Systematic Review

The Effects of Different Exercise Programs on the Prevention of Perinatal Depression: A Systematic Review and Meta-Analysis

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Abstract

Background: To evaluate the preventive effect of different exercise programs on perinatal depression and to provide practical suggestions to guide the maternal daily exercise plan. **Methods**: Nine electronic bibliographic databases were searched from inception until 18 January 2022. Meta-analysis of all data was performed using RevMan 5.4. **Results**: Sixteen RCTs consisting of 2233 maternal cases were included. Compared to women in the control group, women who received exercise effectively prevented maternal perinatal depression (Std. mean difference [SMD] = –1.31, 95% confidence interval [CI] –1.40 to –1.21). Prenatal exercise (SMD = –1.45), aerobic exercise (SMD = –1.78), personal exercise (SMD = –2.03), <30 minutes per single duration (SMD = –1.84), >3 times a week (SMD = –1.91) was the best preventive measure of maternal depression. **Conclusions**: Exercise can effectively improve the mental health status of perinatal pregnant women, and different exercise start time, exercise content, exercise frequency, exercise form, and single duration of exercise can improve depressive symptoms differently. It is recommended that pregnant women begin from the prenatal period of personal aerobic exercise 3 times a week, each exercise lasting less than 30 minutes, and adjust appropriately according to their own physical conditions.

Keywords: exercise; perinatal depression; preventive effect; meta-analysis

1. Introduction

Perinatal depression (PDN) is a psychiatric disorder that occurs during pregnancy (prenatal depression) or within one year after delivery (postpartum depression (PPD)) [1,2]. The prevalence of PDN ranges from 11.4% to 17.4% worldwide [3,4]. PDN can directly affect maternal health and pregnancy outcomes [5]. Therefore, preventing the occurrence of PDN becomes particularly important.

At present, the primary methods to treat PDN include drug treatment and psychotherapy; however, there are side effects of drug intervention, and the cost of psychotherapy is relatively high. Exercise intervention has the advantage of low cost and is easy to complete, attracting wide attention from scholars at home and abroad [6]. Studies have shown that exercise intervention can relieve PDN; however, existing research primarily focuses on the effect of exercise on improving the symptoms of perinatal women with a history of depression [7]. There are few reports of perinatal women with no history of depression before pregnancy being able to prevent depression by exercising during the perinatal period. This study conducts a meta-analysis of perinatal exercise research and reveals the prevention effect of exercise on PDN, analyzes the influence of different exercise programs on PDN, and explores an ideal exercise plan to prevent PDN.

2. Materials and Methods

The systematic review and meta-analysis were conducted following the PRISMA guidelines [8] and registered at the International Prospective Register of Systematic Reviews (CRD42022314645).

2.1 Search Strategy

We systematically searched five English databases (PubMed, Web of Science, The Cochrane Library, EBSCO, and APA/PsycNET) and four Chinese databases (CNKI, CBM, WanFang, and VIP) from their inception to 18 January 2022. Three groups of terms were combined according to the syntax rules for each database: (1) Perinatal period-related terms, including puerpera, pregnancy, expectant mother, antenatal, postpartum period, puerperium, postpartum care, postnatal care, and perinatal care; (2) exercise-related terms, including sports, exercise, physical activity, movement behavior, yoga, walking, running, jogging, swimming, aerobic, anaerobic, and pilates; (3) depression-related terms, including depressive symptoms, depression, depressive disorder, PDN, baby blues, mental health, psychological health, psychological function, mental function, and psychological. In addition to the digital bibliographic databases, we searched the Chinese clinical trial registry and World Health Organization (WHO) international clinical trial registry for unpublished trials relevant to this systematic review.
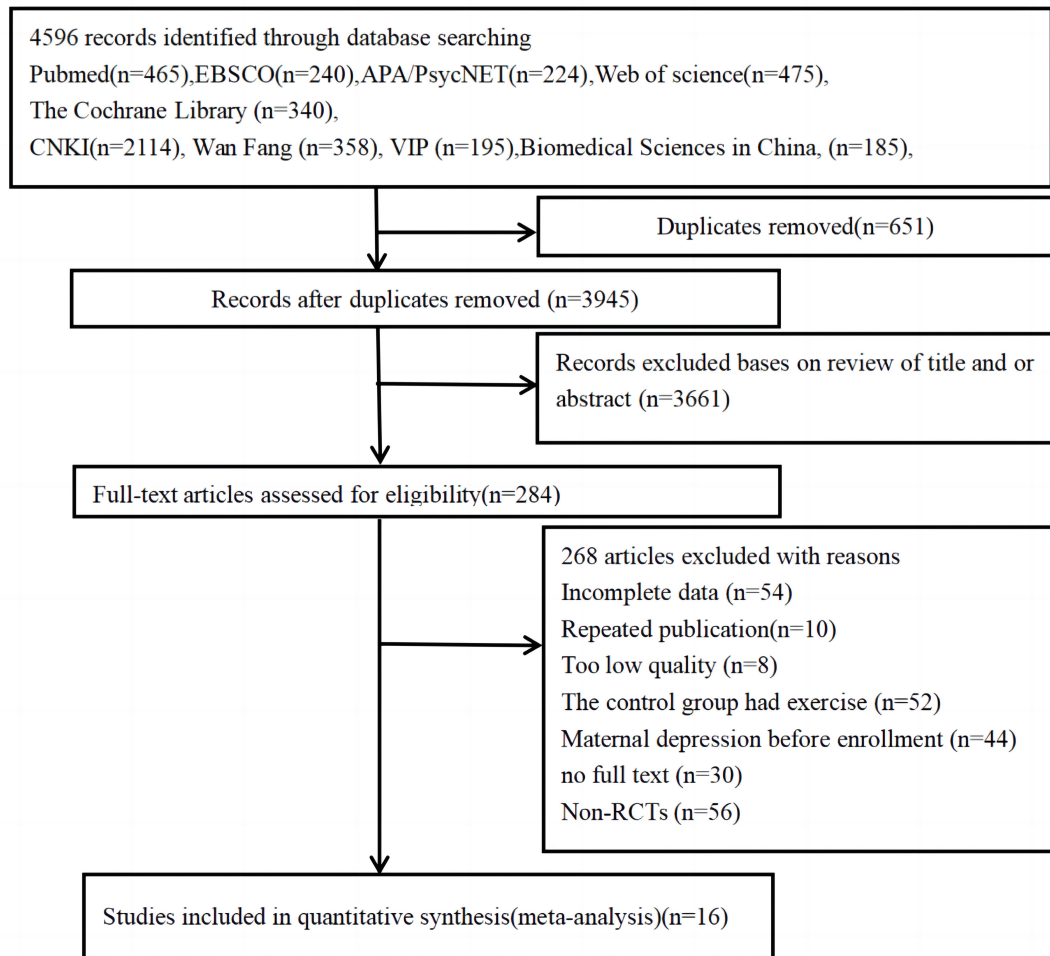
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Fig. 1. Database search flow diagram.

2.2 Inclusion and Exclusion Criteria

2.2.1 Types of Participants

(1) Pregnant women and women within one year after delivery were included. (2) Patients with psychiatric disorders were excluded. (3) Pregnant women with a history of depression, that is, if they met one of the following criteria, were excluded: ① score ≥13 on the Edinburgh Postpartum Depression Scale (EPDS); ② score ≥54 on the Self-rated Depression Scale (SDS); ③ score ≥11 on Hospital Anxiety and Depression Scale (HADS); ④ Health-related Quality of Life (HRQoL) Questionnaire: score ≤42 indicates the risk of depression; ⑤ score ≥15 on Center for Epidemiological Survey, Depression Scale (CES-D).

2.2.2 Intervention Group

The women in the intervention group underwent regular exercise for a fixed period. The various sub-elements analyzed included exercise start time, exercise content, exercise frequency, practice form, and duration of exercise.

2.2.3 Control Group

The women in the control group received routine care, including psychological care and health education, but did not practice any form of exercise intervention.

2.2.4 Outcome Measures

The primary outcome measure was depression symptoms, determined using the following scales: Edinburgh Postpartum Depression Scale (EPDS) ≥13 points, Self-rated Depression Scale (SDS) ≥54 points, Hospital Anxiety and Depression Scale (HADS) ≥11 points, Center for Epidemiological Survey, Depression Scale (CES-D) ≥15 points, and Health-related Quality of Life (HRQoL) Questionnaire ≤42 points.

2.2.5 Types of Study

Randomized control trials (RCTs) were included.

Table 1. Characteristics of 16 included RCTs.

First author	Particular year	Country/ region	Age		Sample capacity		Exercise programs					Outcomes
			I	C	I	C	Start time	Content	Frequency	Duration	Form	
Gao [14]	2021	China	27.92 ± 2.81	28.63 ± 2.80	19	12	postpartum	yoga	≤3 times/week	>60 min	personal	①
Yan [12]	2021	China	36.65 ± 1.88	36.85 ± 2.63	100	106	prenatal	dance gymnastics	>3 times/week	30–60 min	combination	①
Wu [19]	2019	China	32.24 ± 4.58	32.6 ± 5.05	34	35	prenatal	aerobic exercise	>3 times/week	30–60 min	combination	④
Hu [15]	2020	China	25.16 ± 3.47	25.08 ± 3.35	49	49	prenatal	aerobic exercise	>3 times/week	>60 min	combination	④
Tang [25]	2014	China	23~30		100	100	prenatal	dance gymnastics	>3 times/week	<30 min	personal	④
Ming [20]	2019	China	26.35 ± 4.72	27.85 ± 5.06	80	80	prenatal	dance gymnastics	>3 times/week	N/A	personal	③
Huang [16]	2020	China	≥35		280	280	prenatal	aerobic exercise	≤3 times/week	<30 min	group	①
Fan [22]	2017	China	25.89 ± 4.17	26.02 ± 4.11	80	80	prenatal	yoga	≤3 times/week	N/A	personal	④
Li [13]	2021	China	31.15 ± 1.21	30.21 ± 1.01	40	40	prenatal	aerobic exercise	>3 times/week	N/A	N/A	④
Wang [23]	2017	China	34.33 ± 2.01	31.82 ± 1.93	30	30	prenatal	aerobic exercise	>3 times/week	<30 min	N/A	④
Rodriguez [17]	2020	Spain	32.12 ± 4.43	30.58 ± 4.75	65	64	prenatal	water sports	≤3 times/week	>60 min	group	⑤
Gallagher [18]	2019	USA	30.44 ± 6.17	27.65 ± 7.46	48	31	prenatal	yoga	≤3 times/week	<30 min	personal	③
Yi [27]	2007	TaiWan	34.17 ± 3.20	34.33 ± 3.53	31	30	prenatal	yoga	≤3 times/week	>60 min	group	②
Norman [26]	2010	Australia	29.3 ± 4.0	30.1 ± 5.3	62	73	postpartum	strength exercise	≤3 times/week	>60 min	group	①
Aguilar [21]	2018	Spain	34.52 ± 4.50	33.67 ± 5.37	16	22	prenatal	water sports	>3 times/week	>60 min	group	①
Perales [24]	2014	Spain	31.08 ± 3.39	31.66 + 3.86	90	77	prenatal	aerobic exercise	>3 times/week	30–60 min	N/A	②

Note: I: Intervention Group; C: Control Group; ① EPDS; ② CES-D; ③ HADS; ④ SDS; ⑤ HRQOL .

Table 2. Analysis of the effect of the exercise program on intervention in perinatal depress.

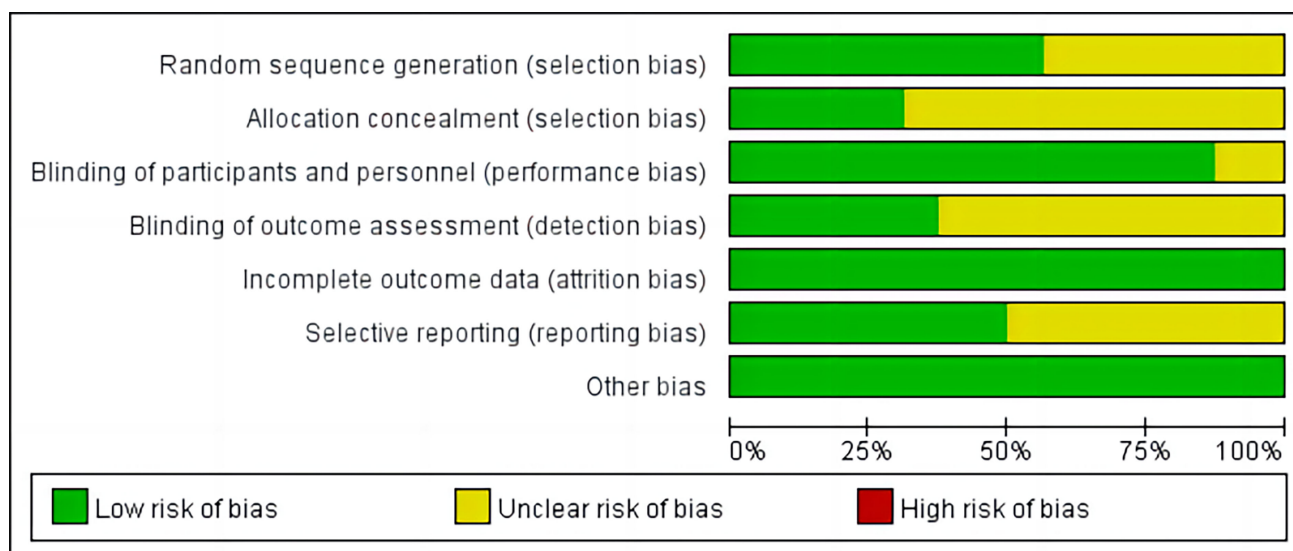| Variable	Subunit	Article offer measure	Sample size	Total number of samples	SMD	[95% CI]	Two-tailed test	
							Z	p
Start time	Antenatal	13	2006	2233	−1.45	[−1.56, −1.35]	27.16	<0.001
	Postpartum	3	227		−0.37	[−0.63, −0.10]	2.72	0.007
	Yoga	4	331		−1.34	[−1.59, −1.09]	10.55	<0.001
	Comprehensive aerobic exercise	6	1034		−1.78	[−1.94, −1.63]	23.03	<0.001
Sports content	water sports	2	167	2233	−0.03	[−0.34, 0.28]	0.20	0.840
	Dance gymnastics	3	566		−1.34	[−1.54, −1.15]	13.65	<0.001
	Power movement	1	135		−0.24	[−0.58, 0.10]	1.38	0.170
	Personal practice	7	770		−2.03	[−2.21, −1.84]	21.89	<0.001
Practice form	group practice	6	1090	2233	−1.06	[−1.19, −0.92]	15.44	<0.001
	Combination practice	3	373		−0.89	[−1.11, −0.66]	7.66	<0.001
Frequency	≤3 times/week	7	1155	2233	−1.01	[−1.91, −0.12]	2.22	0.030
	>3 times/week	9	1078		−1.91	[−2.73, −1.10]	4.59	<0.001
	<30 min	4	899		−1.84	[−2.00, −1.68]	22.78	<0.001
Duration of exercise	30–60 min	3	442	1833	−0.49	[−0.68, −0.30]	5.05	<0.001
	>60 min	6	492		−0.54	[−0.73, −0.35]	5.46	<0.001

Fig. 2. Risk of bias graph.

2.3 Study Selection

Endnote X9 software (Thomson Scientific, Philadelphia, PA, USA) was used to import all references and remove duplicates. Two independent authors evaluated the remaining studies according to inclusion and exclusion criteria first by screening the abstract and then the full text of potentially relevant papers. Any disagreements with respect to eligibility were resolved by a third independent author (H.C.H.).

2.4 Assessment of the Risk of Bias

Two authors (S.Y.M. and Y.L.) independently evaluated the risk of bias of eligible studies using the Cochrane Risk of Bias assessment tool [9], which evaluates for presence of selection bias, performance bias, detection bias, attrition bias, reporting bias, and other biases. According to the evaluation criteria, each item was classified as low, high, and unclear. Any disagreements were resolved by a third independent author (X.Y.Y.).

2.5 Data Extraction

Two authors (S.Y.M. and Y.L.) independently extracted relevant data from eligible articles, including the author, sample size, age, intervention, control, start time of exercise, exercise content, exercise frequency, practice form, single duration of exercise and results. Any differences between the two authors (S.Y.M. and Y.L.) were resolved by a third author (X.Y.Y.).

2.6 Synthesis and Analysis of Data

Statistical analysis was performed using RevMan 5.4 (Nordic Cochrane Centre, Hillerød, Denmark). Std. Mean differences (SMDs) and 95% confidence intervals (CIs) were calculated for continuous results. I^2 was adopted to assess for heterogeneity among the included studies. If there

was heterogeneity among studies ($I^2 > 50\%$), the random effect model was used for meta-analysis. If there was no significant heterogeneity among studies ($I^2 \leq 50\%$), the fixed effect model was applied. If there was significant heterogeneity, a subgroup analysis or sensitivity analysis was performed to explore the source of heterogeneity [10,11].

3. Results

3.1 Search Results

This search strategy yielded 4596 potentially relevant citations from the nine electronic databases. Following the removal of 651 duplicate records, 3661 articles were excluded based on the selection of titles and abstracts, and the remaining 284 studies were evaluated in full text. Another 268 studies were excluded from the full text evaluation and a total of sixteen studies [12–27] were included in the final analysis (Fig. 1).

3.2 Description of Included Studies

A total of 16 randomized controlled trials (RCTs) were selected for analysis. The RCTs were conducted in four countries—China, Spain, the U.S. and Australia—and published between 2010–2021. The studies included 2233 participants [12–27]: 1124 (50.3%) in the intervention group and 1109 (49.7%) in the control group. The participants' age ranged from 25 to 37. The baseline characteristics of the 16 RCTs were comparable between the two groups, and each RCT evaluated the preventive effect of exercise on PDN. A detailed summary is shown in Table 1 (Ref. [12–27]).

3.3 The Assessment of Risk of Bias

The risk of bias analysis for the included RCTs is summarized in Fig. 2. Nine RCTs described the use of the random number table method to generate random sequences,
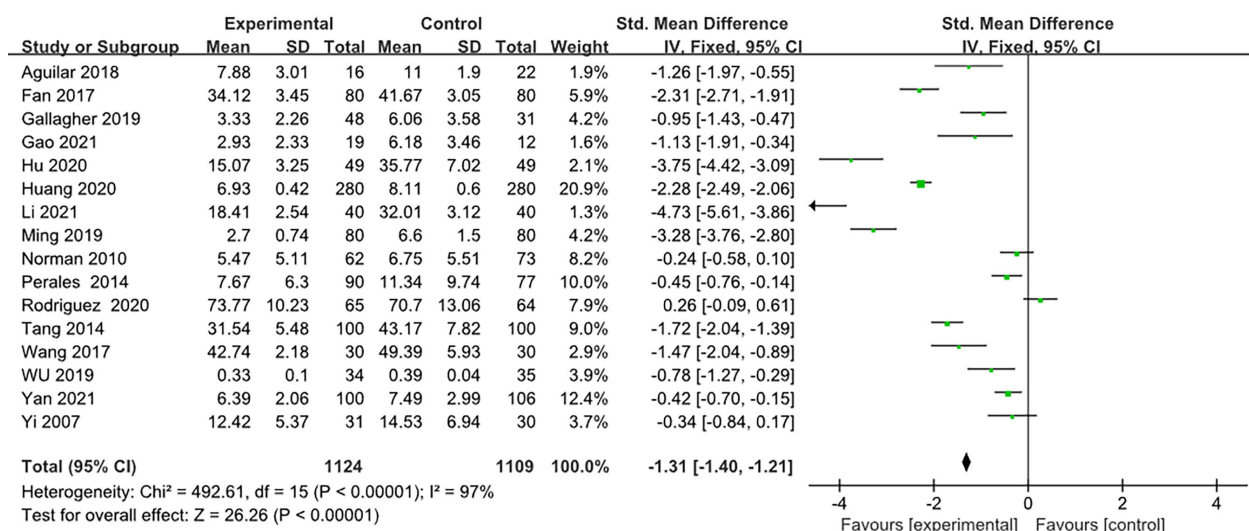
Study or Subgroup	Experimental Mean	SD	Total	Control Mean	SD	Total	Weight	Std. Mean Difference IV, Fixed, 95% CI
Aguilar 2018	7.88	3.01	16	11	1.9	22	1.9%	-1.26 [-1.97, -0.55]
Fan 2017	34.12	3.45	80	41.67	3.05	80	5.9%	-2.31 [-2.71, -1.91]
Gallagher 2019	3.33	2.26	48	6.06	3.58	31	4.2%	-0.95 [-1.43, -0.47]
Gao 2021	2.93	2.33	19	6.18	3.46	12	1.6%	-1.13 [-1.91, -0.34]
Hu 2020	15.07	3.25	49	35.77	7.02	49	2.1%	-3.75 [-4.42, -3.09]
Huang 2020	6.93	0.42	280	8.11	0.6	280	20.9%	-2.28 [-2.49, -2.06]
Li 2021	18.41	2.54	40	32.01	3.12	40	1.3%	-4.73 [-5.61, -3.86]
Ming 2019	2.7	0.74	80	6.6	1.5	80	4.2%	-3.28 [-3.76, -2.80]
Norman 2010	5.47	5.11	62	6.75	5.51	73	8.2%	-0.24 [-0.58, 0.10]
Perales 2014	7.67	6.3	90	11.34	9.74	77	10.0%	-0.45 [-0.76, -0.14]
Rodriguez 2020	73.77	10.23	65	70.7	13.06	64	7.9%	0.26 [-0.09, 0.61]
Tang 2014	31.54	5.48	100	43.17	7.82	100	9.0%	-1.72 [-2.04, -1.39]
Wang 2017	42.74	2.18	30	49.39	5.93	30	2.9%	-1.47 [-2.04, -0.89]
WU 2019	0.33	0.1	34	0.39	0.04	35	3.9%	-0.78 [-1.27, -0.29]
Yan 2021	6.39	2.06	100	7.49	2.99	106	12.4%	-0.42 [-0.70, -0.15]
Yi 2007	12.42	5.37	31	14.53	6.94	30	3.7%	-0.34 [-0.84, 0.17]
Total (95% CI)			1124			1109	100.0%	-1.31 [-1.40, -1.21]

Heterogeneity: Chi² = 492.61, df = 15 (P < 0.00001); I² = 97%
Test for overall effect: Z = 26.26 (P < 0.00001)

Fig. 3. Effects of exercise intervention on perinatal depression.

and five RCTs described the use of the sealed envelope method for allocation and concealment. Of all RCTs, 14 RCTs had their patients and staff blinded, and six RCTs had their calculation results blinded. The results of 16 RCTs were considered complete and confirmed as low risk. Eight selective reporting for those RCTs were determined as unclear risk. 16 RCTs had a low risk in other possible biases.

4. Meta-Analysis

4.1 Preventive Effect in the Intervention Group and the Control Group.

16 RCTs were compared between the intervention group and the control group to evaluate the preventive effect of different exercise programs on PDN. The total heterogeneity test result was >50% among the included RCTs, so a random-effects model was used for meta-analysis. The results suggest that the remission of the depressive symptoms of women in the perinatal period after regular exercise of the intervention group was better than that of the control group, and the results were statistically significant (SMD = –1.31, 95% CI –1.40 to –1.21, $p < 0.001$) (Fig. 3).

In order to explore the reasons for the high heterogeneity, through the sensitivity analysis by excluding the included studies one by one, the overall effect value did not change significantly during the one-by-one exclusion process, suggesting less bias caused by individual studies. Therefore, the relevant subgroup analysis was carried out.

4.2 Exercise Mode

Five sub-elements of the exercise intervention were analyzed: exercise start time, exercise content, exercise frequency, practice form, and duration of exercise.

4.2.1 Exercise Start Time

The results showed that both prenatal and postpartum exercise effectively prevented depression symptoms ($p < 0.01$). The effect of the antenatal intervention (SMD = –1.45, 95% CI = –1.56 to –1.35) was more pronounced than the effect of the postpartum intervention (SMD = –0.37, 95% CI = –0.63 to –0.10) (Table 2).

4.2.2 Exercise Content

The types of exercise in the 16 RCTs included yoga, aerobics, dance gymnastics, water sports, and strength exercise. The effect of all types of exercise on depression was evaluated: yoga (SMD = –1.34, 95% CI = –1.59 to –1.09), aerobics (SMD = –1.78, 95% CI = –1.94 to –1.63), and dance gymnastics (SMD = –1.34, 95% CI = –1.54 to –1.15) had statistically significant effect on depression ($p < 0.001$). Water sports (SMD = –0.03, 95% CI = –0.34 to 0.28) and strength exercise (SMD = –0.24, 95% CI = –0.58 to 0.10), $p > 0.05$. The results showed that aerobics was the best exercise (Table 2).

4.2.3 Exercise Frequency

The exercise frequency was classified as ≤3 times a week and >3 times a week. The effect of exercise frequency on depression was as follows: ≤3 times a week: SMD = –1.01, 95% CI = –1.91 to –0.12); >3 times a week: SMD = –1.91, 95% CI = –2.73 to –1.10 (Table 2).

4.2.4 Duration of Exercise

The duration of a single exercise was divided into <30 min/session, 30–60 min/session, and >60 min/session. Exercise duration had the following effect on depression: <30 min/session: SMD = –1.84, 95% CI = –2.00 to –1.68; 30–60 min/session: SMD = –0.49, 95% CI = –0.68 to –0.30; and >60 min/session: SMD = –0.54, 95% CI = –0.73 to –0.35 (Table 2).

4.2.5 Practice Form

The practice form mainly included personal practice at home, group practice, and combination practice. Practice form effected depression as follows: personal exercise: SMD = –2.03, 95% CI = –2.21 to –1.84; group exercise: SMD = –1.06, 95% CI = –1.19 to –0.92; combined exercise: SMD = –0.89, 95% CI = –1.11 to –0.66 ($p < 0.001$) (Table 2).

5. Discussion

5.1 Main Findings

Related research has focused on intervention experiments and review analysis, This study by systematically reviewing 16 RCTs, evaluated and compared the effect of different exercise programs on the prevention of PDN. Evidence-based results showed that all exercises were effective in preventing PDN symptoms. Dipietro *et al*. [28] found that physical exercise is as effective as psychoactive drugs on the prevention of PDN.

5.2 Interpretation

The findings showed that prenatal exercise had a better effect in preventing PDN than postpartum exercise. According to related studies, the incidence of PPD is highly correlated with the presence of depression during pregnancy [29], indicating that prenatal depression is the strongest predictor of PPD. Exercise during pregnancy reduces prenatal depression and, consequently, the occurrence of PPD [30]. Thus, prenatal exercise is of great value in preventing PDN and promoting fetal development and smooth delivery [31].

Yoga, aerobics, and dance gymnastics effectively prevented depression, with aerobics achieving the best results. Based on the change in maternal body function and risks associated with exercise, walking and Baduanjin are the most common exercises for pregnant women [32]. These exercises promote the blood circulation and metabolism of the maternal body, improve cardiopulmonary function, and are conducive to fetal delivery and maternal body recovery [33].

To avoid fatigue and stress [34], pregnant women should not exercise too frequently or for a longer duration. Evidence-based results found that exercising >3 times a week for <30 min/session was the most effective in preventing depression. This finding corresponds with the American College of Obstetricians and Gynecologists' (ACOG) recommendations for exercise for pregnant and postpartum women [35]. Related studies have suggested that continuous exercise for >45 min can threaten maternal safety by raising fetal body temperature, and advise pregnant women to rest every 15 min while exercising [36].

Personal exercise programs are more effective in improving PDN than other forms of exercise. This may be related to the advantages of individual exercise, which is not limited by time, place, and economy. However, compared to group practice, personal practice lacks the necessary exercise monitoring and technical support, and pregnant women tend to abandon the exercise programs. Research shows that only 23.6% of pregnant women in China insist on exercising, and the main reasons for not exercising include insecurity, lack of a strong will, and no companionship [37]. It is suggested that the rapidly advancing internet technology should be used to establish digital maternal sports management platforms and WeChat groups to develop personal maternal exercise programs [38] to prevent PDN.

5.3 Strengths and Limitations

This study analyzes only RCTs and provides strong evidence for evaluating the preventive effect of different exercise programs on PDN. However, there may be clinical heterogeneity affecting the results; more high-quality studies are required to verify the reliability of the results.

5.4 Implications for Practice and Research

Exercise is a low-cost strategy. This study summarizes the current situation of the preventive effect of different exercise programs on PDN, providing a basis for inspection for future clinical trials. Before designing exercise programs for pregnant women, medical personnel should be aware of their exercise history, including exercise duration and frequency.

6. Conclusions

To sum up, exercise is effective in preventing PDN. It is recommended that pregnant women follow a personalized aerobics exercise regime of <30 min for three times a week to effectively prevent the occurrence of PDN.

Future research will be expanded in the following aspects: (1) to improve the pertinence and adaptability of exercise intervention programs, that is, to optimize exercise programs and conduct precise training according to their pregnancy cycle, postpartum recovery cycle, maternal age and related complications. (2) Strengthen the monitoring of exercise intervention, that is, in view of the special changes of maternal physical function, heart rate and psychological changes, strengthen the monitoring of the exercise process from the aspects of maternal subjective perception, maximum heart rate and maximum oxygen consumption, so as to avoid the risk of maternal exercise to the maximum extent.

Author Contributions

IMR Press

Ethics Approval and Consent to Participate

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Conflict of Interest

Supplementary Material

Supplementary material associated with this article can be found, in the online version, at https://doi.org/10.31083/j.ceog5001009.

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