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Original Paper

A Meta-analysis of the Effect of Aerobic Exercise during Pregnancy on Maternal Labor Pains

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Abstract

Objective: *Systematically evaluate the effect of prenatal aerobic exercise on maternal labor pain.*

Methods: *Systematic search: Cochrane Library, Embase, Web of science, PubMed, China Biomedical Database, China Knowledge Network (CNKI), Wanfang Data Knowledge Service Platform, Wipu.com, etc., and the time limit of the search was from the establishment of the library to June 2024, and randomized controlled trials (RCTs) related to the purpose of the study were collected and included by the after 2 researchers independently screened the literature, extracted information and evaluated the risk of bias of the included studies, RevMan5.3 software was applied to analyze the data.*

Results: *A total of 10 RCTs were included, including 1144 cases of labor. Meta-analysis showed that prenatal aerobic exercise was effective in relieving labor pain level throughout the entire laboring process, with an MD [95% CI] of -1.80 [-2.75,-0.84], (P<0.05), when compared with the control group. However, the effect was not significant in relieving 3-4 cm of uterine opening and when the uterine opening was more than 4 cm.*

Conclusion: *Current evidence suggests that prenatal aerobic exercise relieves labor pain levels throughout labor, but is not significantly effective in relieving uterine opening of 3-4 cm and 4 cm or more. Due to the limitations of the number and quality of included studies, the above conclusions need to be verified by more high-quality studies.*

Keywords

aerobic exercise, exercise, maternal, labor pain, meta-analysis

1. Introduction

Childbirth is an almost inevitable physiological process for women, but the process of childbirth can cause persistent and severe pain for women, which not only brings pain and fear to women, but also has adverse effects on both mothers and fetuses.[1] According to relevant studies, appropriate aerobic exercise during pregnancy can effectively reduce pain during labor, increase the rate of vaginal delivery, shorten the duration of labor and reduce postpartum hemorrhage.[2] Because of the fear of labor pain, most women choose cesarean section, which has led to the high rate of cesarean section in China. According to the World Health Organization's (WHO) 2010 report[3] on a sample survey of delivery methods in nine Asian countries, China's CSR reached 46.2%, the highest in Asia. In addition, the fear of labor pain is more likely to induce anxiety, tension and other negative emotions, prolonging the duration of labor and affecting the outcome of mothers and babies.[4] The Canadian Society of Obstetricians and Gynecologists guidelines[5] and the American College of Obstetricians and Gynecologists[6] recommend that all pregnant women without medical contraindications should engage in physical activity. Studies have shown [7] moderate exercise during pregnancy increases blood levels of endorphins, which can relieve pain during labor and delivery, and that exercise can help prevent and treat gestational diabetes and pre-eclampsia, as well as reduce cesarean section rates, instrumental deliveries, and improve postpartum recovery rates. Mothers will drive the fetus to do activities in the process of aerobic exercise, which strengthens the emotional communication between mothers and fetuses in the process of interaction, and, to a certain extent, is conducive to the development of fetal bones and organs, and improves the immune system.[8]

However, influenced by traditional concepts, most women during pregnancy have low participation and awareness of physical exercise. They think that they can't do too much exercise during pregnancy, otherwise it will lead to the serious consequences of miscarriage.[9] In addition, the pregnancy reaction in the early stages of pregnancy causes weakness and fatigue, which greatly reduces the amount of exercise. This is not only detrimental to the growth and development of the fetus, but also increases the rate of abnormal deliveries. Studies have shown that[10] that up to 60% of women are sedentary during pregnancy and only 15% of women achieve the minimum recommended level of activity during pregnancy. Therefore, this study conducted a meta-analysis of published studies on the effects of prenatal aerobic exercise on maternal labor pain to investigate the effects of prenatal exercise on labor pain, with the aim of providing evidence for clinical practice.

2. Information and Methodology

2.1 Source Search

English databases: Embase, Cochrane Library, PubMed, Web of Science and other published foreign language literature, search for "Aerobics exercise" (OR "yoga" OR "pilates" OR "water exercise" OR "walking" OR "walking"). yoga "OR "pilates "OR "water exercise "OR "walking "OR "breathing exercise") AND "labor pain " (OR "Pain, Labor" OR "Obstetric Pain"). Chinese databases were

searched: China Knowledge, Wipo, Wanfang, and China Biomedical Literature Database (CBLD) for "aerobic exercise" (OR "yoga" OR "pilates"), "exercise walking" OR "breathing exercise" OR "labor pain" (OR "Pain, Labor" OR "Obstetric Pain"). "OR "walking" OR "water exercise" OR "breathing exercise") AND "labor pains" (OR "labor outcomes"). A mixed combination of subject terms and free words, combined with literature tracing, was used to supplement the relevant literature to ensure a complete search rate, and all searched literature started and ended from the time of database construction to June 2024.

2.2 Inclusion and Exclusion Criteria

Literature Inclusion Criteria (1) Study subjects: pregnant women with a singleton, full-term pregnancy, normal obstetric indicators; no previous exercise experience; and age ≥18 years old; (2) Interventions: the experimental group was provided with exercise interventions in different forms, times, cycles, and frequencies; the control group was provided with routine prenatal care and health education only, but did not impose any exercise interventions; (3) Type of study: a Randomized controlled trial (RCT); (4) Outcome indicators: the degree of labor pain after the intervention (the degree of labor pain during the entire labor process, the degree of labor pain from regular contractions to the opening of the uterus by 3 cm, the degree of pain when the uterus opens by 3-4 cm, and when the uterus opens by more than 4 cm).

Exclusion criteria (1) Pregnant women with other pregnancy comorbidities; (2) Randomized controlled trials (RCTs) were not used in the experimental design; (3) Repeatedly published, review-type, or data-absent literature; and (4) Literature for which full text was not available.

2.3 Literature Screening and Data Extraction

The literature was independently screened according to the inclusion and exclusion criteria, and the data were extracted after reading the full text of the data, which mainly included the authors and the year of publication, the country, the subjects of the study, the sample size, the interventions in the control group and the experimental group, the frequency of the interventions, the duration of the interventions, and the measurement tools.

2.4 Quality Evaluation

The quality evaluation of the literature was done independently by two researchers according to the Cochrane Handbook, which included the generation of randomized sequences, allocation concealment, blinding, completeness of data, possibility of reporting bias, and other sources of bias. In case of disagreement, a third researcher was consulted and a consensus was reached through discussion to form the final literature quality assessment.

2.5 Statistical Analysis

Meta-analysis of the data was performed using RevMan 5.3 software. Analyses were performed by MD for those that used the same measurement tools and were continuous outcome variables, and vice versa, by SMD. Heterogeneity was assessed by Q-test and combined with I^2 A fixed-effects model was used if $I^2 \leq 50\%$ and $P \geq 0.05$between studies; otherwise, a random-effects model was used. $P<0.05$ was considered a statistically significant difference.

3. Result

3.1 Literature Search and Screening

Firstly, a total of 1141 articles were retrieved from Chinese and English databases, including 203 articles in Chinese and 938 articles in English, 907 articles were obtained after eliminating duplicates using Note Express software, and 97 articles were obtained by reading the titles and abstracts, and a total of 10 randomized controlled studies were finally included. A total of 10 randomized controlled studies were included, of which 3 were in Chinese[11-13] and 7 were in English.[7-16] The process of literature search and screening is shown in Figure 1.

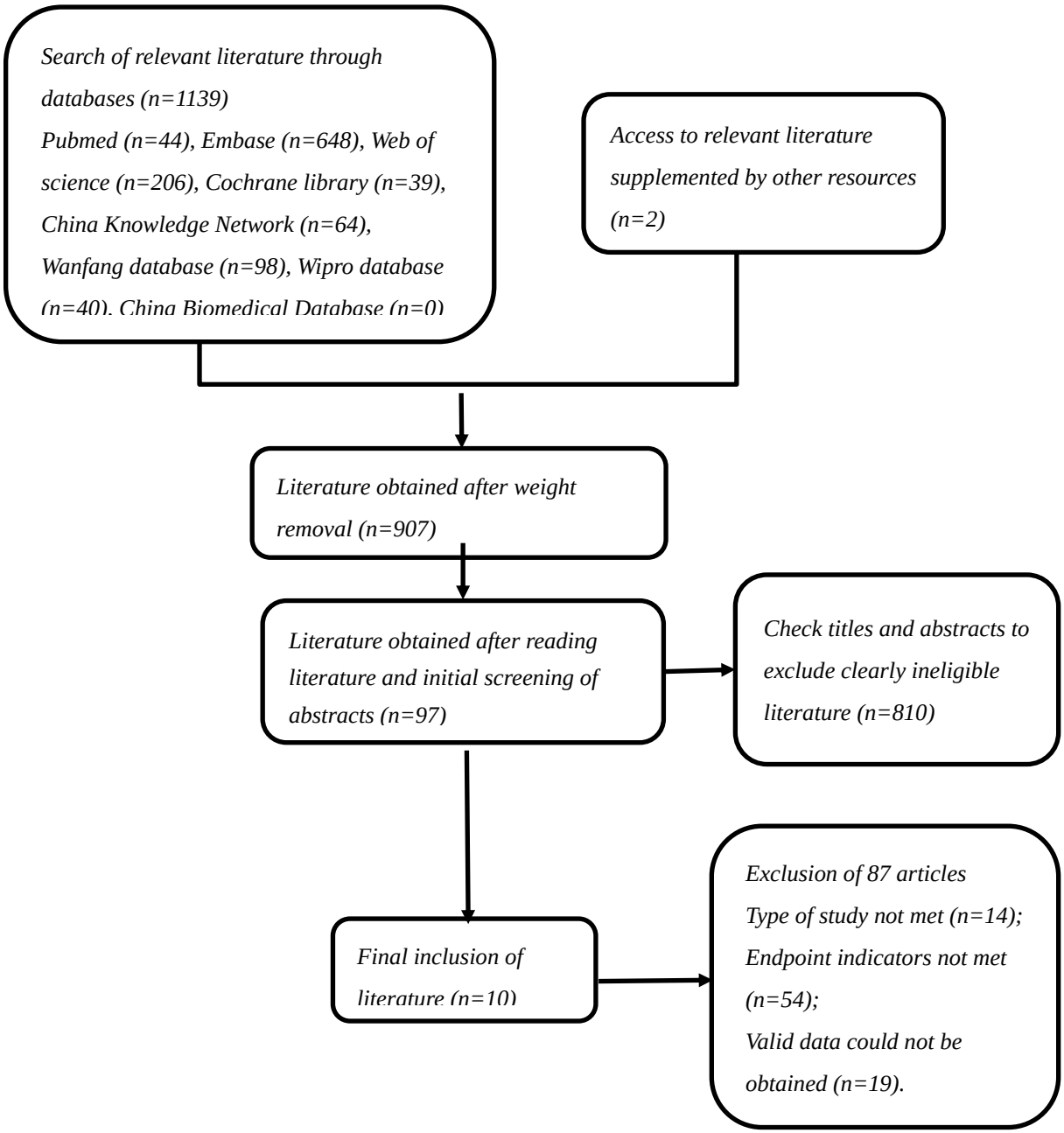

Figure 1. Literature Search and Screening Process

3.2 General Characteristics of Included Studies

A total sample size of 1144 cases was obtained from 10 papers, including 563 cases in the experimental group and 581 cases in the control group, and all the included papers were of medium to high quality. The general characteristics of the included literature are shown in Table 1; the quality assessment is shown in Figure 2.

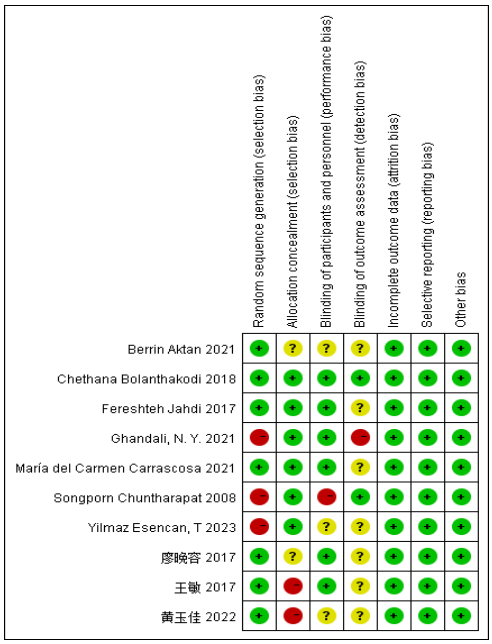

Figure 2. Literature Quality Assessment

Table 1. General Characteristics of the Literature

Author (Year)	States	Research object (age/week of pregnancy)	Sample size (T/C)	Intervention (intervention/control group)	Intervention time	Intervention frequency	Measuring tools	Jadad Scale Total Score
Berrin (2021)	India	maternal (>35 years old) 16-24w	43 (21/22)	Pilates + Birth Training/ No exercise	12 weeks	Pilates training: 2times/week,1h/time+4 weeks labor training(1times/week,1h/time)	VAS	4
Bolanthakodi (2018)	United States	maternal (20-35 years old) 30w	125 (67/58)	Yoga/routine prenatal care	7 weeks	3 times/week, 30min/time	NPIS	7
Carrascosa (2021)	Scotland	maternal (18-40 years old) 14-20w	286 (145/141)	Routine prenatal care + water aerobics/routine prenatal care	20 weeks	3 times/week, 45min/time	VAS	7

Chuntharapat (2008)	United Kingdom	maternal (18-35 years old) Week of pregnancy unknown	66 (33/33)	Yoga/routine prenatal care	6 weeks	1 time/week 60min/time	PBOS	7
Ghandali (2021)	United Kingdom	maternal (23-30 years old) 26-28w	103 (51/52)	Pilates training /no exercise	8 weeks	2 times/week, 35min/time	VAS	5
Fereshteh (2017)	United Kingdom	maternal (18-35 years old) 26w	55 (28/27)	Prenatal Yoga / Routine Prenatal Care	12 weeks	3 times/week, 1h/time	VAS	5
Yilmaz (2023)	United States	maternal Age unknown 20-36w	90 (30/60)	Routine Prenatal Care + Yoga + Meditation / Routine Prenatal Care	10 weeks	2times/week, 60min/time	VAS	4
Huang Yujia (2022)	China	maternal (26-35 years old) Week of pregnancy unknown	90 (45/45)	Yoga exercise instruction/regular pregnancy checkups	not quite clear	1time/day, 60min/time	VAS	4
Liao Wanrong (2017)	China	maternal (25-32 years old) 36-40w	86 (43/43)	Yoga exercise instruction during pregnancy/ routine antenatal instruction (routine labor and diet instruction)	not quite clear	First month: 4 times/week, 60min/time, Second month: 2 times/week, 60min/time	VAS	4
Wang Min (2017)	China	maternal (22-32 years old) 13w	200 (100/100)	Yoga training/routine prenatal checkups	not quite clear	1time/week, 60min/time	VAS	4

Note. T: test group; C: control group; VAS: Visual Analog Scale; PBOS: Pain Behavioral Observation Scale; NPIS: Numeric Pain Intensity Scale

3.3 Meta-analysis Results

3.3.1 The Effect of Prenatal Aerobic Exercise on Labor Pain Levels of Women throughout Labor

There are 4 papers reporting the effect of prenatal aerobic exercise on labor pain levels of women throughout labor.[12, 13, 15, 17] After the heterogeneity test (I^2 =90%, P<0.05), indicating a high degree of heterogeneity, we analyzed the random-effects model, and the combined effect sizes were found to be: MD [95% CI] of -1.80 [-2.75,-0.84], (P<0.05), indicating that prenatal aerobic exercise had a significant effect on relieving the degree of labor pain, and the difference was statistically significant compared with that of the control group (Figure 3).

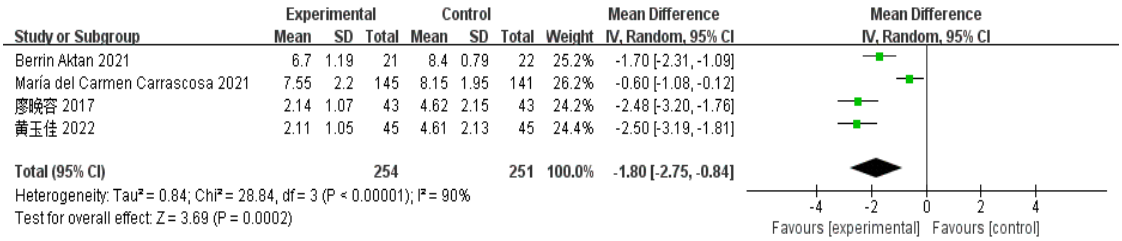

Figure 3. Forest Plot of the Effect of Prenatal Aerobic Exercise on the Degree of Labor Pain throughout the Labor Course of the Mother

3.3.2 The Effect of Prenatal Aerobic Exercise on the Level of Pain when the Uterine Opening is 3-4 cm.

There are three papers reporting the effect of prenatal aerobic exercise on the level of pain when the uterine opening is 3-4 cm.[16, 18, 20] After the heterogeneity test (I^2 =95%, P<0.05) indicating high heterogeneity, so the random effects model analysis was applied to obtain, the combined effect sizes were found to be: the SMD [95% CI] was -0.61 [-1.81,0.60], (P=0.32), indicating that the prenatal aerobic exercise was not effective in relieving the level of pain when the uterine opening was 3-4 cm wide, and the difference was not statistically significant compared with the control group (Figure 4).

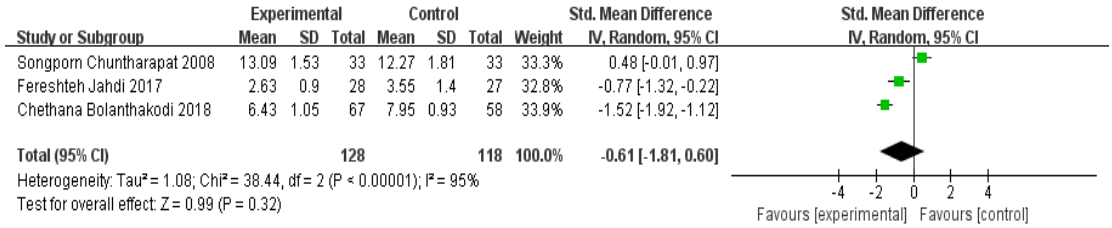

Figure 4. Forest Plot of the Effect of Prenatal Aerobic Exercise on the Level of Pain at 3-4 cm of Maternal Uterine Opening

3.3.3 The Effect of Prenatal Aerobic Exercise on the Level of Pain when the Uterine Opening is more than 4cm.

There were 4[11, 16, 19, 20] literature reported the effect of prenatal aerobic exercise on the degree of pain at the time of maternal uterine opening of more than 4 cm, after the heterogeneity test, (I^2 =98%, P<0.05) indicating a high degree of heterogeneity, so the random effects model analysis was applied to obtain, the combined effect sizes were found to be: SMD [95% CI] -0.87 [-2.11,0.38], (P=0.17), indicating that the prenatal aerobic exercise was not effective in relieving the level of pain in labor when the uterine opening was more than 4 cm wide, and the difference was not statistically significant compared to the control group (Figure 5).

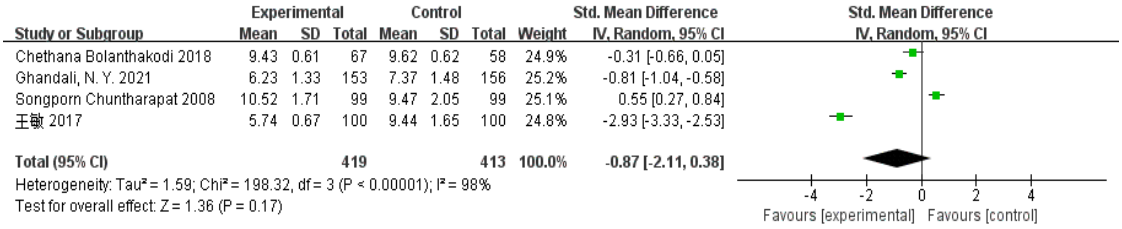

Figure 5. Forest Plot of the Effect of Prenatal Aerobic Exercise on the Level of Pain when the Uterus Opens more than 4 cm in Labor

Since only one[14] article in the literature on the effect of prenatal aerobic exercise on relieving the level of labor pain during the latency period, it was not combined and only qualitative description of the results was done, Yilmaz Esencan[14] The results of the study showed that prenatal aerobic exercise was effective in relieving labor pain during the latency period, and the difference was statistically significant compared to the control group. However, the conclusions drawn through a few studies may be somewhat biased.

3.3.4 Analysis of Bias

As can be seen from the funnel plot of publication bias (Figure 6), the 10 studies showed good symmetry, indicating that there was no publication bias among the studies, and all of them were suitable for inclusion in this meta-analysis.

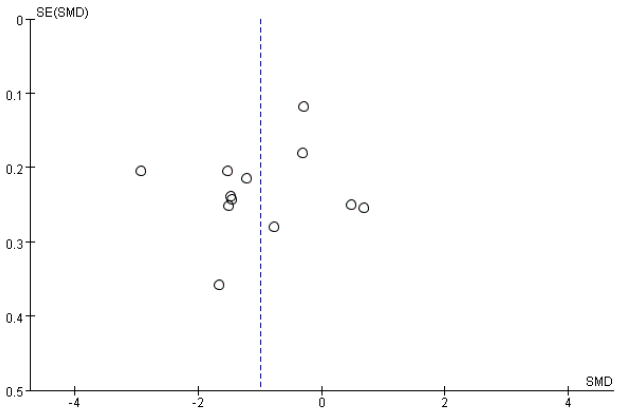

Figure 6. Funnel Plot of Publication Bias Test for Included Studies

Results of subgroup analyses due to the large heterogeneity among the studies, and in order to explore the sources of heterogeneity, the frequency of exercise interventions and the duration of a single intervention were analyzed as subgroup variables (Table 2).

3.4 Frequency of Intervention

A total of 254 cases were included, and after the test of heterogeneity, there was high heterogeneity between the effect sizes of the two groups (I^2 =90%,P<0.05), indicating that the frequency of exercise interventions was the main factor influencing the degree of labor pain throughout the labor and delivery

process, and that the effect sizes of the frequency of exercise≤2 times/week versus >2 times/week on influencing the degree of labor pain throughout the labor were respectively MD[95% CI] -2.08 [-2.86,-1.30],(P<0.05),I^2 =65%, and MD[95% CI] -1.52 [-3.36,0.32],(P>0.05),I^2 =94%. Where exercise frequency≤2 times/week was the largest effect size influencing the level of labor pain throughout the labor course. Among the intervention frequency subgroups, Exercise frequency≤2 times/week had a significant effect on relieving maternal labor pain throughout labor, and heterogeneity between studies decreased, suggesting that exercise frequency≤2 times/week was not a source of heterogeneity. Exercise frequency >2 times/week was not effective in relieving labor pain throughout labor, the difference was not statistically significant compared to the control group, and the heterogeneity between studies did not decrease, suggesting that exercise frequency >2 times/week was a source of large heterogeneity.

3.5 Duration of Single Intervention

A total of 254 cases were included, and after the heterogeneity test, there was high heterogeneity between the effect sizes of the two groups (I^2 =90%,P<0.05), suggesting that the duration of a single intervention was the main factor influencing the level of labor pain throughout the labor. The effect sizes of intervention on the degree of labor pain throughout the labor and delivery for the 60-min group MD[95%CI] -2.17[-2.56,-1.79] (P<0.05), I^2 =49%; and the 45-min group MD[95%CI] -0.60[-1.08,-0.12], (P<0.05), there was only one group in the 45-min group, respectively. Therefore, no comparison between groups was made. It can be seen that the 60min group achieved the greatest intervention effect in relieving maternal labor pain. In the single intervention duration subgroup, the 60min group had a significant effect on relieving labor pain throughout the entire labor period, and the heterogeneity between studies decreased, indicating that a single intervention duration of 60min was not a source of heterogeneity.

Table 2. Analysis of the Effect of Moderating Variables in Aerobic Exercise to Intervene in Maternal Labor Pain Effect

moderator variable	heterogeneity		subgroup	Number of documents	sample size (statistics)	MD [95% CI]	two-tailed test	
	P	I^2					Z	P
Intervention frequency	<0.00001	90%	≤2 times/week	2	66	-2.08[-2.86,-1.30]	5.21	<0.00001
			>2 times/week	2	188	-1.52 [-3.36,0.32]	1.62	0.11
Duration of single intervention	<0.00001	90%	60min	3	109	-2.17 [-2.56,-1.79]	11.05	<0.00001
			45min	1	145	-0.60[-1.08,-0.12]	2.44	<0.00001

4. Discussion

This study used Meta-analysis based on 10 included studies to clarify the intervention effect of prenatal aerobic exercise on maternal labor pain. The results showed that after the intervention of prenatal aerobic exercise, the effect on relieving maternal labor pain throughout the labor process was significant. This is similar to the findings of Zhao Shuliang et al.[21]. Aerobic exercise during pregnancy can increase oxygen intake, improve lung capacity, enhance cardiopulmonary function, and put the body in a state of deep relaxation, thus reducing the tension and anxiety during labor and achieving the purpose of reducing pain[22]. This study also found that the effect of prenatal aerobic exercise on the degree of labor pain throughout the labor process was related to the frequency of intervention and the duration of a single intervention. Exercise frequency ≤2 times/week (MD [95% CI] -2.08 [-2.86,-1.30]) had the greatest effect on the level of labor pain throughout the labor process compared to >2 times/week (MD [95% CI] -1.52 [-3.36,0.32]). This is similar to Liao Qunying's[23] findings. According to the American College of Obstetricians and Gynecologists (ACOG) guidelines[6] it is recommended that pregnant women try to maintain at least 30 min/exercise session or more most of the time each week, and the maternal benefits of exercise during pregnancy have been well documented[7]. Exercise during pregnancy increases flexibility and improves cerebrospinal fluid circulation, which has been shown to increase the release of endorphins and 47-hydroxytryptamine[24]. And endorphins and 47-hydroxytryptophan have the ability to increase pain perception thresholds[25]. However, the effect was not significant on labor pain levels for 3-4 cm versus more than 4 cm of cervical opening. Although the reasons for the differences in the results of the study are multifactorial, the factor of cultural background should not be ignored, as it is possible that the subjects included were from different countries with differences in racial and economic and cultural backgrounds, the period of intervention and differences in measurement tools, which could potentially affect the outcome indicators.

5. Limitations

Due to the methodological limitations of the included studies, only studies published in English and Chinese were included in this review, and the small number of included literature may lead to publication bias in the results; therefore, relevant studies may have been missed; there are differences in the interventions, intervention times, and scales of the included studies, which may pose a risk of bias; the generation of randomized protocols of RCTs included in this study, and implementation of the blinding method, etc. may exist bias.

6. Summary and Prospect

Pregnant women, as a special group of people, are not only related to their own health and well-being, but also directly related to the health and development of the fetu. Therefore, pregnant women maintain appropriate sports and exercise during pregnancy, which can promote the development and health of the fetus while enhancing the quality of the body and immunity, and more importantly, it can

effectively alleviate the pain of labor during the process of labor and shorten the duration of the labor to reduce the difficulty of labor, hemorrhage and other adverse events. In conclusion, exercise as a safe and economical non-pharmacological intervention has a certain effect in the process of relieving labor pain. Therefore, clinicians should strengthen prenatal guidance and encourage pregnant women to perform prenatal physical exercise to reduce the occurrence of obstetric adverse events and improve women's quality of life.

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