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The Impact of Birth Ball Exercises on Mode of Delivery and Length of Labor: A Systematic Review and Meta-Analysis

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ABSTRACT

Background & aim: Recently, the use of birth ball in childbirth has been widely considered. This review study aimed to critically evaluate the evidence regarding the effect of using the birth ball on the mode of delivery and length of labor.
Methods: For the purpose of the study, the articles related to the subject of interest and published up to August 5th, 2018 were searched in several scientific databases, including Cochrane library, CENTRAL, and PubMed. This review included all randomized control trials evaluating the use of birth ball for giving birth. Two study outcomes were considered in the present study, namely the type of delivery and length of labor stages. Finally, five studies were entered into the systematic review and meta-analysis. The risk of bias was calculated by means of the Cochrane's tool.
Results: The included studies had a different range of quality, mostly lower than the standard level. The results of the reviewed articles revealed that the group who used birth ball had shorter active labor phase, as compared to the control group (P=0.048). However, the use of birth had no statistically significant effect on the length of the second stage of labor (P=0.128). In addition, using birth ball did not increase the chance of vaginal delivery (P=0.922).
Conclusion: Given the findings of the present study, it is essential to perform further high-quality studies with more scientific design to provide clinical evidence on the use of birth ball as a maternity service.

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Introduction

Physiotherapists used birth balls (Swiss balls) for the first time in the 1960s to treat neurodevelopmental complications (1, 2). Perez and Simkin, childbirth educators, utilized this tool in the 1980s to improve childbirth process (1). Perez expressed that the birth ball exercises have some physical benefits for pregnant and childbearing women (3). According to the findings of a recent meta-analysis, the application of birth balls during childbirth process causes a significant reduction in labor pain from the laboring women's viewpoints (4).

Other recommended advantages of the birth ball exercises in childbearing women are the reduction of laboring women's anxiety, use of opiates in a less frequent manner, facilitation of fetal head rotation and descent, decrease of labor length, and enhancement of women's wellbeing and satisfaction (5-8). In a study conducted on the South African multiparous laboring women, the use of birth ball as a helpful labor tool resulted in shortened labor

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duration and women empowerment during the labor (9). In another study performed by Gau et al., the use of birth balls in the Taiwanese pregnant women was reported as an efficient way to promote women's self-efficacy in childbirth, reduce labor pain, and decrease the length of labor (10).

One of the ultimate goals of intrapartum care is shortening the length of labor by using safe methods (11). According to the literature, longer duration of labor and delivery is associated with lower chance of normal vaginal birth, higher risk of cesarean section (C-section), and serious maternal and fetal complications (12, 13). The C-section rate remains high in numerous parts of the world, as well as in Iran (14).

Evidence suggests that the risk of serious maternal morbidity is even higher in a planned C-section than that in vaginal delivery (15). In addition, women who have a longer length of labor are more likely to be exposed to vaginal examinations; meanwhile, some women consider this process as uncomfortable and painful (16, 17).

The present study was conducted to review all randomized controlled trials (RCTs) investigating birth ball impact on the length of labor. Moreover, the type of delivery was evaluated as a labor outcome. The findings of this study may help the healthcare providers to manage childbirth process.

Materials and Methods

The articles related to the subject of interest and published up to August 05, 2018, were searched in several scientific databases, such as Cochrane library, CENTRAL, and PubMed, as well as Google Scholar. The search process was independently conducted by two investigators using a comprehensive search strategy. The articles were searched using the following keywords and MESH terms: “Labor”, “Obstetric”, “Childbirth”, “Parturition”, “Pregnancy”, “Birth”, “Swiss”, “Swedish”, “Balance”, “Fitness”, “Gym”, “Sport”, “Stability”, and “Ball”. No limitation was considered regarding the language of the studies. Personal contacts were made with the authors of trials for further information, if necessary.

The present review included the RCTs that analyzed the effect of using a birth ball during labor on the length of various stages of labor and/or type of delivery (i.e., normal vaginal delivery or C-section). This study included both nulliparous and multiparous women with a low-risk full-term pregnancy at the first stage of labor.

Two outcomes were considered in the present study, namely the type of delivery and length of labor stages. Active labor phase was defined as a cervical 3-5 cm to full dilatation of the cervix, and the second labor stage was regarded as the time between the full dilatation of the cervix to newborn expulsion.

Two researchers individually examined the titles and abstracts identified in the primary search of databases. In the next phase, the full texts of the seemingly relevant studies were retrieved, and then entered into the study in case of eligibility. It was tried to resolve any conflicts of opinions and disagreements with logical discussion.

Extraction of useful data was performed by two reviewers using a prepared form including the required information for each study.

Cochrane’s tool was used to evaluate the quality of the included studies (18). This tool, named as the risk of bias, has six domains assessing the bias of selection, performance bias, detection, attrition, report, and other sources of bias. The risk of bias is shown as high, low, or unknown. Additional data were obtained from the authors of the publications, if necessary.

Odds ratio (OR) was used as the main effect size for the evaluation of C-section rate. Difference in means was employed as the main effect size for assessing the birth ball effect on the length of labor. Furthermore, pooling across studies was performed by means of random effects model. Forest plots were utilized for a graphical display of the estimated results. Heterogeneity was calculated by Cochran's Q-value and I^2 index. P-value < 0.05 and $I^2 > 50\%$ were statistically significant (19). The CMA software (version 2) was used for all analyses.

Results

Figure 1 displays the PRISMA flow chart of the review process. The initial search of databases resulted in the inclusion of 874 published studies. In the next stage, the screening of titles and abstracts was carried out. Afterwards, the full papers of the 27 seemingly relevant studies were carefully studied. After removing the ineligible studies, five studies were entered into the meta-analysis. Table 1 depicts the specifications related to the studies entered into a meta-analysis.

Participants and settings

Each of the reviewed RCTs included a sample size of 60-100 cases. Out of the five studies, three articles were performed on only nulliparous women (20-22), and the two others investigated both nulliparous and primiparous women (10, 23). In most of the trials, the birth ball was used in the active labor phase. Two RCTs were conducted in Iran (21, 23), and the other three were carried out in India (22), Spain (20), and Taiwan (10).

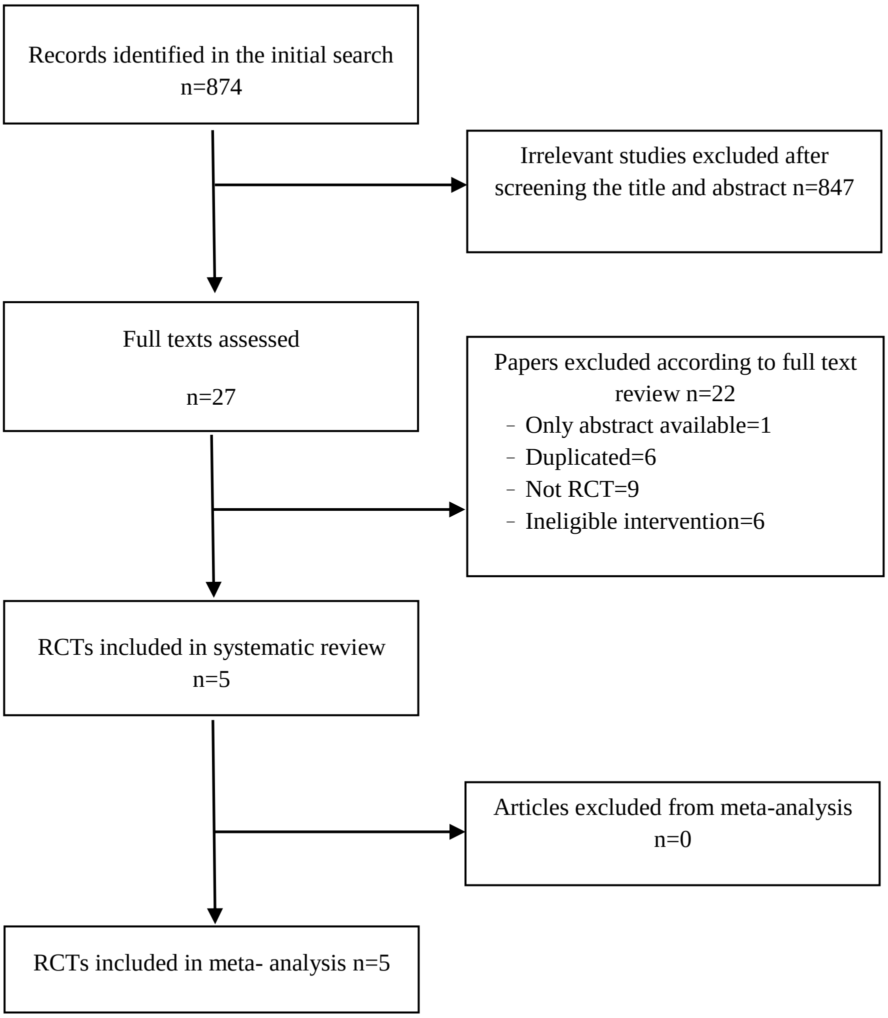


Figure 1. PRISMA flow chart of the review process

Table 1. Specifications of the studies entered into meta-analysis

Name of the first author (year)	Country	Subjects	Interventions and comparisons	Results
Bolbol Haghighi (2017)	Iran	- Pregnant women within the age of 18-45 years, with a gestational age of 38-42 weeks, a single fetus in cephalic presentation, reactive non-stress test, and a cervical dilatation of 4-10 cm were included. - Those with high-risk pregnancy or obstetric problems were excluded.	- Group 1: Sitting on the birth ball and doing the pelvic movements for a minimum of 30 min - Group 2: No intervention	- Shorter length of active phase (P=0.002) in birth ball group - No difference in the length of the second labor stage
Delgado-Garcia (2012)	Spain	- Low-risk healthy primiparous women within the age of 18-35 years, with term pregnancy in cephalic presentation were included. Women with physical disabilities and disease related to maternal morbidity were excluded.	- Group 1: Doing pelvic movements sitting on a birth ball during labor for a minimum of 20 min - Group 2: Freedom of movement	- 75% of vaginal delivery in birth ball group versus 91.6% in control group - No significant difference in the length of labor between groups
Gau (2011)	Taiwan	- Pregnant women with the gestational age of 30-32 weeks, single fetus, no major obstetric or medical complications were included. - Women with preterm labor, epidural anaesthesia, cervical dilation of >4cm, and emergency C-section were excluded.	- Group 1: Practicing birth ball exercises at home for a period of 6-8 weeks, choosing movements and exercises with birth ball during labor - Group 2: Standard care	- Shorter length of active labor phase in birth ball group - No significant difference in the length of the second labor stage between groups - 75% of vaginal delivery in birth ball group versus 63.9% in control group -
Mathew (2012)	India	- Primigravida mothers in the first stage of labor were included.	- Group 1: Performing birth ball therapy with a cervical dilatation of 1-3 cm - Group 2: Ambulation - Group 3: No intervention	- 100% vaginal delivery in birth ball group versus 80% in control group - Shorter duration of active phase and second labor stage in birth ball group
Taavoni (2011)	Iran	- Primiparous women within the age of 18-35 years, with the gestational age of 38-40 weeks, single fetus in vertex presentation, cervical dilatetion of 4-8 cm, and no history of infertility were included. Those with obstetric complications were excluded.	- Group 1: Sitting on birth ball and rocking the hips for a minimum of 30 min - Group 2: No intervention	- No significant difference in the duration of active labor phase and type of delivery between groups

Types of intervention

In four studies, using birth ball was started just during the labor (20-23), and in one of the trials, the birth ball exercises were started from the last trimester of pregnancy, and then continued during the labor process (10). In a study carried out by Delgado-Garcia, laboring women performed hip movements on a birth ball (20). Taavoni and Bolbol Haghighi clarified that women were instructed to sit on the birth ball and shake their hips forward and backward, around, as well as right and left for at least 30 min (21, 23). In another study, the women in the third trimester of pregnancy practiced the birth ball exercises at home three times a week for 6-8 weeks, afterwards they continued to practice these exercises during the labor (10). Mathew did not explain how the birth ball exercises were performed (22).

Types of control groups

In the included studies, the birth ball was compared with ambulation, standard nursing and midwifery care, as well as routine care.

Detailed quality of studies

Figure 2 and 3 depict a summary of the quality of studies. Generally, none of the studies were free of bias at all domains. Four RCTs were considered to have a low risk of bias in terms of random sequence generations. Only one study reported a sufficient allocation concealment (10). In a study carried out by Taavoni, the issue of allocation concealment was not considered because the participants were assigned into the intervention and control groups based on odd or even random numbers given to each sample (21).

Regarding the type of interventions, it was not possible to keep the subjects or staff blind to the study in all reviewed RCTs. Therefore, the level of performance bias was high in all studies. In the study by Taavoni, two exclusions occurred after randomization, and it was not clarified that how many subjects in each group were analyzed (21). The attrition bias was considered at a high risk in three studies (10, 20, 22).

An example of incomplete data was found in the study by Mathew, in which all C-sections were excluded from the analysis of labor length (22). Three studies had a low risk of reporting bias". An instance was found in a study by Gau, which explained that all analyses were repeated. Furthermore, the sensitivity analyses suggested no significant differences regarding the effects according to intention-to-treat analyses, as well as per-protocol approaches; however, the relevant data were not presented (10).

Outcome measures

Four studies reported the type of delivery, and all studies provided data on the length of labor stages. The results of meta-analysis in

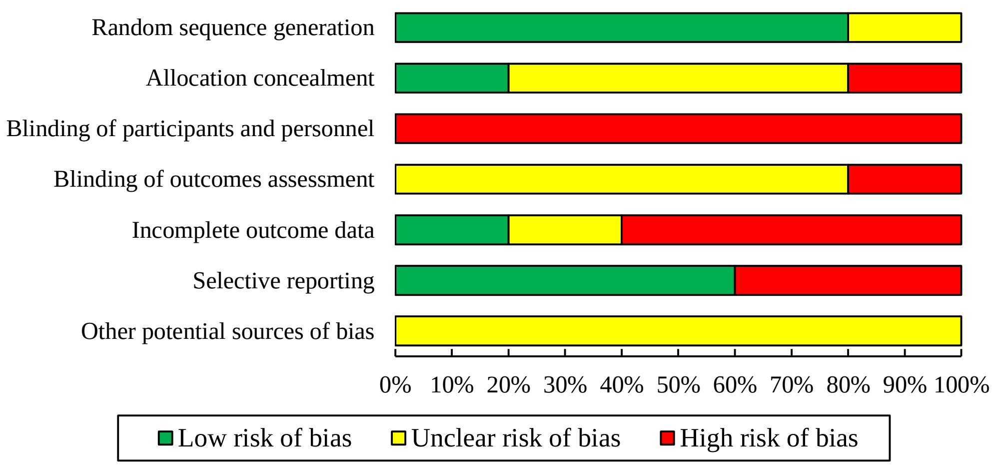


Figure 2. Risk of bias for each domain presented as percentages

	Random sequence generation	Allocation concealment	Blinding of participants and personnel	Blinding of outcomes assessment	Incomplete outcome data	Selective reporting	Other potential sources of bias
Bolbol Haghighi 2017	+	?	-	-	+	-	?
Delgado-Garcia 2012	?	?	-	?	-	+	?
Gau 2011	+	+	-	?	-	-	?
Mathew 2012	+	?	-	?	-	+	?
Taavoni 2011	+	-	-	?	?	+	?

Figure 3. Risk of bias domain for each included study

light of the independent variables are as follows:

1. Length of labor

Figure 4 presents the meta-analysis of the impact of birth ball on the length of active labor phase. As compared to control groups, the women using birth ball experienced a shortened length of active labor phase for 111.99 min, which was statistically significant (P=0.048). We found a significant heterogeneity among the included studies (Q-value=53.55, P<0.001, I^2 =92.53%).

Analyses estimated based on parity group (only primiparous or mixed partiy) showed that in mixed parity group, the length of active labor phase was significantly shorter in birth ball group, compared to that in the control group (P<0.001). Moreover, subgroup analysis showed no evidence of significant heterogeneity in the subgroup of mixed parity women (Q-value=0.418, P=0.518, I^2=0.0%).

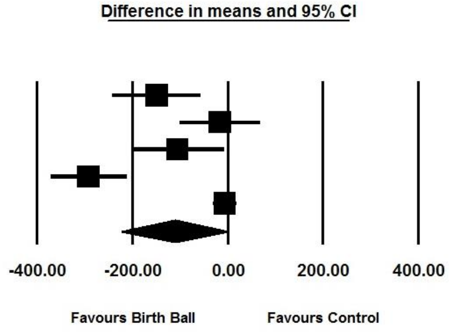
Overall, the length of the second stage of labor was not statistically shorter in the birth ball group, compared with that in the control group (P=0.128). On the other hand, the birth ball shortened the length of second labor stage for 11.01 min in the intervention group, compared to that in the control groups; however, it was not statistically significant (Figure 5). No heterogeneity was achieved between RCTs (Q-value=15.179, P=0.002, I^2=80.236%).

Subgroup analysis based on parity revealed that in primiparous women, the length of second labor stage was significantly shorter in the birth ball group, compared to that in the control group (P<0.001). There was no evidence regarding the heterogeneity significance in the subgroups of only primiparous women (P=0.567, I^2=0.0%) and mixed parity women (P=0.964, I^2=0.0%).

2. Type of delivery

Figure 6 depicts the meta-analysis of birth ball effect on the type of delivery based on OR. Birth ball exercises did not increase the chance of vaginal delivery by the OR of 0.934 (95% CI 0.237-3.679, P=0.922). There was no significant heterogeneity between trials (Q-value=6.428, P=0.093, I^2=53.331%). As demonstrated in Figure 7, the funnel plot shows no publication bias

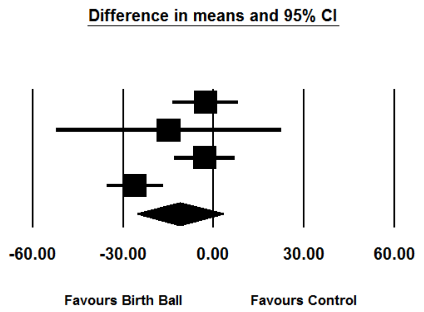
Study name	Difference in means	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Bolbol Haghigh,i 2017	-149.400	46.857	2195.611	-241.239	-57.561	-3.188	0.001
Delgado-Garcia, 2012	-16.900	43.065	1854.565	-101.305	67.505	-0.392	0.695
Gau, 2011	-105.400	49.239	2424.466	-201.906	-8.894	-2.141	0.032
Mathew. 2012	-292.000	40.413	1633.185	-371.207	-212.793	-7.225	0.000
Taavoni, 2011	-6.600	12.475	155.616	-31.050	17.850	-0.529	0.597
	-111.993	56.653	3209.525	-223.030	-0.956	-1.977	0.048



Meta Analysis

Figure 4. Forest plot of birth ball effect on the length of active labor phase

Study name	Difference in means	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Bolbol Haghigh,i 2017	-2.480	5.512	30.378	-13.283	8.323	-0.450	0.653
Delgado-Garcia, 2012	-14.700	19.011	361.403	-51.960	22.560	-0.773	0.439
Gau, 2011	-2.820	5.070	25.708	-12.758	7.118	-0.556	0.578
Mathew. 2012	-25.910	4.662	21.736	-35.048	-16.772	-5.557	0.000
	-11.014	7.243	52.466	-25.211	3.183	-1.521	0.128



Meta Analysis

Figure 5. Forest plot of birth ball effect on the length of second labor stage

Study name	Odds ratio	Lower limit	Upper limit	Z-Value	p-Value
Delgado-Garcia, 2012	3.667	0.682	19.701	1.515	0.130
Gau, 2011	0.591	0.274	1.277	-1.339	0.181
Mathew. 2012	0.089	0.004	1.783	-1.581	0.114
Taavoni 2011	3.000	0.118	76.580	0.665	0.506
	0.934	0.237	3.679	-0.098	0.922

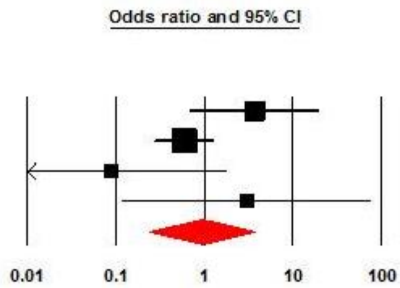


Figure 6. Forest plot of birth ball effect on the type of delivery

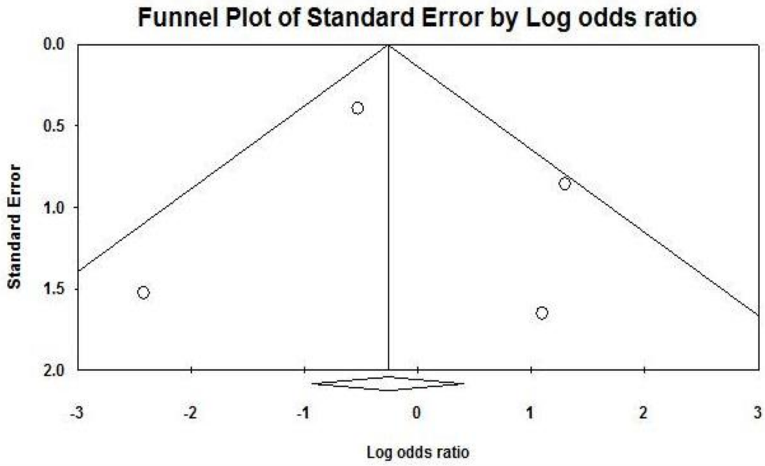


Figure 7. Funnel plot of birth ball effect on the type of delivery

(Egger's regression intercept=-0.5007, P=0.7893).

Discussion

The present study is the first meta-analysis investigating the impact of birth ball on the type of delivery and length of labor. According to the findings of the reviewed studies, the use of birth ball led to the shortening of active labor phase length. Nevertheless, the C-section rate was not affected by the intervention. However, the precise mechanisms by which birth ball exercises reduce the length of labor are unclear. It seems that there are some potential mechanisms in this regard. According to some evidence, the implementation of pelvic movements by the mother in an upright position and freedom of movement during the labor will assist the gravity power, facilitate the descent of presenting part, strengthen the uterine contractions, and reduce the length of labor (24).

The reduction of labor length can also be related to the mitigation of the labor pain. The findings of a recent study indicated that the use of a birth ball in the childbirth process can decrease the labor pain (4). There is a close relationship between the fear and anxiety caused by the labor process and labor pain (25). When the labor pain is severe and non-tolerable, the level of maternal anxiety increases and leads to the increased cortisol and adrenaline release, inferiority of the uterine contractions, and slow progression of labor (26, 27).

In the present study, pelvic exercises with the birth ball did not affect the rate of C-section. Various factors have an impact on the type of delivery. One of these factors is the duration of second labor stage, which was not influenced by the birth ball exercises in this study. In a previous study conducted by Allen et al., it has been explained that the risk of C-section raised with the increased length of the second labor stage (28).

In the present study, it was attempted to reduce the amount of bias during the database searching and article reviewing and criticizing as much as possible. In searching for articles, the time or language limitations were not considered. All research stages, including database searching, selection of studies, quality evaluation, and data extraction were independently conducted by two reviewers. The likelihood cannot be ruled out that some evidence has been missed because it is believed that some data are not promptly available in primary database.

The results of this study were affected by a number of limitations. First, the quality evaluation of the included trials demonstrated that it was mixed and under mediate. The RCTs are the most rigorous methods for the investigation of a cause-effect relationship between the treatment and outcome for assessing the cost-effectiveness of a treatment. It is clear that well-designed RCTs precisely estimate the effects of the interventions (29).

In the present review, only 20% of the included trials had a low risk of bias regarding the allocation concealment. A critical component of randomization is the implementation of the randomized allocation sequence. According to the scientific evidence, RCTs that used inadequate allocation concealment reported a larger unrealistic estimate of effect size (30-32).

In the reviewed studies, it was impossible to blind the subjects and their care providers to group allocation; therefore, the risk of performance bias increased. Subjects who realize that they have been assigned into the treatment group might have favorable expectations or increased anxiety (33).

In the present study, 60% of the included RCTs had a high risk of attrition bias. Attrition can represent bias if the characteristics of the subjects lost to follow up vary between the randomized groups. Loss to follow up can enormously influence the strength of a trial results (34).

A second potential limitation is that the quality of the results related to the duration of labor was also affected by an unexplained significant heterogeneity of the included studies, which may have been caused by various factors. The protocol for the use of the birth ball was different in the included studies.

In some studies, routine or standard care was not explicitly explained by the authors. In one study, the birth ball exercises were started from the third trimester of pregnancy and continued during the labor (10). Consequently, it is impossible to distinguish between the effects of prenatal and intrapartum exercises on the length of labor. In another study, the intervention was implemented in the latent labor phase (22), while in the remaining studies, it was performed during the active phase (10, 20, 21, 23).

A comprehensive control of heterogeneity between studies is very difficult. Even with the presence of the same inclusion criteria in the totally homogeneous studies, some degrees of heterogeneity are predicted between studies due to such factors as the methodological details of the study and research quality (35). In this study, a subgroup analysis was performed to control the heterogeneity. It should be noted that given the inadequate number of RCTs in each subgroup, the statistical strength seems to be limited.

Conclusion

Considering the findings of the reviewed articles, it is essential to perform further high-quality studies with a more scientific design to provide clinical scientific information on the use of birth ball in maternity services.

Acknowledgements

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Conflicts of interest

The authors declare no conflicts of interest.

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