.02456.

Sanda, B. *et al.* (2018) 'What is the effect of physical activity on duration and mode of delivery? Secondary analysis from the Norwegian Fit for Delivery trial', *Acta Obstetricia et Gynecologica Scandinavica*, 97(7), pp. 861–871. doi: 10.1111/aogs.13351.

Santos-Rocha, R. (2019) *Exercise and Sporting Activity During Pregnancy*. 1st edn. Edited by R. Santos-Rocha. Rio Maior, Portugal: Springer International Publishing AG, part of Spinger Nature 2019. doi: 10.1007/978-3-319-91032-1.

Skivington, K. *et al.* (2021) 'Framework for the development and evaluation of complex interventions: Gap analysis, workshop and consultation-informed update', *Health Technology Assessment*, 25(57), pp. i–132. doi: 10.3310/HTA25570.

Slade, S. C. and Dionne, C. E. (2016) 'Consensus on Exercise Reporting Template (CERT): Explanation and Elaboration Statement', *British Journal of Sports Medicine*, 1(50), pp. 1428–1437. doi: 10.1136/bjsports-2016-096651.

Soultanakis, H. N., Artal, R., & Wiswell, R. A. (1996). 'Prolonged exercise in pregnancy: glucose homeostasis, ventilatory and cardiovascular responses'. *Seminars in perinatology*, 20(4), 315–327. https://doi.org/10.1016/s0146-0005(96)80024-3

Spaight, C. *et al.* (2016) 'Gestational diabetes mellitus', *Endocrine Development*, 31, pp. 163–178. doi: 10.1159/000439413.

Stafne, S. N. *et al.* (2012) 'Does regular exercise including pelvic floor muscle training prevent urinary and anal incontinence during pregnancy? A randomised controlledtrial', *BJOG: An International Journal of Obstetrics and Gynaecology*, 119(10), pp. 1270–1280. doi: 10.1111/j.1471-0528.2012.03426.x.

Tendais, I. *et al.* (2014) 'Screening for depression and anxiety disorders from pregnancy to postpartum with the EPDS and STAI', *Spanish Journal of Psychology*, 17, pp. 1–9. doi: 10.1017/sjp.2014.7.

Thoits, P. A. (2011) 'Mechanisms linking social ties and support to physical and mental health', *Journal of Health and Social Behavior*, 52(2), pp. 145–161. doi: 10.1177/0022146510395592.

Thompson, P. D. *et al.* (2013) 'ACSM's New Preparticipation Health Screening Recommendations from ACSM's Guidelines for Exercise Testing and Prescription', *Current Sports Medicine Reports*, 12(4), pp. 215–217. doi: 10.1249/JSR.0b013e31829a68cf.

Thompson, W. R. (2022) 'Worldwide Survey of Fitness Trends for 2022', *ACSM's Health & Fitness Journal*, 26(1). Available at: https://journals.lww.com/acsm-healthfitness/Fulltext/2022/01000/Worldwide_Survey_of_Fitness_Trends_for_2022.6.aspx.

Topp, C. W. *et al.* (2015) 'The WHO-5 well-being index: A systematic review of the literature', *Psychotherapy and Psychosomatics*, 84(3), pp. 167–176. doi: 10.1159/000376585.

Vargas-Terrones, M. *et al.* (2019) 'Physical exercise programme during pregnancy decreases perinatal depression risk: A randomised controlled trial', *British Journal of Sports Medicine*, 53(6), pp. 348–353. doi: 10.1136/bjsports-2017-098926.

Voerman, E. *et al.* (2019) 'Association of Gestational Weight Gain With Adverse Maternal and Infant Outcomes', *Jama*, 321(17), pp. 1702–1715. doi: 10.1001/jama.2019.3820.

Warburton, D. E. R. *et al.* (2011) 'Evidence-based risk assessment and recommendations for physical activity clearance: Consensus Document 2011', *Applied Physiology, Nutrition and Metabolism*, 36(1), pp. 266–298. doi: 10.1139/H11-062.

Watterberg, K. L. *et al.* (2015) 'The Apgar Score', *American Academy of Pediatrics*, 136(4), pp. 819–822. doi: 10.1542/peds.2015-2651.

Woodley, S. J. *et al.* (2020) 'Pelvic floor muscle training for preventing and treating urinary and faecal incontinence in antenatal and postnatal women', *Cochrane Database of Systematic Reviews*, (5). doi: 10.1002/14651858.CD007471.pub4.

Zheng, Y. *et al.* (2022) 'Developing a Home-Based Body Weight Physical Activity/Exercise Program', *ACSM's Health & Fitness Journal*, 26(2), pp. 20–28. doi:

10.1249/FIT.0000000000000746.