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Systematic Review

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Effect of Castor Oil on Cervical Ripening and Labor Induction: a systematic review and meta-analysis

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Objectives: Post-term pregnancy is a condition associated with increased maternal and fetal complications. Administration of castor oil causes cervical stimulation by increasing the production of prostaglandins. We examined the effects of castor oil on cervical ripening and labor induction through a systematic review and meta-analysis.
Methods: The search process was performed to obtain relevant articles from databases including Pubmed, Cochrane library, Scopus, Science direct, SID, Iran Medex, and Google Scholar using the English keywords of cervical ripening, post-term, castor oil, labor induction, Bishop score, and pregnancy considering all possible combinations without time constraints and their Persian equivalents from national databases.
Results: A total of eight related articles from the 19 primary studies were extracted and systematically reviewed. According to a cumulative chart, the difference in the post-intervention Bishop score was statistically significant (standard mean difference [SMD]: 1.64, 95% confidence interval [CI]: 1.67-2.11, p = 0.001), indicating an effect of castor oil on increasing the Bishop score. In addition, the difference in labor induction was statistically significant after the intervention (odds ratio: 11.67, 95% CI: 3.34-40.81, p = 0.001), indicating an effect of castor oil on increasing the odds ratio of labor induction (experience of vaginal delivery).
Conclusion: This meta-analysis showed that oral administration of castor oil is effective for cervical ripening and labor induction. Midwives should closely monitor pregnant women with prolonged labor and collaborate with obstetricians to employ castor oil as a safe intervention to induce cervical ripening and labor to prevent undue caesarean surgery.

Keywords: cervical ripening, labor induction, bishop score, castor oil, post term pregnancy, systematic review

INTRODUCTION

Labor induction is defined as the commencement of uterine contractions before the spontaneous onset of labor and is indicated in cases where the benefits of giving birth outweigh the benefits of prolonged pregnancy for the mother or fetus [1, 2]. Abnormal prolongation of pregnancy causes leakage of amniotic fluid, acute umbilical cord compression, meconium aspiration, macrosomia, placental insufficiency with fetal growth restriction, and ultimately death [3]. Labor induction can accelerate this process and prevent many complications [4, 5]. Cervical ripening is one of the major stages of labor during the last few weeks of pregnancy [6]. Lack of cervical ripening and labor induction for any reason lead to increased adverse maternal-fetal outcomes and increased need for cesarean sections [7, 8]. One quantitative method for predicting the consequences of labor induction and determining cervical ripening is the Bishop scoring system [1]. Studies have shown that if the cervix is not ripening, the duration of the labor will increase by approximately two to three times [9, 10]. Oxytocin is one of the most commonly used drugs in labor induction. There are several side effects reported for this drug including uterine hyperstimulation, water intoxication, placental abruption, and increased postpartum hemorrhage [11, 12].

In some cases, prostaglandins may not be used in pregnant women due to complications such as nausea and vomiting, fever and chills, blurred vision, diarrhea, and a bitter taste in the mouth [13, 14]. Non-pharmacological methods for cervical ripening and labor induction include espand (steppenraute), dates, flaxweed, and chamomile. Given the limited number of studies and poor methodology, it is impossible to draw definitive conclusions about the impact of these plants [15]. Castor oil has been used to induce and accelerate childbirth since ancient Egypt. The precise mechanism of its action at the onset of childbirth is not known but is probably due to increased production of prostaglandins [16, 17]. In a study by Gilad et al., labor induction was achieved in 91% of women who consumed castor oil [17]. In a cohort study conducted between 2005 and 2007, Boel et al. found no significant difference in the time of birth between women receiving castor oil and a control group. In addition, no cases of maternal mortality, uterine rupture, or other harmful effects on the mother or fetus were reported in relation to the use of castor oil [18]. In a study by Okoro et al., a single oral dose of castor oil significantly reduced post-term pregnancy with no adverse effects for the mother or infant [19]. In a systematic review by Kelly et al. regarding the impact of castor oil on labor induction, only three studies met the inclusion criteria [20]. However, these studies revealed an uncertain impact of castor oil. Given the importance of labor induction in line with the World Health Organization 2018 policy to decrease caesarean delivery rates [21], which is also now a problem in Iran, the present systematic review and meta-analysis was conducted to evaluate and summarize the results of clinical trials on the impact of castor oil on cervical ripening and labor induction.

MATERIALS AND METHODS

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist was used to provide materials ranging from analysis and interpretation, problem determination to study, and data collection [22]. The search process was performed to obtain relevant articles from databases including Pubmed, Scopus, Science direct, SID, Iran Medex, and Google Scholar using the English keywords of cervical ripening, post-term, castor oil, labor induction, Bishop score, and pregnancy as well as their Persian equivalents from national databases considering all possible combinations without time constraints using Boolean OR/AND operators. The inclusion criteria were all randomized human clinical trials published in English and Persian that examined the impact of castor oil on cervical ripening and labor induction with a study population of pregnant women with a gestational age greater than 40 weeks without contraindications for labor induction. The exclusion criteria included irrelevant studies, duplicate studies, failure to provide study purpose, and descriptive or qualitative studies.

To select the articles and extract the data, all articles with titles or abstracts containing the keywords were selected by the first author. The articles were initially reviewed on a basis of abstract, and access to the full text. References cited in the identified articles were also reviewed to access more articles in this area. The corresponding authors of the articles were contacted by the third author to seek further information. The quality assessment of and extraction process for the articles were performed independently by all authors. The Cochrane Collaboration's "Risk of Bias" tool was used to assess the quality of the articles, and the studies were reviewed in terms of selection bias (random sequence generation and allocation concealment), implementation (blinding participants and evaluators), detection (blinding statistical analyzer), attrition (post-randomization exclusion), and reporting (selective reporting of outcomes) [23]. Table 1 presents short descriptions (authors/year, location, variables, research sample, intervention group, control group, tool, complications, and results) of the articles included in this review. Data were analyzed with comprehensive meta-analysis software using the I^2 index to evaluate heterogeneity between studies and a random-effects model to perform the meta-analysis.

RESULTS

The PRISMA study flow chart is illustrated in Fig. 1. In total, 314 articles were identified after the primary search; 16 of these were considered eligible articles after eliminating duplicate and irrelevant studies. Eight articles were excluded because seven articles were retrospective studies or reviews [15, 20, 21, 24-27]

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Table 1. Characteristics of studies included in systematic review

Author/year, reference number	Location	Variables	Research sample	Intervention group	Control group	Tool	Complications	Results
Kahnamoyiagdam et al., 2014 [29]	Iran	Labor induction	100 pregnant women with gestational age of 41 weeks and more	A single dose of 60 mL of castor oil with 140 mL of orange juice (n = 50)	Placebo with 2 mL of orange juice (n = 50)	Examining the labor induction 24 hours after intervention	No mention	Oral administration of castor oil was not effective in labor induction.
Azarkish et al., 2008 [30]	Iran	Cervical ripening and labor induction based on Bishop score	30 pregnant women with gestational age of 41 weeks or more	A single dose of 60 mL of castor oil with fruit juice (n = 15)	No intervention (n = 15)	Examining the labor induction 24 hours after intervention	Hypertension of the uterine contractions (n = 1), nausea (n = 15) and vomiting (n = 2)	Oral administration of castor oil was effective in cervical ripening and labor induction.
Iravani et al., 2006 [31]	Iran	Cervical ripening and labor induction based on Bishop score	80 pregnant women with postterm pregnancy	A single dose of 60 g of castor oil with 60 g of orange juice (n = 40)	No intervention (n = 40)	Examining the labor induction 12 hours after intervention	Hypertension of the uterine contractions (n = 1), nausea (n = 29) and vomiting (n = 3)	Oral administration of castor oil was effective in cervical ripening and labor induction.
Saberi et al., 2008 [32]	Iran	Labor induction	200 pregnant women with gestational age of 40 weeks or more	A single dose of 60 mL castor oil (n = 100)	No intervention (n = 100)	Examining the labor induction 24 hours after intervention	No complication	Oral administration of castor oil was effective in labor induction.
Saberi et al., 2008 [33]	Iran	Cervical ripening based on Bishop score	200 pregnant women with gestational age of 40 weeks or more	A single dose of 60 mL castor oil (n = 100)	No intervention (n = 100)	Cervical examination 24 hours after intervention	No complication	Oral administration of castor oil was effective in cervical ripening.
Azhari et al., 2006 [34]	Iran	Cervical ripening and labor induction based on Bishop score	47 pregnant women with gestational age of 40 to 42 weeks	A single dose of 60 mL castor oil (n = 24)	No intervention (n = 23)	Examining the labor induction 24 hours after intervention	No mention	Oral administration of castor oil was effective in cervical ripening and labor induction.
Gilad et al., 2018 [17]	Israel	Labor induction	81 pregnant women with gestational age of 40 to 41 weeks and 6 days	A single dose of 60 mL castor oil along with orange juice (n = 43)	60 cc of sunflower oil (n = 38)	Examining the labor induction 24 hours after intervention	No complication	Oral administration of castor oil was effective in labor induction.
Okoro et al., 2019 [19]	Nigeria	Labor induction	211 pregnant women with gestational age of 40 to 41 weeks	A single dose of 60 mL castor oil (n = 105)	No intervention (n = 106)	Examining the labor induction 24 hours after intervention	No complication	Oral administration of castor oil was effective in labor induction.

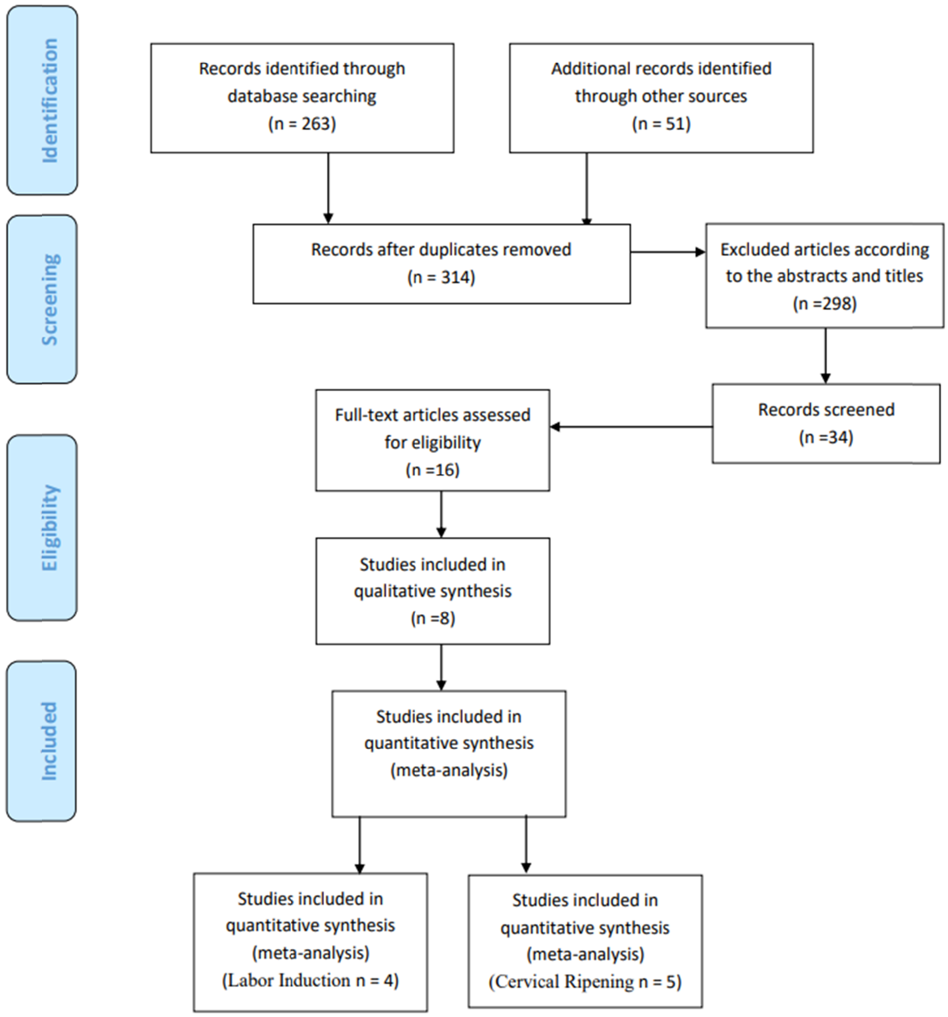

Figure 1. Study selection procedure (PRISMA flowchart).

studies and one article had poor methodology [28]. Ultimately, eight articles related to the effects of castor oil on labor induction and cervical ripening (sample size = 902) were systematically reviewed [17, 19, 29-34]. Four of the eight articles were reviewed for the Bishop score (cervical ripening) [30, 31, 33, 34], and seven articles were reviewed for labor induction [17, 19, 29-32, 34].

For the risk of bias assessment using the Cochrane Collaboration's "Risk of Bias" tool, the random sequences of two studies were considered ambiguous because there were no explanations of randomization [30, 31]. Four studies were considered to have low bias due to the use of method and allocation concealment, such as random sequence generation software [17, 19] and envelopes [32, 33] to assign individuals to the control and intervention groups. Two studies were considered to have high bias due to the allocation of individuals on the basis of even and odd days [29, 34]. Three studies were considered ambiguous because of insufficient information to judge [30, 31, 34]. One double-blind study [17] and two single-blind studies were found to have low implementation bias [29, 30]. Regarding detection bias, the allocation of the treatment or control groups in the two studies was not clear [29, 30]. In terms of attrition bias, the participants who participated in two studies were aware of the time of randomization to the time of analysis of the results [32, 34]. Three studies [17, 19, 31] reported the number of dropouts and reasons for dropout; therefore, these studies were assessed to have low bias in terms of attrition bias. In reviewing reporting bias, all eight published articles apparently contained all expected outcomes; thus, they were considered to be unbiased. In summary, the risk of bias for each study is presented in Figs. 2 and 3.

Kahnamoyiagdam et al. investigated the effects of castor oil on labor induction among subjects randomly assigned to either intervention or control groups. The intervention group received

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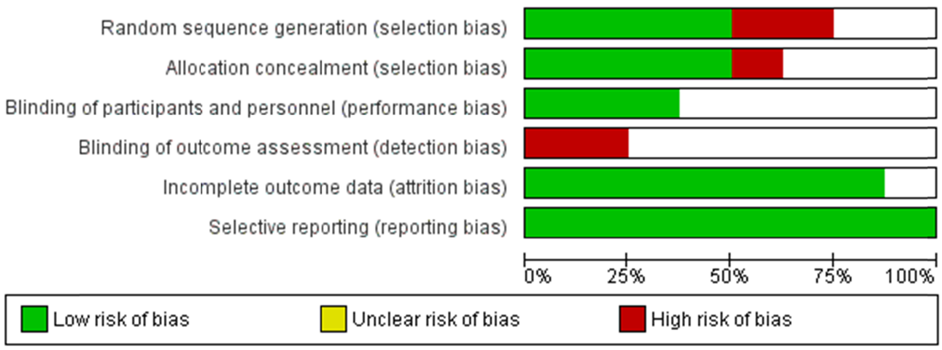

Figure 2. Risk of bias graph; review authors' judgements about each risk of bias item presented in percentages across all studies.

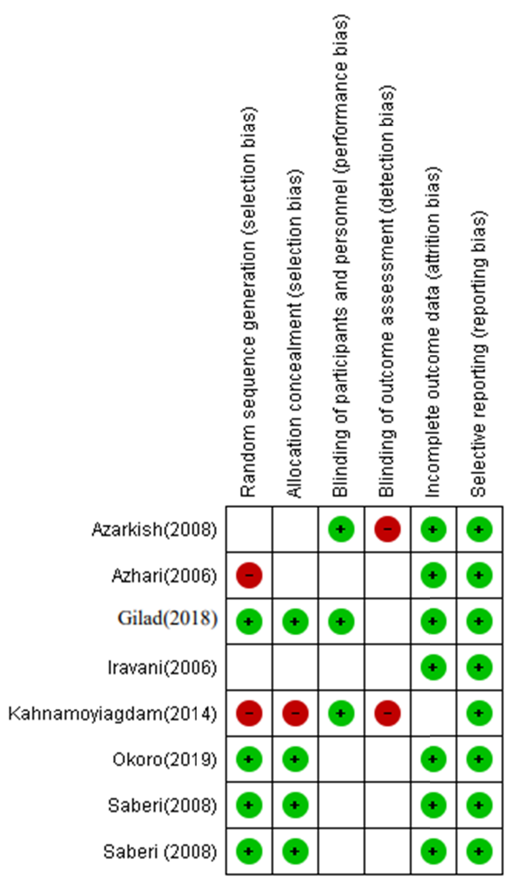

Figure 3. Risk of bias summary; review authors' judgements about each risk of bias item for each included study.

60 mL of oral castor oil, and the control group received no medication. Although the rate of caesarean section was higher in the intervention group (36%) than in the control group (44%), the duration of each contraction was longer in the intervention group than in the control group. More women (58%) who received castor oil experienced uterine contractions than those in the control group (42%), but there was no statistically significant difference between the two groups ($p > 0.05$) [29].

Azarkish et al. evaluated the effects of oral castor oil on labor induction in post-term pregnancy. The intervention group consumed a single dose 60 mL of castor oil plus fruit juice, but the control group received no intervention. The mean Bishop score (4.40 ± 0.63 intervention group and 2.66 ± 0.72 control group; $p = 0.000$) and number of vaginal deliveries (13 in the intervention group and five in the control group; $p = 0.003$) were statistically significantly different in the intervention group compared to the control group [30]. Iravani et al. investigated the effects of oral castor oil on cervical ripening and labor induction. The subjects were assigned to an intervention group (60 g of castor oil once) and a control group (placebo). The results showed that oral administration of castor oil caused the onset of regular and spontaneous contractions compared with placebo (62.5% vs 7.5%). The mean change in the Bishop score for the cervix in the intervention group was statistically significantly different (5.1 ± 1.1 for the intervention group and 3.7 ± 0.9 for the control group; $p < 0.001$), but no significant difference between the two groups in the Bishop score for the cervix was found ($p < 0.06$) [31].

Saberi et al. investigated the effects of oral castor oil on labor induction and cervical ripening after 40 weeks of gestation. In this study, the subjects in the intervention group consumed a single dose of 60 cc of castor oil, and no intervention was performed in the control group. Regular uterine contractions began in 70% of individuals in the intervention group within 24 hours after oral administration of castor oil, whereas the uterine contraction rate for the control group was only 12% [32]. The mean Bishop score was 5.4 ± 3.63 in the intervention group and 1.25 ± 0.67 in the control group, and the difference between the two groups was statistically significant ($p < 0.001$) [33]. Azhari et al. also examined the effects of a single dose of oral castor oil on labor induction. The mean Bishop score in the intervention group increased from 2.50 ± 1.29 to 6.79 ± 3.20, and this change

Study name	Std diff in means	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Azarkish(2008)	2.888	1.520	0.270	1.849	3.887	5.515	0.000
Iravani(2006)	1.522	1.254	0.064	1.025	2.020	5.995	0.000
Saberi (2008)	1.293	0.155	0.024	0.988	1.597	8.313	0.000
Azhari(2006)	1.548	0.336	0.113	0.889	2.207	4.605	0.000
	1.637	0.240	0.058	1.166	2.107	6.813	0.000

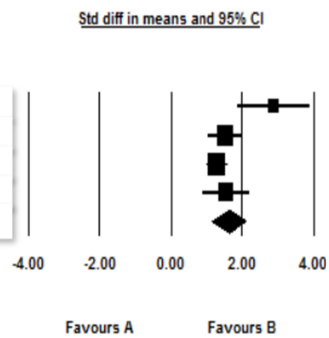

Figure 4. Cumulative chart for the effect of castor oil on Bishop Score.

was statistically significant ($p < 0.001$) [34].

In a study by Gilad et al., the intervention group received a single dose of 60 cc of castor oil with orange juice, and the control group received 60 cc of sunflower oil. Both groups were followed for 24 hours, 36 hours, and 48 hours. Labor induction in multiparous women at all three time points was statistically significant compared with the control group ($p < 0.05$), but this difference was not significant in primiparous women ($p = 0.78$) [17]. In a similar study, Okoro et al. measured the effects of a single oral dose of castor oil (60 mL) on labor induction. Labor induction 24 hours after the intervention occurred in 57% of individuals in the intervention group and 4% of those in the control group. The rate of delivery 48 hours after the intervention was 48.6% in the intervention group and 21.7% in the control group. The proportion of women requiring formal induction of labor with misoprostol or oxytocin was significantly lower in the intervention group than in the control group (17.1% vs 41.5%). Individuals in the intervention group were less likely to have their labor augmented with oxytocin than those in the control group (47.1% vs 71.0%) [19].

The heterogeneity of Bishop scores after the intervention was 65% based on the I^2 index, which is in the range of studies with moderate heterogeneity ($p = 0.035$). The significance of the T2 test ($p = 0.041$), which indicates variance between studies, may be due to the heterogeneity between studies due to differences in sample size, sampling error, year of the study, or location of the study. According to the cumulative chart, the difference in the Bishop score after the intervention was statistically significant (standard mean difference [SMD]: 1.64, 95% confidence interval [CI]: 1.67-2.11, $p = 0.001$), indicating the effect of castor oil on increasing the Bishop score. In addition, labor induction was statistically significant after the intervention (odds ratio: 11.67, 95% CI: 3.34-40.81, $p = 0.001$), indicating the effect of castor oil on increasing the odds ratio of labor induction (experiencing vaginal delivery). In the evaluation of publication bias in the included studies, no information bias occurred according to the Egger test Fig. 4.

DISCUSSION

The present systematic review and meta-analysis synthesized the results of eight clinical trials on the impact of castor oil on cervical ripening and labor induction. In six studies, castor oil caused labor induction [17, 19, 30-32, 34], confirming a possible association between intestinal prostaglandin production due to castor oil consumption and its effects on uterine activity. Increased prostaglandin, platelet-activating factor, and nitric oxide levels play important roles in cervical ripening and labor induction [34-36]. Iravani et al. (2006) showed that oral administration of castor oil significantly initiated regular and effective spontaneous uterine contractions in an intervention group compared with a control group [31]. The increase in the rate of labor induction during post-term pregnancy in the castor oil group was significant in three studies [30, 32, 34]. Okoro et al. (2019) showed that women receiving castor oil progressed significantly more towards childbirth than those in the control group within 24 hours of the intervention [19]. Gilad et al. [17] found that the administration of castor oil was more effective in labor induction in multiparous women. These studies support that the onset of uterine contractions after the administration of castor oil can be attributed to prostaglandin production [17, 19, 30-32, 34]. In contrast, in another study, oral administration of castor oil had no significant effect on labor induction [29]. The possible reason might be due to the failure of the tocometer device to accurately measure the onset time and severity of uterine contractions. In terms of the Bishop score in pregnant women who received castor oil, an increased Bishop score indicated cervical ripening in four studies [30, 31, 33, 34]. Cervical ripening in pregnant women did not increase the risk of caesarean section and did not decrease the neonatal Apgar score [30, 31,

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33, 34].

One of the most important objectives of a meta-analysis is to provide reliable and accurate results from a large sample size by the combination of different studies to reduce the confidence interval of the samples and solve problems arising from controversial results of previous studies [37]. Therefore, the findings of four studies [30, 31, 33, 34] investigating the effects of castor oil on the Bishop score with a similar methods were combined in the meta-analysis. The results of these studies found statistically significant differences in Bishop scores and labor induction after the intervention. The US Food and Drug Administration (FDA) has classified the use of castor oil as a safe laxative [38]. There were no complications in the four studies reviewed [17, 19, 32, 33]. Complications reported in two studies were hypertension, uterine contractions, nausea, and vomiting [30, 31].

The Cochrane Collaboration's "Risk of Bias" tool was used to assess the quality of the reviewed articles [23]. Most studies had proper methodology. Ambiguous bias was present in two studies in terms of random sequence generation and three studies in terms of allocation concealment. Therefore, further studies with a larger sample size and stronger methodology can provide additional stronger evidence in identifying the effects of castor oil on cervical ripening and labor induction.

CONCLUSION

Uterine contractions before the onset the spontaneous labor are indicated in cases where the benefits of giving birth outweigh the benefits of prolonged pregnancy. Cervical ripening before the induction of labor and termination of pregnancy at different gestation periods reduces maternal and foetal complications including the need for caesarean section. The administration of a non-pharmacological intervention using a single dose of 60 mL of orally administered castor oil induces cervical ripening and labor. Nurse managers should encourage midwives to closely monitor pregnant women with prolonged labor and collaborate with obstetricians regarding the use of castor oil as a safe intervention to induce cervical ripening and labor to prevent undue caesarean surgery.

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CONFLICT OF INTEREST

The authors declared no conflict of interest with respect to the research, authorship, and publication of this article.

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