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SYSTEMATIC REVIEW

Influence of pelvic floor muscle training alone or as part of a general physical activity program during pregnancy on urinary incontinence, episiotomy and third- or fourth-degree perineal tear: Systematic review and meta-analysis of randomized clinical trials

Dingfeng Zhang[1] | Kari Bo[2,3] | Rocío Montejo[4,5] | Miguel Sánchez-Polán[1] | Cristina Silva-José[1] | Montse Palacio[6,7] | Rubén Barakat[1]

[1]AFIPE Research Group, Universidad Politécnica de Madrid, Madrid, Spain

[2]Department of Sports Medicine, Norwegian School of Sport Sciences, Oslo, Norway

[3]Department of Obstetrics and Gynecology, Akershus University Hospital, Norway

[4]Department of Obstetrics and Gynecology, Institute of Clinical Sciences, University of Gothenburg, Gothenburg, Sweden

[5]Department of Obstetrics and Gynecology, Sahlgrenska University Hospital, Gothenburg, Sweden

[6]BCNatal, Fetal Medicine Research Center, Hospital Clínic and Hospital Sant Joan de Déu, Barcelona, Spain

[7]Hospital Universitario Clinic, Barcelona, Spain

Correspondence
Rocío Montejo, Department of Obstetrics and Gynecology, Institute of Clinical Sciences, Sahlgrenska Academy, University of Gothenburg, Gothenburg, Sweden.
Email: rocio.montejo.rodriguez@gu.se

Abstract

Introduction: The complex process of pregnancy and childbirth significantly influences the well-being of both mother and child. Today all pregnant women without medical contraindications are recommended to start or continue regular aerobic and strength training for at least 150 min per week to prevent pregnancy-related diseases and conditions. Urinary incontinence in pregnancy, episiotomy and third- or fourth-degree perineal tear during labor can greatly impact womens' health, quality of life and ability to be physically active. The aim of this study was to examine the efficacy of pelvic floor muscle training (PFMT) during pregnancy in the prevention of urinary incontinence, episiotomy, and third- or fourth-degree perineal tear.

Material and methods: A systematic review and meta-analysis (CRD42022370600) was performed. Only randomized clinical trials published between 2010 and 2023 were included. The following databases were examined: EBSCO (including Academic Search Premier, Education Resources Information Center, MEDLINE, SPORTDiscus and OpenDissertations databases), Clinicaltrials.gov, Web of Science, Scopus, Cochrane Database of Systematic Reviews and Physiotherapy Evidence Database (PEDro). Three meta-analyses to investigate the effect of PFMT exclusively or implemented as a section within a physical activity program during pregnancy on urinary incontinence, episiotomy, and third- or fourth-degree perineal tear were conducted.

Results: Thirty studies were analyzed ($N = 6691$). An effective preventive action of PFMT was found for urinary incontinence ($z = 3.46$; $p < 0.0005$; relative risk [RR] = 0.72, 95% confidence interval [CI]: 0.59, 0.87, $I^2 = 59\%$) and third- or fourth-degree perineal

Abbreviations: PA, physical activity; PFMT, pelvic floor muscle training; RCT, randomized clinical trials; UI, urinary incontinence.

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tear ($z = 2.89$; $p = 0.004$; RR = 0.50, 95% CI: 0.31, 0.80, $I^2 = 48\%$) but not for episiotomy ($z = 0.80$; $p = 0.42$; RR = 0.95, 95% CI: 0.85, 1.07, $I^2 = 75\%$).

Conclusions: PFMT during pregnancy proves to be an effective preventive intervention for reducing the risk of urinary incontinence and the occurrence of third- or fourth-degree perineal tears. These findings highlight the importance of incorporating PFMT into antenatal care and training programs to improve maternal well-being and overall childbirth outcomes.

KEYWORDS
episiotomy, pelvic floor muscle training, PFMT, pregnancy, third- or fourth-degree perineal tear, urinary incontinence

1 | INTRODUCTION

The WHO 2020 guideline on physical activity (PA) recommends that all pregnant women without obstetric contraindications should be encouraged to start or continue an exercise program of at least 150 min of moderate intensity PA per week including both cardiorespiratory and strength training activities.[1] Such PA programs have been shown to reduce the risk of pre-eclampsia, gestational hypertension, gestational diabetes, excessive gestational weight gain, delivery complications and postpartum depression and no increase in risk of stillbirth, newborn complications or adverse effects on birth weight.[2–6]

Urinary incontinence (UI) is common during pregnancy with prevalence rates of 31% in nulliparous women and 42% in parous women. Furthermore, the onset of UI during pregnancy is strongly predictive of post-partum UI (adjusted relative risk [RR] 2.3, 95% confidence interval [CI]: 2.2–2.4).[7] While there is conflicting evidence that episiotomy is a risk factor for UI it may be associated with perineal pain and sexual dysfunction. Episiotomy aims to prevent severe perineal tears, and third and fourth degree perineal tears may increase the risk for postpartum anal incontinence.[8–12] The major risk factors for third and fourth degree perineal tear are instrumental delivery, increased birthweight and prolonged second stage of labor.[13]

Pelvic floor disorders such as UI, anal incontinence, pelvic organ prolapse and pelvic floor pain may negatively affect a woman's desire and ability to be physically active and are therefore a threat to womens' health in general. Pelvic floor muscle training (PFMT) during pregnancy is recommended in prevention of UI in late pregnancy and during the first 6 months postpartum.[14] PFMT can be conducted both individually as a sole intervention but also as part of a general PA program. Including PFMT in a general PA program may be more motivating for both the women and the caregivers.[15] In addition, a general PA program including more than PFMT also has the potential to give the other health benefits associated with participation in general aerobic and strength training programs during pregnancy.[1,16,17]

Contradictory to the myth that PFMT during pregnancy may tighten the pelvic floor and thereby negatively affect vaginal birth, it has been shown that PFMT significantly lowers both first and second stage of labor with no negative effect on birth outcome.[18] The rationale for this effect is not known, but one theory is that PFMT may improve the woman's awareness of the contraction and relaxation status of the muscles. In addition, it may increase blood circulation and make the muscles more flexible. Although there are many factors contributing to the use of episiotomy and the incidence of third and fourth degree perineal tear, PFMT has been considered an adequate preventive strategy for alterations. The Cochrane review of PFMT during pregnancy included studies up to June 2019 only,[15] and to date there is scant knowledge whether PFMT during pregnancy can prevent episiotomy and third and fourth degree perineal tear.[19,20] A recent systematic review and meta-analysis, comprising exclusively randomized controlled trials (RCTs), investigated the effectiveness of various interventions aimed at preventing perineal trauma in parturient individuals, but limited the inclusion of studies on PFMT to RCTs that compared training with untreated controls.[21]

Therefore, the aim of this systematic review was to examine the effect of PFMT, implemented as a specific section within a PA program or as a single intervention during pregnancy, on UI, episiotomy and third- or fourth-degree perineal tear.

Key message

Pelvic floor muscle training throughout pregnancy is a basic and fundamental therapy in the prevention of complications for women. Preventing urinary incontinence during pregnancy significantly improves the quality of life of the pregnant woman.

2 | MATERIAL AND METHODS

A systematic review and meta-analysis design based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines was carried out.[22]

The protocol was registered in the International Prospective Registry of Systematic Reviews, registration no. CRD42022370600.

2.1 | Eligibility criteria

The eligibility criteria for this meta-analysis was guided by the PICOS framework: participants, interventions, comparisons, outcomes and study design.[22]

2.2 | Population

The target population consisted of pregnant women who did not have any contraindications to engage in physical exercise. Absolute contraindications were defined as conditions including ruptured membranes, premature labor, persistent second or third trimester bleeding, and other similar factors.[2,23,24]

2.3 | Intervention (exposure)

Three reviewers (DZ, MS and CS) conducted a search to identify PFMT interventions during pregnancy. The primary objective was to extract relevant information, including the family name of the first author, publication year, country, number of participants in the intervention group and control group, duration of the intervention, intensity of the activities, types of activities, weekly frequency, session duration, participant adherence, whether supervision was provided, primary and secondary outcomes.

2.4 | Comparison

Comparator was no exercise (i.e., the control group of the selected studies), normally involving pregnant women participating in a regular obstetrical follow-up in the health centers.

2.5 | Outcome

The main outcome of the study was UI. Relevant secondary variable outcomes were episiotomy and third- or fourth-degree perineal tear.

2.6 | Study design

Only RCTs were included. Nonrandomized clinical trials, observational studies, some type of review (narrative, systematic or systematic review with meta-analysis) and qualitative research were excluded.

2.7 | Data sources

An exhaustive and comprehensive search was conducted by three reviewers (DZ, MS, and CS) using the Universidad Politécnica de Madrid software in the following databases: EBSCO (including Academic Search Premier, Education Resources Information Center, MEDLINE, SPORTDiscus, and OpenDissertations databases), Clinicaltrials.gov, Web of Science, Scopus, Cochrane Database of Systematic Reviews, and Physiotherapy Evidence Database (PEDro). To ensure equality in the selection process, the same article selection criteria were used for all databases, considering differences in controlled vocabulary and rules of selection syntax. The search terms used were:

- English: physical activity OR exercise OR training OR physical exercise OR fitness OR strength training OR physical intervention OR Pilates OR Yoga OR strengthening OR aerobic OR resistance training OR pelvic floor muscle training AND pregnancy OR maternal OR antenatal OR pregnant AND urinary incontinence OR incontinence OR episiotomy OR perineal tear OR third-degree perineal tear AND randomized clinical trial OR randomized controlled trial OR RCT.
- Spanish: actividad física O ejercicio O entrenamiento O ejercicio físico O fitness O entrenamiento de fuerza O intervención de actividad física O Pilates O Yoga O fortalecimiento O aeróbico O entrenamiento de resistencia O fortalecimiento del suelo pélvico Y embarazo O materno O antenatal O embarazada Y incontinencia urinaria O incontinencia O episiotomía O desgarro perineal O tercer desgarro perineal Y ensayo clínico aleatorizado O ensayo controlado aleatorizado O ECA.

2.8 | Study selection and data extraction

In addition to RCTs, we conducted a search for previously published systematic reviews in the same field to compare our results. We considered articles published between 2010 and 2023, written in English and Spanish. To ensure comprehensiveness, we retrieved the reference lists of selected studies to identify other relevant research that might have been missed by the electronic keyword search.

The abstracts that met the initial screening criteria underwent further analysis. Subsequently, two reviewers (DZ and MS) independently screened the full texts to identify outcomes of interest for data extraction.

In cases where a study had multiple publications, we selected the most recent or comprehensive publication as the primary source. However, relevant data from all the publications were extracted to ensure that no valuable information was overlooked.

For studies in which one reviewer recommended exclusion, both reviewers attempted to reach a consensus to make a final decision regarding inclusion or exclusion. In instances of absolute discrepancy, a third reviewer (RM) provided their expert opinion on whether the study should be included or excluded. The detailed study selection process is presented in Figure 1.

Data extraction tables were created in an Excel sheet. One reviewer (MS) extracted the data and then data extraction was

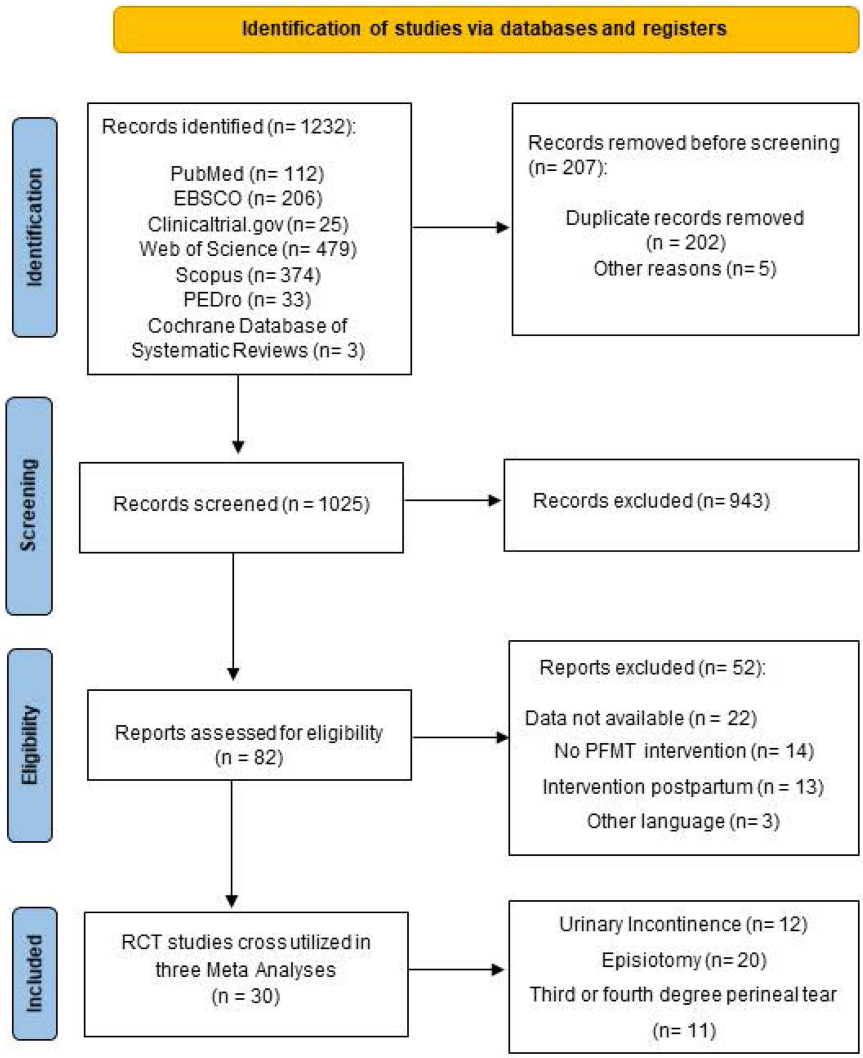


FIGURE 1 Flow chart of the retrieved and analyzed articles.

independently verified by a content expert to facilitate further analysis.

2.9 | Quality of evidence and risk of bias assessments

To evaluate the quality of evidence for each study design and outcome, the grading of recommendations assessment, development and evaluation framework was used by two reviewers (DZ and CS). This framework provides a standardized and comprehensive approach to assess the strength of the evidence across multiple studies.[25]

To evaluate the risk of bias, the Cochrane handbook was utilized. The potential sources of bias evaluated were: selection bias (inadequate randomization procedures for RCTs), performances bias (compliance with the intervention for RCTs), detection bias (flawed outcome measurement), attrition bias (incomplete follow-up and high loss to follow-up), and reporting bias (selective or incomplete outcome reporting).[26]

In order to assess potential publication bias in each developed meta-analysis, the Egger regression test was employed due to its enhanced sensitivity in detecting publication bias under conditions of weak or moderate heterogeneity. Typically, this test yields a metric indicating significant publication bias when $p < 0.1$.[27]

2.10 | Statistical analyses

Statistical analyses were performed with the software STATA (version 17.0). In this study all the outcomes were dichotomous outcomes, UI, episiotomy, third or fourth perineal tear were expressed as categorical variables (Yes/No), the number of the event exists in intervention and control group and its RR were recorded,[28] using for both type of variables random effects model. To establish the compensated average in both dichotomous and continuous analyses, a weight system was used that considered the sample size per groups and generally, contributed by each study. To assess the variation in study results between studies (i.e., the degree of heterogeneity), the I^2 statistic was interpreted using established thresholds:

low heterogeneity <25%, moderate heterogeneity 25% to 75%, high heterogeneity >75%.[29]

3 | RESULTS

3.1 | Study characteristics

A total of 30 studies that met the inclusion criteria were identified, involving 6691 pregnant women across 14 countries on five continents. The studies were cross utilized in three meta-analyses: UI, episiotomy, and third or fourth perineal tear degree, respectively. All the studies were RCTs, 26 PFMT alone or as part of a general PA program, four including PFMT and perineal massage.

All the studies included in the analysis focused on PFMT interventions. However, the structure of PFMT programs varied in terms of sections, workload, frequencies and intensities, as well as the duration of the programs. Similar differences were on the general exercises. The interventions were implemented during the first, second, and third trimesters of pregnancy and had durations ranging from 4 to 28 weeks. Additional details about the studies can be found in Table 1. The results on UI, episiotomy, third- and fourth degree perineal tear are presented as follows.

3.2 | Risk of bias assessment

Collectively, the quality of evidence varied from low to high. Blinding of participants to the intervention or control group as well as blinding of the instructor is typically impossible to achieve due to the intervention characteristics (PA intervention), resulting in unclear or high risk of bias (performance bias) depending on how it was recorded. Other sources of bias in some cases found, were the impossibility to find the article protocol published (to compare the planned and measured outcomes), but also not transparently reporting the randomization process. Overall, most of the studies presented low risk of bias within the five types of bias assessed. Risk of bias analysis is reported in Figure 2.

3.3 | Effect of PFMT or PA programs including PFMT during pregnancy on urinary incontinence

This analysis comprised a total of 12 studies.[31–38,49,50,59] There was a statistically significant association ($Z = 3.46$; $p < 0.0005$) between PFMT or PA including PFMT during pregnancy and the likelihood of UI (RR = 0.72, 95% CI: 0.59, 0.87, $I^2 = 59\%$, $P_{\text{heterogeneity}} = 0.005$). Quantification evaluation of the risk of publication bias test in the analyzed articles showed that there was no potential publication bias ($p = 0.99$) in this analysis.

Figure 3 displays the forest plot for the present meta-analysis. The experimental group had a lower risk of UI (RR = 0.72) than the control group (395/1137 = 37.74% vs. 544/1144 = 47.55%).

3.4 | Effect of PFMT or PA programs including PFMT during pregnancy on episiotomy

There was a total of 20 studies that were incorporated in this analysis.[39–47,49–59] Incorporating regular PFMT or PA including PFMT during pregnancy did not significantly change the outcome ($Z = 0.80$; $p = 0.42$) in the rate of having an episiotomy (RR = 0.95, 95% CI: 0.85, 1.07, $I^2 = 75\%$, $P_{\text{heterogeneity}} < 0.00001$). The quantitative assessment of the publication bias risk in the analyzed articles revealed no indication of potential publication bias in this analysis ($p = 0.68$).

The forest plot corresponding to the current meta-analysis is illustrated in Figure 4. Regarding RR (0.95), there were no significant differences between the study groups for episiotomy (experimental group: 824/2184 = 37.72% vs. control group: 915/2211 = 41.38%).

3.5 | Effect of PFMT or PA programs including PFMT during pregnancy on third- or fourth-degree perineal tear

A total of 11 studies were incorporated in this analysis.[48,51–59] There was an association ($z = 2.89$; $p = 0.004$) between the third- or fourth-degree perineal tear and PFMT or PA including PFMT during pregnancy (RR = 0.50, 95% CI: 0.31, 0.80, $I^2 = 48\%$, $P_{\text{heterogeneity}} = 0.04$). Statistical significance was observed in the quantitative assessment of the publication bias risk test for the articles analyzed ($p = 0.02$).

Figure 5 visually presents the results of the meta-analysis through a forest plot. The experimental group had a lower risk of third- or fourth-degree perineal tear (RR = 0.50) than the control group (60/1417 = 4.23% vs. 114/1373 = 8.3%).

4 | DISCUSSION

The study aimed to evaluate the impact of PFMT when implemented as a component of a PA program or as a standalone intervention during pregnancy on UI, episiotomy, and severe perineal tears, as these factors significantly influence the quality of life and health of women. Determining the most suitable and effective intervention type throughout pregnancy and its proposed effects, such as controlling maternal weight gain, preventing gestational diabetes, and improving perinatal outcomes, is of significant scientific and clinical interest. This knowledge holds crucial importance for healthcare systems, especially considering the persistently low prevalence of PA during pregnancy,[60] despite numerous recommendations from official organizations.[1,2,24]

The meta-analyses examining the effects of PFMT on the three study outcomes found a positively significant effect on UI and third and fourth degree perineal tears but not on occurrence of episiotomies. The results of this study provide compelling evidence that

TABLE 1 Characteristics of the analyzed studies.

Author	Year	Country	Type	*N*	EG N/%	CG N/%	*p*-Value	Intervention, exercise program							Main variables analyzed	Secondary variables analyzed
								Freq	Intensity	Duration of program	Type of exercise	Sup. class	Duration of class	Adh.		
Urinary incontinence																
Alagirisamy et al.[30]	2022	Malaysia	RCT	122	63/46	59/37.3	0.660	7	Low	16 w	PFMT	No	15–20 min	80%	Knowledge and attitude of practice of pelvic floor	Continence status and severity of urinary incontinence
Barakat et al.[31]	2011	Spain	RCT	80	34/29.4	33/33.3	<0.05	3	Low—Mod	28 w	Exercise program including PFMT	Yes	35–45 min	90%	Maternal health status, urinary incontinence	Gestational age, type of delivery, perineal tear, birthweight
Bø and Haakstad[32]	2011	Norway	RCT	105	42/40	42/38	0.82	2	Mod	12 w	Exercise program including PFMT	Yes	60 min	80%	Urinary, flatus or anal incontinence	-
Fritel et al.[33]	2015	France	RCT	282	112/44.6	112/43.7	0.89	1	Low	8 w	PFMT	Yes	20–30 min	-	Urinary incontinence	Type of delivery and birthweight
Kocaöz et al.[34]	2013	Turkey	RCT	102	52/17.3	50/48/5	0.002	7	Low	12 w	PFMT	No	12 min	-	Urinary incontinence	-
Miquelutti et al.[35]	2013	Brazil	RCT	149	78/41.2	71/68.4	N/A	7	Low	7 w	PFMT, aerobic and stretching exercises	No	30 min	-	Urinary incontinence, lumbopelvic pain and anxiety	Type of delivery, duration of delivery, birthweight
Pelaez et al.[36]	2014	Spain	RCT	152	63/4.8	89/39.3	<0.001	3	65%–70% Max HR	22 w	Exercise program including PFMT	Yes	55–60 min	80%	Urinary incontinence	-
Sangsawang and Sangsawang[37]	2016	Thailand	RCT	63	33/27.3	30/53.3	<0.01	5	Low	6 w	PFMT	No	30 min	-	Stress urinary incontinence	Severity of the urinary incontinence
Stafne et al.[38]	2012	Norway	RCT	762	397/42	365/53	0.004	1 2	Mod - High	12 w	Aerobic, strength, PFMT	Yes No	60 min 45 min	55%	Urinary and anal incontinence	Type of delivery, birthweight
Episiotomy																
Dias et al.[39]	2011	Norway	RCT	42	21/38	21/24	N/A	1 6	Low	16 w	Exercise program including PFMT	Yes No	30 min 20 min	75%	Type of delivery , duration of labor , birthweight	Episiotomy
Ghandali et al.[40]	2021	Iran	RCT	103	51/71.1	52/88.1	0.051	2	Low-Mod	8 w	Pilates exercise. PFMT	Yes	35 min	-	Episiotomy	Severe labor pain, duration of labor, type of delivery
Haakstad and Bø[41]	2020	Norway	RCT	90	43/36.5	47/30.2	0.496	2 3	Mod	12 w	Aerobic exercise PFMT	Yes No	60 min 30 min	80%	Duration of labor, type of delivery, episiotomy	-
Johannessen et al.[42]	2021	Norway	RCT	722	383/17	339/13	0.158	1 2	Mod	12 w	Aerobic, strength and PFMT	Yes No	55 - 70 min 45 min	-	Urinary incontinence at 3 months postpartum	Type of delivery, episiotomy, epidural, duration of labor, birthweight
Okido et al.[43]	2015	Brazil	RCT	59	26/35.3	33/28.3	N/A	1 6	Low	16 w	PFMT	Yes No	20 min 20 min	-	Type of delivery, duration of delivery, birthweight	Episiotomy

TABLE 1 (Continued)

Author	Year	Country	Type	*N*	EG N/%	CG N/%	*p*-Value	Intervention, exercise program							Main variables analyzed	Secondary variables analyzed
								Freq	Intensity	Duration of program	Type of exercise	Sup. class	Duration of class	Adh.		
Rodriguez-Diaz et al.[44]	2017	Spain	RCT	100	50/2	50/50.9	0.001	2	Mod	8 w	Pilates. PFMT	Yes	40–45 min	90%	Gestational weight gain, blood pressure, strength, flexibility and spinal curvature	Type of delivery, episiotomy, analgesia and birth weight
Sanda et al.[45]	2018	Norway	RCT	544	271/38.4	273/33.3	0.19	2 3	Mod	22 w	Aerobic, strength, PFMT. Dietary counseling	Yes No	60 min 30 min	-	Duration of labor, type of delivery	Episiotomy, gestational age
Silva-Jose et al.[46]	2021	Spain	RCT	98	48/12	50/38	0.031	2 1	55%–65% Max HR	28 w	Exercise program including PFMT	Yes No	55–60 min	80%	Episiotomy, perineal tear	-
Yekefallah et al.[47]	2021	Iran	RCT	70	35/77.1	35/65.7	0.29	2	Low-Mod	11 w	Yoga. PFMT	Yes	75 min	-	Episiotomy, perineal tear, type of delivery	Birthweight, gestational age, duration of labor
Third- or fourth-degree perineal tears																
Garnaes et al.[48]	2017	Norway	RCT	74	38/18	36/10	0.66	3 2 7	Mod	20 w	Aerobic, strength training PFMT	Yes No No	60 min 50 min 1 min	-	Birthweight	Type of delivery, perineal tears, gestational age
Rate of urinary incontinence, episiotomy																
Ko et al.[49]	2011	China	RCT	300	150/34 102/97	150/51 107/97	<0.01 0.87	1 6	Low	12 w	PFMT	Yes No	45 min 20 min	80%	Urinary incontinence	Duration of labor, type of delivery, episiotomy
Wang et al.[50]	2020	China	RCT	108	54/11.1 54/24	54/14.8 54/29.6	N/A N/A	7	Low	12 w	Audio guidance. PFMT	No	30 min	-	Stress urinary incontinence, episiotomy	Pelvic floor muscle strength, bladder neck mobility and sexual function
Rate of episiotomy, third- or fourth-degree perineal tears																
Abd El fttah Ali[51]	2015	Egypt	RCT	180	110/29.1 110/10	70/42.8 70/38.6	0.031 <0.001	7	Low	4 w	Perineal massage PFMT	No	10–15 min 5 min	-	Episiotomy Perineal tear	
Carrascosa et al.[52]	2021	Spain	RCT	263	124/28.2 133/3	123/29.3 130/2.3	0.856 0.944	3–5	55%–65% Max HR	20 w	Water aerobic exercise	Yes	45 min	-	Use of epidural analgesia during labor	Type of delivery, episiotomy, perineal tear
Dieb et al.[53]	2019	Egypt	RCT	400	200/29.5 200/13.5	200/38.5 200/21.5	0.045 0.034	3 3	Low	4 w	Perineal massage PFMT	No	5 min 10 min	-	Episiotomy, perineal tear	Duration of labor, fetal distress, episiotomy, birthweight
Dönmez and Kavlak[54]	2015	Turkey	RCT	101	62/85.5 62/6.4	39/100 39/30.8	0.014 0.000	7	Low	6 w	Perineal massage Pelvic floor muscle training	No	10 min 5 min	-	Episiotomy, perineal tear	Gestational age, duration of labor, birthweight

(Continues)

TABLE 1 (Continued)

Author	Year	Country	Type	*N*	EG N/%	CG N/%	*p*-Value	Intervention, exercise program							Main variables analyzed	Secondary variables analyzed
								Freq	Intensity	Duration of program	Type of exercise	Sup. class	Duration of class	Adh.		
Ferreira et al.[55]	2019	Portugal	RCT	255	99/72.2 99/2.2	156/66.4 156/0	0.450 0.082	3	Mod	24 w	Aerobic, strength, coordination and flexibility exercises. PFMT	Yes	45–50 min	-	Duration of labor, type of delivery	
Leon-Larios et al.[56]	2017	Spain	RCT	466	254/50.2 254/5.7	212/81.8 212/15.62	<0.001 0.003	5	Low	6 w	Perineal massage and PFMT	No	18–23 min	-	Perineal tear and episiotomy	Type of delivery, duration of labor, birthweight and epidural analgesia
Salvesen et al.[57]	2014	Sweden	RCT	413	207/31 206/6	201/24 207/6	0.11 0.99	1 2	Low Mod	12 w	Aerobic, strength, PFMT	Yes No	55–70 min 45 min	-	Gestational diabetes	Episiotomy, perineal tear
Sobhgol et al.[58]	2022	Australia	RCT	200	93/37.1 93/2.2	96/40.5 96/6.25	0.73 N/A	7	Low	16 w	PFMT	No	30 min	50%	Female sexual Function	Type of delivery, perineal tear, episiotomy, duration of labor and birth weight
Rate of urinary incontinence, episiotomy, third- or fourth-degree perineal tears																
Mason et al.[59]	2010	England	RCT	286	60/40 145/23.7 145/2.2	96/53 141/27.5 141/3.1	0.138 N/A N/A	7	Low	16 W	PFMT, 45-min physiotherapy class once a month for 4 months	No	20 min	70%	Urinary incontinence	Perineal tear, episiotomy, birth weight

Note: Author, first author last name and reference. Year, year of study. Country, country where the study has been developed. Type, type of study. N, total number of women analyzed in study groups. EG N/%, number of women analyzed in the intervention group/the rate of urinary incontinence, episiotomy, third- or fourth-degree perineal tears. CG N/%, number of women analyzed in the control group/ the rate of urinary incontinence, episiotomy, third- or fourth-degree perineal tears. Freq, weekly frequency of exercise sessions (3 days a week, 2, etc.). Intensity, moderate, high. Duration of program, total duration of the program. Type of exercise: PFMT, pelvic floor muscle training, aerobic, muscle strengthening, and so forth. Sup. Classes, whether or not there was supervision. Duration of class, minutes of each session. Adh., adherence of the participants to the intervention (%). Main variables analyzed, lists all the main variables of the study. Secondary variables, secondary variables analyzed. In the same study, it may involve different types of exercises, varying duration for each exercise, and both supervised and unsupervised exercises.Abbreviations: HR, heart rate; N/A, not available; PFMT, pelvic floor muscle training; RCT, randomized controlled trial.

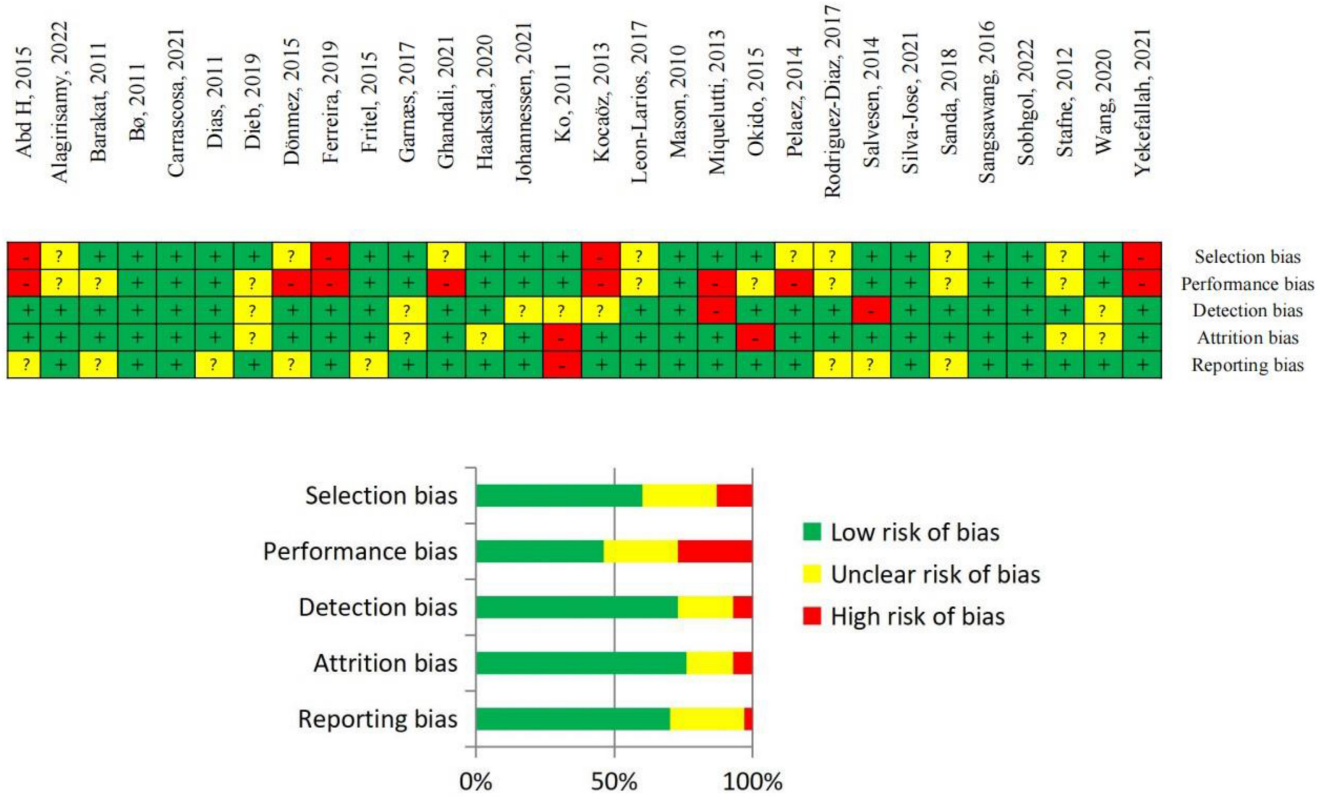


FIGURE 2 Risk of bias.

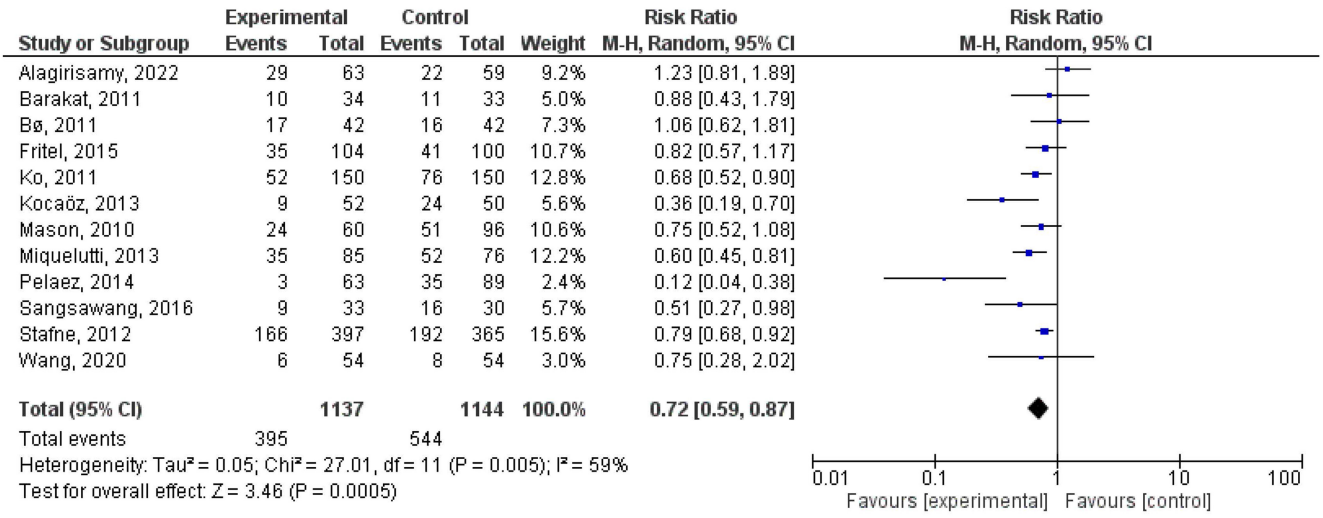


FIGURE 3 Effect of pelvic floor muscle training during pregnancy on urinary incontinence.

argues for the promotion and improvement of PFMT among pregnant women without contraindications.

As most of the included studies included PFMT in a group training session together with other exercises, our results on the effects of PFMT on UI demonstrate the efficacy of incorporating this type of training within an exercise program during pregnancy. Bø et al.[61] developed the group training concept of PFMT, and showed the evidence in an RCT in 1990 and later that the same program was more effective than electrostimulation and vaginal cones compared with a control group.[62] Dumoulin et al. showed that a group intervention of PFMT with equal training dos individual training was no less effective.[63] Both these PFMT group training programs included individual clinical assessment of ability to correctly contract the PFM, and the combination of individual assessment and instruction in addition to the PFMT has been used in most of the RCTs in the present meta-analysis. However, Barakat et al.[31] and Peleaz et al.[36] also found a large effect size of instruction of PFMT without prior individual assessment of PFM function before start of the general exercise program including specific

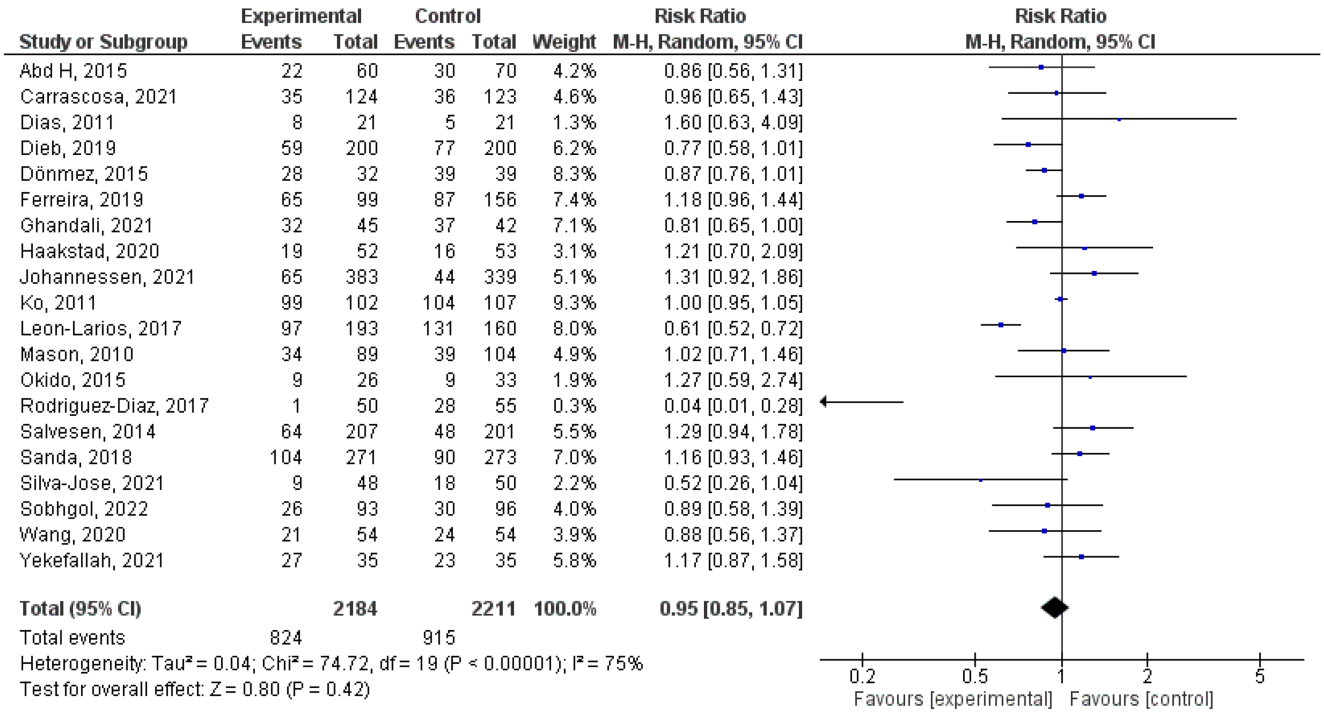


FIGURE 4 Effect of pelvic floor muscle training during pregnancy on episiotomy.

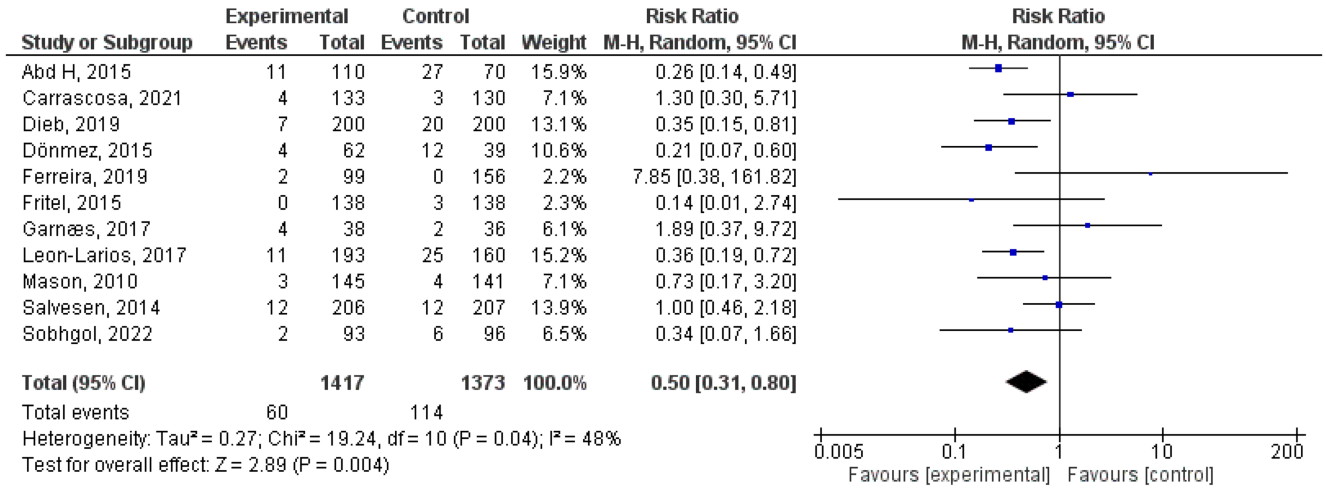


FIGURE 5 Effect of pelvic floor muscle training during pregnancy on third- or fourth-degree perineal tear.

PFMT. This indicates that it is possible to effectively teach pregnant women PFMT also without clinical assessment of PFM function. It is, however, a prerequisite that the instructor has proper knowledge of PFM anatomy and physiology and can explain and teach how to conduct a correct contraction.

Regarding the cost-effectiveness of interventions, Brennen et al. found that PFMT was more effective during pregnancy compared to the postpartum period.[64] However, it is emphasized that both phases should incorporate PFMT due to the benefits it may offer in preventing and treating postpartum UI and fecal incontinence.[15] The evidence on fecal incontinence remains unclear and further RCTs with high methodological and interventional quality are warranted on this condition.

Von Aarburg et al. studied the relationship between PA and UI during pregnancy and concluded that the currently available evidence, although of low quality, does not strongly support a significant association between general PA (eg, walking, brisk walking, running, training in fitness centers, strength training, and so forth) during pregnancy or postpartum and UI.[65] Also Luginbuehl et al. found no additional effect of adding general exercise (jumping and running) to an PFMT program.[66] However, moderate general PA should still be encouraged based on evidence-based benefits observed in other obstetrical outcomes, such as gestational weight gain, gestational diabetes, hypertension, and the mode of delivery.[1,2]

Regarding episiotomies, the results of the present review did not show positive effects of PFMT. Four of the 20 RCTs in our review

contained perineal massage in addition to PFMT, and none of these studies showed any effect on episiotomy rate.[51,53,54,56] Contrary to our results, a systematic review by Venugopal et al., examined the results of 10 RCTs ($N=4088$), and found that perineal massage during labor had a significantly lower incidence of episiotomy, reducing the risk of severe perineal trauma.[20] It is challenging to study episiotomy as an outcome as episiotomy rates vary greatly between countries and different health politics and practices may determine the clinical decision-making process at the maternity ward.[67] In our study, eight of 20 studies showed positive or trends of positive effects of PFMT alone or included as part of a general PA program during pregnancy. Possible mechanisms for how this would influence the rate of episiotomy needs further investigation, and there is a need for a comprehensive investigation taking many factors into account.

The results of the present study show an effective influence of PFMT as a preventive tool for the occurrence of third- or fourth-degree perineal tear. Contradictory to our findings, a review by Gomes et al. developed on nine RCTs ($N=1866$) concluded that there was no preventive effect of PFMT on perineal laceration.[19] The inclusion of more RCTs in our meta-analysis may explain the difference in outcome. Our results are in line with the systematic review of da Silva et al. including 50 RCTs ($N=17\,221$) of different interventions both during pregnancy and during labor.[21] They concluded with evidence for interventions during pregnancy, but not during labor, to lower the risk of perineal laceration when compared to no intervention (RR=0.81, 95% CI [0.71, 0.93]: $p=0.05$, $I^2=47\%$). Among the different techniques included in their review perineal massage had RR=0.69, 95% CI [0.54, 0.87]: $p<0.01$) to prevent laceration when compared to no intervention. Our meta-analysis included only interventions with PFMT alone or PFMT included in a general exercise program. Shown to be effective, further studies are needed to elaborate on how PFMT and regular PA can prevent severe perineal tears.

A strength of our systematic review is that we were able to conduct meta-analyses of the effect of PFMT alone or as part of a general exercise program during pregnancy on UI, episiotomy and third- and fourth-degree perineal tears. As most of the RCTs have investigated different outcomes based on the same intervention, we consider it important to describe the programs and report these results together.

A limitation of the meta-analyses of PFMT alone or as part of a comprehensive exercise program on episiotomy and severe perineal tears was that all the studies had UI as the primary outcome and therefore may not have been adequately powered to find significant differences in these outcomes. In addition, although programs including aerobic, strength training, balance and stretching exercises are included with the aim to affect other health and fitness variables than UI, episiotomy and perineal tears, these other exercises cannot be totally ruled out to have contributed to the effect. More general shortcomings of the review may be uncertainties in data sources, limitations in the study population, and variations in the interventions used.

Another limitation of this study was the identified risk of publication bias in the analysis related to third- or fourth-degree perineal tears (Figure 5), potentially attributed to the variation in sample sizes between the study groups. Nevertheless, despite the acknowledged risk of bias and the limited number of available articles, we opted to conduct this meta-analysis, deeming it pertinent from a scientific standpoint within the scope of the topic under investigation.

Furthermore, the moderate to high heterogeneity observed in this meta-analysis prompted the utilization of the random-effects model, aiming to produce rigorous but conservative outcomes.[68] However, it is essential to note that the random-effects model may not always outperform the fixed-effects model, particularly in cases of potential publication bias, as evident in our study.[69–71] This aspect warrants careful consideration in future research endeavors. Additionally, beyond rigorously assessing heterogeneity, there is a need to explore alternative methodologies for robustly estimating the overall effect size, especially in the presence of outliers.[72]

5 | CONCLUSION

The current systematic review and meta-analyses confirmed the effect of PFMT alone or included as part of a general exercise program during pregnancy to prevent UI and third and fourth degree perineal tears but there was no effect on rate of episiotomy. The findings of this study hold the potential to facilitate the design and implementation of PA programs that incorporate PFMT during pregnancy. These insights are particularly relevant for healthcare professionals responsible for the well-being of pregnant women, especially health practitioners and sports science professionals.

AUTHOR CONTRIBUTIONS

Dingfeng Zhang: conducted fieldwork and gathered primary data. Collected data. Conducted statistical analyses and interpreted the results. Drafted the initial manuscrip. Kari Bo: provided critical insights and expertise in the theoretical framework. Revised the manuscript for intellectual content. Rocío Montejo: provided critical insights and expertise in the theoretical framework. Conceptualized the research study. Miguel Sánchez-Polán: conducted fieldwork and gathered primary data. Created visualizations, graphs, and figures to illustrate key findings. Cristina Silva-José: contributed to the literature review, ensured accurate citations. and collected data. Montse Palacio: provided critical insights and supervised the research process. Rubén Barakat: developed the methodology and supervised the research process. Provided critical insights and expertise in the theoretical framework.

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CONFLICT OF INTEREST STATEMENT

The authors confirm there are no conflicts of interest.

ORCID

Rocío Montejo https://orcid.org/0000-0001-8917-1882
Cristina Silva-José https://orcid.org/0000-0001-9134-2011
Rubén Barakat https://orcid.org/0000-0002-4165-7039

REFERENCES

1. Bull FC, Al-Ansari SS, Biddle S, et al. World Health Organization 2020 guidelines on physical activity and sedentary behaviour. *Br J Sports Med*. 2020;54:1451-1462.
2. Mottola MF, Davenport MH, Ruchat SM, et al. 2019 Canadian guideline for physical activity throughout pregnancy. *Br J Sports Med*. 2018;52:1339-1346.
3. Ribeiro MM, Andrade A, Nunes I. Physical exercise in pregnancy: benefits, risks and prescription. *J Perinat Med*. 2021;50(1):4-17.
4. Perales M, Valenzuela PL, Barakat R, et al. Obesity can offset the cardiometabolic benefits of gestational exercise. *Int J Obes (Lond)*. 2021;45:342-347.
5. Silva-Jose C, Nagpal TS, Coterón J, Barakat R, Mottola MF. The 'new normal' includes online prenatal exercise: exploring pregnant women's experiences during the pandemic and the role of virtual group fitness on maternal mental health. *BMC Pregnancy Childbirth*. 2022;22:251.
6. Barakat R, Franco E, Perales M, López C, Mottola MF. Exercise during pregnancy is associated with a shorter duration of labor. A randomized clinical trial. *Eur J Obstet Gynecol Reprod Biol*. 2018;224:33-40.
7. Milsom I, Alman D, Cartwright R, et al. Epidemiology of urinary incontinence (UI) and other lower urinary tract symptoms (LUTS), pelvic organ prolapse (POP) and anal (AI) incontinence. In: Cardozo L, Rovner E, Wagg A, Wein A, Abrams P, eds. *Incontinence*. 7th ed. ICUD-EAU; 2023:13-130.
8. Choudhari RG, Tayade SA, Venurkar SV, Deshpande VP. A review of episiotomy and modalities for relief of episiotomy pain. *Cureus*. 2022;14:e31620.
9. Correa Junior MD, Passini JR. Selective episiotomy: indications, Techinique, and association with severe perineal lacerations. *Rev Bras Ginecol Obstet*. 2016;38:301-307.
10. Serati M, Salvatore S, Rizk D. Episiotomy in modern clinical practice: friend or foe? *Int Urogynecol J*. 2019;30:669-671.
11. Shmueli A, Gabbay Benziv R, Hiersch L, et al. Episiotomy—risk factors and outcomes. *J Matern Fetal Neonatal Med*. 2017;30:251-256.
12. Ejegård H, Ryding EL, Sjogren B. Sexuality after delivery with episiotomy: a long-term follow-up. *Gynecol Obstet Invest*. 2008;66:1-7.
13. ACOG Practice Bulletin No. 198 summary: prevention and Management of Obstetric Lacerations at vaginal delivery. *Obstet Gynecol*. 2018;132:795-797.
14. Woodley SJ, Lawrenson P, Boyle R, et al. Pelvic floor muscle training for preventing and treating urinary and faecal incontinence in antenatal and postnatal women. *Cochrane Database Syst Rev*. 2020;5:CD007471.
15. Theodorsen NM, Strand LI, Bø K. Effect of pelvic floor and transversus abdominis muscle contraction on inter-rectus distance in postpartum women: a cross-sectional experimental study. *Physiotherapy*. 2019;105:315-320.
16. Barakat R. An exercise program throughout pregnancy: Barakat model. *Birth Defects Res*. 2021;113:218-226.
17. Bø K. Physiotherapy management of urinary incontinence in females. *J Physiother*. 2020;66:147-154.
18. Du Y, Xu L, Ding L, Wang Y, Wang Z. The effect of antenatal pelvic floor muscle training on labor and delivery outcomes: a systematic review with meta-analysis. *Int Urogynecol J*. 2015;26:1415-1427.
19. Gomes Lopes L, Maia Dutra Balsells M, Teixeira Moreira Vasconcelos C, Leite de Araújo T, Teixeira Lima FE, de Souza Aquino P. Can pelvic floor muscle training prevent perineal laceration? A systematic review and meta-analysis. *Int J Gynaecol Obstet*. 2022;157:248-254.
20. Venugopal V, Deenadayalan B, Maheshkumar K, et al. Perineal massage for prevention of perineal trauma and episiotomy during labor: a systematic review and meta-analysis. *J Family Reprod Health*. 2022;16:162-169.
21. Lucena da Silva M, Andressa Bastos Primo de Sousa Santos T, Wane Carvalho Leite L, et al. The effectiveness of interventions in the prevention of perineal trauma in parturients: a systematic review with meta-analysis. *Eur J Obstet Gynecol Reprod Biol*. 2023;283:100-111.
22. Moher D, Shamseer L, Clarke M, et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Syst Rev*. 2015;4:1.
23. ACOG Committee Obstetric Practice. ACOG Committee opinion. Number 267, January 2002: Exercise during pregnancy and the postpartum period. *Obstet Gynecol*. 2002;99:171-173.
24. ACOG Committee Opinion No. 650: physical activity and exercise during pregnancy and the postpartum period. *Obstet Gynecol*. 2015;126:e135-e142.
25. Granholm A, Alhazzani W, Møller M. Use of the GRADE approach in systematic reviews and guidelines. *Br J Anaesth*. 2019;123:554-559.
26. Sterne JAC, Savović J, Page MJ, et al. RoB 2: a revised tool for assessing risk of bias in randomised trials. *BMJ*. 2019;366:l4898.
27. Lin L, Chu H. Quantifying publication bias in meta-analysis. *Biometrics*. 2018;74:785-794.
28. Higgins JP, Thompson SG. Quantifying heterogeneity in a meta-analysis. *Stat Med*. 2002;21:1539-1558.
29. Lane PW, Higgins JP, Anagnostelis B, et al. Methodological quality of meta-analyses: matched-pairs comparison over time and between industry-sponsored and academic-sponsored reports. *Res Synth Methods*. 2013;4:342-350.
30. Alagirisamy P, Sidik S, Rampal L, Ismail S. Effectiveness of a pelvic floor muscle exercise intervention in improving knowledge, attitude, Practice, and self-efficacy among pregnant women: a randomized controlled trial. *Korean J Fam Med*. 2022;43:42-55.
31. Barakat R, Pelaez M, Montejo R, Luaces M, Zakynthinaki M. Exercise during pregnancy improves maternal health perception: a randomized controlled trial. *Am J Obstet Gynecol*. 2011;204:402.e1-7.
32. Bø K, Haakstad LA. Is pelvic floor muscle training effective when taught in a general fitness class in pregnancy? A randomised controlled trial. *Physiotherapy*. 2011;97:190-195.
33. Fritel X, de Tayrac R, Bader G, et al. Preventing urinary incontinence with supervised prenatal pelvic floor exercises: a randomized controlled trial. *Obstet Gynecol*. 2015;126:370-377.
34. Kocaöz S, Eroğlu K, Sivaslıoğlu AA. Role of pelvic floor muscle exercises in the prevention of stress urinary incontinence during pregnancy and the postpartum period. *Gynecol Obstet Invest*. 2013;75:34-40.
35. Miquelutti MA, Cecatti JG, Makuch MY. Evaluation of a birth preparation program on lumbopelvic pain, urinary incontinence, anxiety and exercise: a randomized controlled trial. *BMC Pregnancy Childbirth*. 2013;13:154.
36. Pelaez M, Gonzalez-Cerron S, Montejo R, Barakat R. Pelvic floor muscle training included in a pregnancy exercise program is effective in primary prevention of urinary incontinence: a randomized controlled trial. *NeurourolUrodyn*. 2014;33:67-71.
37. Sangsawang B, Sangsawang N. Is a 6-week supervised pelvic floor muscle exercise program effective in preventing stress urinary incontinence in late pregnancy in primigravid women? A randomized controlled trial. *Eur J Obstet Gynecol Reprod Biol*. 2016;197:103-110.
38. Stafne SN, Salvesen KÅ, Romundstad PR, Eggebø TM, Carlsen SM, Mørkved S. Regular exercise during pregnancy to prevent gestational diabetes: a randomized controlled trial. *Obstet Gynecol*. 2012;119:29-36.
39. Dias LA, Driusso P, Aita DL, Quintana SM, Bø K, Ferreira CH. Effect of pelvic floor muscle training on labour and newborn outcomes: a randomized controlled trial. *Rev Bras Fisioter*. 2011;15:487-493.
40. Ghandali NY, Iravani M, Habibi A, Cheraghian B. The effectiveness of a Pilates exercise program during pregnancy on childbirth outcomes: a randomised controlled clinical trial. *BMC Pregnancy Childbirth*. 2021;21:480.

41. Haakstad LAH, Bø K. The marathon of labour-does regular exercise training influence course of labour and mode of delivery?: secondary analysis from a randomized controlled trial. *Eur J Obstet Gynecol Reprod Biol*. 2020;251:8-13.
42. Johannessen HH, Frøshaug BE, Lysåker PJG, et al. Regular antenatal exercise including pelvic floor muscle training reduces urinary incontinence 3 months postpartum-follow up of a randomized controlled trial. *Acta Obstet Gynecol Scand*. 2021;100:294-301.
43. Okido MM, Valeri FL, Martins WP, Ferreira CH, Duarte G, Cavalli RC. Assessment of foetal wellbeing in pregnant women subjected to pelvic floor muscle training: a controlled randomised study. *Int Urogynecol J*. 2015;26:1475-1481.
44. Rodríguez-Díaz L, Ruiz-Frutos C, Vázquez-Lara JM, Ramírez-Rodrigo J, Villaverde-Gutiérrez C, Torres-Luque G. Effectiveness of a physical activity programme based on the Pilates method in pregnancy and labour. Efectividad de un programa de actividad física mediante el método Pilates en el embarazo y en el proceso del parto. *Enferm Clin*. 2017;27:271-277.
45. Sanda B, Vistad I, Sagedal LR, Haakstad LAH, Lohne-Seiler H, Torstveit MK. What is the effect of physical activity on duration and mode of delivery? Secondary analysis from the Norwegian fit for delivery trial. *Acta Obstet Gynecol Scand*. 2018;97:861-871.
46. Silva-Jose C, Sánchez-Polán M, Díaz-Blanco Á, et al. Influence of a virtual exercise program throughout pregnancy during the COVID-19 pandemic on perineal tears and episiotomy rates: a randomized clinical trial. *J Clin Med*. 2021;10:5250.
47. Yekefallah L, Namdar P, Dehghankar L, Golestaneh F, Taheri S, Mohammadkhaniha F. The effect of yoga on the delivery and neonatal outcomes in nulliparous pregnant women in Iran: a clinical trial study. *BMC Pregnancy Childbirth*. 2021;21:351.
48. Garnæs KK, Nyrnes SA, Salvesen KÅ, Salvesen Ø, Mørkved S, Moholdt T. Effect of supervised exercise training during pregnancy on neonatal and maternal outcomes among overweight and obese women. Secondary analyses of the ETIP trial: a randomised controlled trial. *PloS One*. 2017;12:e0173937.
49. Ko PC, Liang CC, Chang SD, Lee JT, Chao AS, Cheng PJ. A randomized controlled trial of antenatal pelvic floor exercises to prevent and treat urinary incontinence. *Int Urogynecol J*. 2011;22:17-22.
50. Wang X, Xu X, Luo J, Chen Z, Feng S. Effect of app-based audio guidance pelvic floor muscle training on treatment of stress urinary incontinence in primiparas: a randomized controlled trial. *Int J Nurs Stud*. 2020;104:103527.
51. Abd El fttah Ali H. Effects of prenatal perineal massage and Kegel exercise on the episiotomy rate. *IOSR J Nurs Health Sci*. 2015;4:61-70.
52. Carrascosa MDC, Navas A, Artigues C, et al. Effect of aerobic water exercise during pregnancy on epidural use and pain: a multi-Centre, randomised, controlled trial. *Midwifery*. 2021;103:103105.
53. Dieb AS, Shoab AY, Nabil H, et al. Perineal massage and training reduce perineal trauma in pregnant women older than 35 years: a randomized controlled trial. *Int Urogynecol J*. 2020;31:613-619.
54. Dönmez S, Kavlak O. Effects of prenatal perineal massage and Kegel exercises on the integrity of postnatal Perine. *Health*. 2015;7:495-505.
55. Ferreira CLM, Guerra CML, Silva AITJ, do Rosário HRV, Pereira MBFLO. Exercício na gravidez: impacto de um programa de intervenção na duração do trabalho de parto e via de parto. [Exercise in pregnancy: the impact of an intervention program in the duration of labor and mode of delivery.]. *Rev Bras Ginecol Obstet*. 2019;41:68-75.
56. Leon-Larios F, Corrales-Gutierrez I, Casado-Mejía R, Suarez-Serrano C. Influence of a pelvic floor training programme to prevent perineal trauma: a quasi-randomised controlled trial. *Midwifery*. 2017;50:72-77.
57. Salvesen KÅ, Stafne SN, Eggebø TM, Mørkved S. Does regular exercise in pregnancy influence duration of labor? A secondary analysis of a randomized controlled trial. *Acta Obstet Gynecol Scand*. 2014;93:73-79.
58. Sobhgol SS, Smith CA, Thomson R, Dahlen HG. The effect of antenatal pelvic floor muscle exercise on sexual function and labour and birth outcomes: a randomised controlled trial. *Women Birth*. 2022;35:e607-e614.
59. Mason L, Roe B, Wong H, Davies J, Bamber J. The role of antenatal pelvic floor muscle exercises in prevention of postpartum stress incontinence: a randomised controlled trial. *J Clin Nurs*. 2010;19:2777-2786.
60. Silva-Jose C, Sánchez-Polán M, Barakat R, Gil-Ares J, Refoyo I. Level of physical activity in pregnant populations from different geographic regions: a systematic review. *J Clin Med*. 2022;11:4638.
61. Bø K, Hagen RH, Kvarstein B, Jørgensen J, Larsen S. Pelvic floor muscle exercise for the treatment of female stress urinary incontinence: III. Effects of two different degrees of pelvic floor muscle exercises. *Neurourol Urodyn*. 1990;9(5):489-502.
62. Bø K, Talseth T, Holme I. Single blind, randomised controlled trial of pelvic floor exercises, electrical stimulation, vaginal cones, and no treatment in management of genuine stress incontinence in women. *BMJ*. 1999;318:487-493.
63. Dumoulin C, Cacciari L, Mayrand MH. Implementing group-based pelvic floor muscle training in clinical Practice-reply. *JAMA Intern Med*. 2021;181:406-407.
64. Brennen R, Frawley HC, Martin J, Haines TP. Group-based pelvic floor muscle training for all women during pregnancy is more cost-effective than postnatal training for women with urinary incontinence: cost-effectiveness analysis of a systematic review. *J Physiother*. 2021;67(2):105-114.
65. Von Aarburg N, Veit-Rubin N, Boulvain M, Bertuit J, Simonson C, Desseauve D. Physical activity and urinary incontinence during pregnancy and postpartum: a systematic review and meta-analysis. *Eur J Obstet Gynecol Reprod Biol*. 2021;267:262-268.
66. Luginbuehl H, Lehmann C, Koenig I, Kuhn A, Buergin R, Radlinger L. Involuntary reflexive pelvic floor muscle training in addition to standard training versus standard training alone for women with stress urinary incontinence: a randomized controlled trial. *Int Urogynecol J*. 2022;33:531-540.
67. Graham ID, Carroli G, Davies C, Medves JM. Episiotomy rates around the world: an update. *Birth*. 2005;32:219-223.
68. Chalmers TC. Problems induced by meta-analyses. *Stat Med*. 1991;10:971-980.
69. Poole C, Greenland S. Random-effects meta-analyses are not always conservative. *Am J Epidemiol*. 1999;150:469-475.
70. Henmi M, Copas JB. Confidence intervals for random effects meta-analysis and robustness to publication bias. *Stat Med*. 2010;29:2969-2983.
71. Stanley TD, Doucouliagos H. Neither fixed nor random: weighted least squares meta-analysis. *Stat Med*. 2015;34:2116-2127.
72. Lin L, Chu H, Hodges JS. Alternative measures of between-study heterogeneity in meta-analysis: reducing the impact of outlying studies. *Biometrics*. 2017;73:156-166.

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