

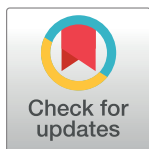
RESEARCH ARTICLE

Obstructed labor and its effect on adverse maternal and fetal outcomes in Ethiopia: A systematic review and meta-analysis

Yordanos Gizachew Yeshitila^{1*}, Beniam Daniel¹, Melaku Desta², Getachew Mullu Kassa³

1 School of Nursing, College of Medicine and Health Science, Arba Minch University, Arba Minch, Ethiopia, **2** Department of Midwifery, College of Medicine and Health Science, Debre Markos University, Debre Markos, Ethiopia, **3** College of Medicine and Health Science, Debre Markos University, Debre Markos, Ethiopia

* yordanos.gizachew@yahoo.com



Abstract

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Abbreviations: MMR, Maternal Mortality Ratio; NOS, Newcastle-Ottawa scale; OL, Obstructed labor; PRISMA-P, Preferred Reporting Items for

Background

Obstructed labor is one of the five major causes of maternal mortality and morbidity in developing countries. In Ethiopia, it accounts for 19.1% of maternal death. The current review aimed to assess maternal and perinatal outcomes of obstructed labor in Ethiopia.

Methods

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline was followed for this systematic review and meta-analysis. A literature search was made using PubMed/MEDLINE, CINAHL, Summon country-specific search, and Cochrane Libraries' online databases. Search terms were adverse outcome, obstructed labor, maternal outcome, fetal outcome, and Ethiopia. The Newcastle-Ottawa scale (NOS), based on a star scoring system, was used to assess the quality of the included studies. The meta-analysis was conducted using STATA 16 software. The pooled prevalence of an adverse maternal outcome, fetal outcome, and association between adverse outcome and obstructed labor was calculated using a random-effects model. Egger's test and funnel plot were used to evaluate publication bias.

Result

Eighty-seven studies were included in this review, with an overall sample size of 104259 women and 4952 newborns. The pooled incidence of maternal death was estimated to be 14.4% [14.14 (6.91–21.37)]. The pooled prevalence of uterine rupture and maternal near-miss was 41.18% (95% CI: 19.83, 62.54) and 30.5% [30.5 (11.40, 49.59)] respectively. Other complications such as postpartum hemorrhage, sepsis, obstetric fistula, hysterectomy, bladder injury, cesarean section, and labor abnormalities were also reported. The pooled prevalence of perinatal death was 26.4% (26.4 (95% CI 15.18, 37.7)). In addition, the

Systematic Reviews and Meta-Analysis; SNNPR, Southern Nations, Nationalities, and People's Region.

association of obstructed labor with stillbirth, perinatal asphyxia, and meconium-stained amniotic fluid was also demonstrated.

Conclusions

In Ethiopia, the incidence of perinatal and maternal mortality among pregnant women with obstructed labor was high. The rate of maternal death and maternal near miss reported in this review was higher than incidences reported from high-income and most low and middle-income countries. Uterine rupture, postpartum hemorrhage, sepsis, fistula, hysterectomy, and bladder injury were also commonly reported. To improve the health outcomes of obstructed labor, it is recommended to address the three delay models: enhancing communities' health-seeking behavior, enhancing transportation for an obstetric emergency with different stakeholders, and strengthening the capacity of health facilities to handle obstetric emergencies.

Introduction

Obstructed labor (OL) is when the presenting part of the fetus cannot progress through the pelvis due to obstruction that usually occurs at the pelvic brim, in the cavity, or at the outlet of the pelvis despite strong uterine contractions [1,2], where the obstruction can only be relieved by either cesarean section or other instrumental delivery (forceps, vacuum extraction or symphysiotomy) [1].

Causes of OL are due to mechanical factors, which are mainly due to abnormal fetopelvic relationships. They often cause prolonged labor, but OL is confirmed when further progress is impossible without assistance [3]. Another significant cause of OL can be abnormal presentations that occur more frequently in multi-parous women, where the shoulders of the fetus can also hinder passage through the pelvic outlet [3,4]. In rare cases, soft tissue abnormalities can cause OL [3].

The global number of maternal deaths per 100,000 live births declined by only 2.3% between 1990 and 2015. Nonetheless, accelerated decline rates in MMR were observed from 2000 onwards. During the same period, in sub-Saharan Africa, the reduction in the MMR rate remained hampered, and most countries in the region made sluggish progress in reducing maternal mortality [5–7]. Ethiopia was among the six countries globally that contributed to more than 50% of maternal deaths worldwide in 2008 [8,9]. OL is one of the five major causes of MMR and morbidity in developing countries [10]. In Ethiopia, it accounts for 19.1% of maternal death [11].

OL causes significant perinatal mortality and morbidity in the short and long term [12]. Maternal complications due to OL include intrauterine infection, bladder and rectal injuries due to damage during labor, and uterine rupture with subsequent bleeding, shock, or even death [1]. The long-term condition after OL is the obstetric fistula, an opening that forms in the vaginal wall and communicates in the bladder or rectum or both [1,2,13]. OL accounts for about 80–90% of obstetric fistula [2,14]. Neglected Obstetric fistula is one of the causes of MMR in developing countries [15]. Mental health issues related to OL include depression, anxiety, and social consequences such as stigma, divorce, abandonment, loss of income, and loss of property [16]. Perinatal complications of neglected OL include asphyxia which leads to stillbirth [17], brain damage, or neonatal death [1,16].

The preventable causes of MMR, such as social, cultural, economic, educational, and infra-structural factors of any given country, reflect not only the adequacy of obstetric care but also the socio-economic development level of the country [18,19]. In resource-constrained areas, the poorly functioning health system cannot guarantee the availability of a cesarean section where the amplified effect of OL is observed [10,19]. Early diagnosis and treatment of OL can prevent maternal deaths and obstetric fistulas, but this requires access to emergency obstetric care, a service that most mothers in developing countries do not have [20].

The three delay model has been considered a significant factor in averting maternal complications and mortality from the onset [21]. Studies conducted in Ethiopia showed the effect of each delay on the incidence of maternal complications related to obstructed labor [22–24]. Moreover, proper use of partograph in health facilities will enable the obstetrician to diagnose prolonged or obstructed labor early and easily is recommended [25]. WHO also emphasizes the use of partograph in line with evidence-based reference. Using recordings and reviewing their observations against these references, health personnel could avoid unnecessary interventions and act on warning signs [26]. Studies in Ethiopia reported adverse complications due to obstructed labor due to non/improper use of partograph [23,27,28].

Studies to date show that the problem of OL and its adverse perinatal outcomes are serious and a common public health problem in Ethiopia, and uterine rupture is the leading cause of MMR associated with OL [29–33]. The prevalence of OL in Ethiopia is estimated at 20% [8], ranging between 3.3% and 34.3% in the Tigray [32] and Oromia regions [28], respectively. Incidence of adverse fetomaternal outcomes attributed to obstructed labor were reported in different studies: post-partum hemorrhage [34–36], obstetric fistula [37–39], sepsis [31,33] maternal near miss [40–42], hysterectomy [32,33] maternal mortality [42–44], perinatal asphyxia [45–48], perinatal mortality [49–51], neonatal near miss [52], non-reassuring fetal heart rate [53], and neonatal hypothermia [54].

Identifying adverse fetomaternal outcomes associated with OL is crucial for reducing morbidity and mortality by recognizing modifiable factors and informing evidence-based public health interventions. In this review, the double burden of obstructed labor was investigated, and the incidence of postpartum haemorrhage and sepsis attributed to the prevention of OL attracted our attention. Evidence-based public health interventions to reduce OL will alleviate various adverse complications that cause severe morbidities and mortalities in both the fetus and the mother. Therefore, this systematic review and meta-analysis aimed to estimate adverse maternal and perinatal outcomes of OL.

Methods

Protocol and registration

This systematic review and meta-analysis were conducted following the recommendation of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines. This review protocol is registered in the International Prospective Register of Systematic Reviews (PROSPERO) database and can be accessed at [display_record.php?RecordID=CRD42020196153](https://www.crd.york.ac.uk/PROSPERO/display_record.php?RecordID=CRD42020196153)https://www.crd.york.ac.uk/PROSPERO/display_record.php?RecordID=CRD42020196153. The systematic review protocol is written following the PRISMA guidelines. See [S1 Checklist](#) for the completed PRISMA-P checklist.

Eligibility criteria. *Study design/characteristics.* Observational studies (cross-sectional, case controls, and cohort) that reported adverse fetal and maternal outcomes of OL were included in the current review. Studies that reported adverse fetomaternal outcomes due to OL among mothers or women who have recently given birth were also included. This review included studies conducted in Ethiopia and published in English.

Population. Studies report OL as a cause for adverse perinatal outcome/birth outcome, and studies reporting OL and associated feto-maternal outcomes.

Settings. Studies conducted in Ethiopia were considered. There are 10 regions and 2 chartered cities in Ethiopia.

Outcome of interest. The following adverse perinatal outcomes were reviewed in the current review.

Maternal adverse outcomes: uterine rupture, sepsis, PPH, vesicovaginal fistula (VVF), bladder rupture, wound dehiscence, anemia, perineal tear, cervical tear, hysterectomy, maternal near-miss, labor abnormalities, adverse birth outcome, and maternal death.

Neonatal adverse outcomes: Asphyxia, sepsis, neonatal jaundice, birth injury (cranial injury), non-reassuring fetal heart rate fetal/, meconium-stained amniotic fluid, and perinatal mortality.

Information sources and search strategy. A systematic search of PubMed/MEDLINE, CINAHL, Summon country-specific search, and Cochrane Libraries was conducted from inception. The search strategy was developed in PubMed/MEDLINE (see [S1 File](#)) and adapted to the other bibliographic databases. The following search terms were included in the subject headings (e.g., MeSH in PubMed/MEDLINE) for each database and free-text words for the key concepts of “adverse outcome”, “obstructed labor,” “labor complication”, “maternal near-miss”, “sepsis”, “postpartum hemorrhage”, “bladder injury”, “hysterectomy”, “neonatal near miss”, “cesarean section”, “obstetric fistula”, “birth asphyxia”, “stillbirth”, “meconium-stained amniotic fluid”, “neonatal sepsis”, “neonatal hypothermia”, “non-reassuring fetal heart rate”, “perinatal mortality, and “Ethiopia.” Grey literature was searched, including Google Scholar, Open Grey, and the World Health Organization (WHO) websites. Reference lists of included studies and related reviews were also searched manually.

Study selection and data extraction. The primary online search for the review was conducted between December 16 to March 12, 2022. We have included studies irrespective of their publication date through March 12, 2022. The citations were downloaded into the Endnote software, and duplicate articles were excluded. Two review team members (YGY, GMK) independently screened all studies identified from the literature search in two stages. In the first stage, the two reviewers (YGY, and GMK) independently screened titles and abstracts based on the eligibility criteria outlined above. Reasons for exclusion of the studies excluded from the review were documented. In the second stage, full-text versions of selected articles were downloaded/retrieved and examined in detail by the two reviewers (YGY, GMK) for eligibility. They extracted data from eligible papers identified during the full-text screening step. Any disagreements were resolved through discussion between the two authors. References of all considered articles were hand-searched to identify any relevant report missed in the search strategy. The following information were extracted using validated standard data extraction form: first author, region in which the study was conducted, year of publication, study design, sample size, outcome reported, and study population. Data were extracted independently by two authors (YGY, and GMK). In case of missing data, the corresponding and last authors of studies were communicated by email. A decision on whether to include the study in the final review was made after the authors failed to provide additional information. See ([Fig 1](#)), a flow chart showing the studies included and excluded at each stage of the study selection process.

Assessment of methodological quality. The Newcastle-Ottawa scale (NOS), based on a star scoring system, was used to assess the quality of the included studies [55]. The tool focuses on three components: the methodological quality of each study which is graded by five stars, the comparability of the studies, graded by two stars; and the last component of the tool assesses the outcomes and statistical analysis of the original studies, which was graded from three stars. Quality assessment was checked independently by two authors, and any

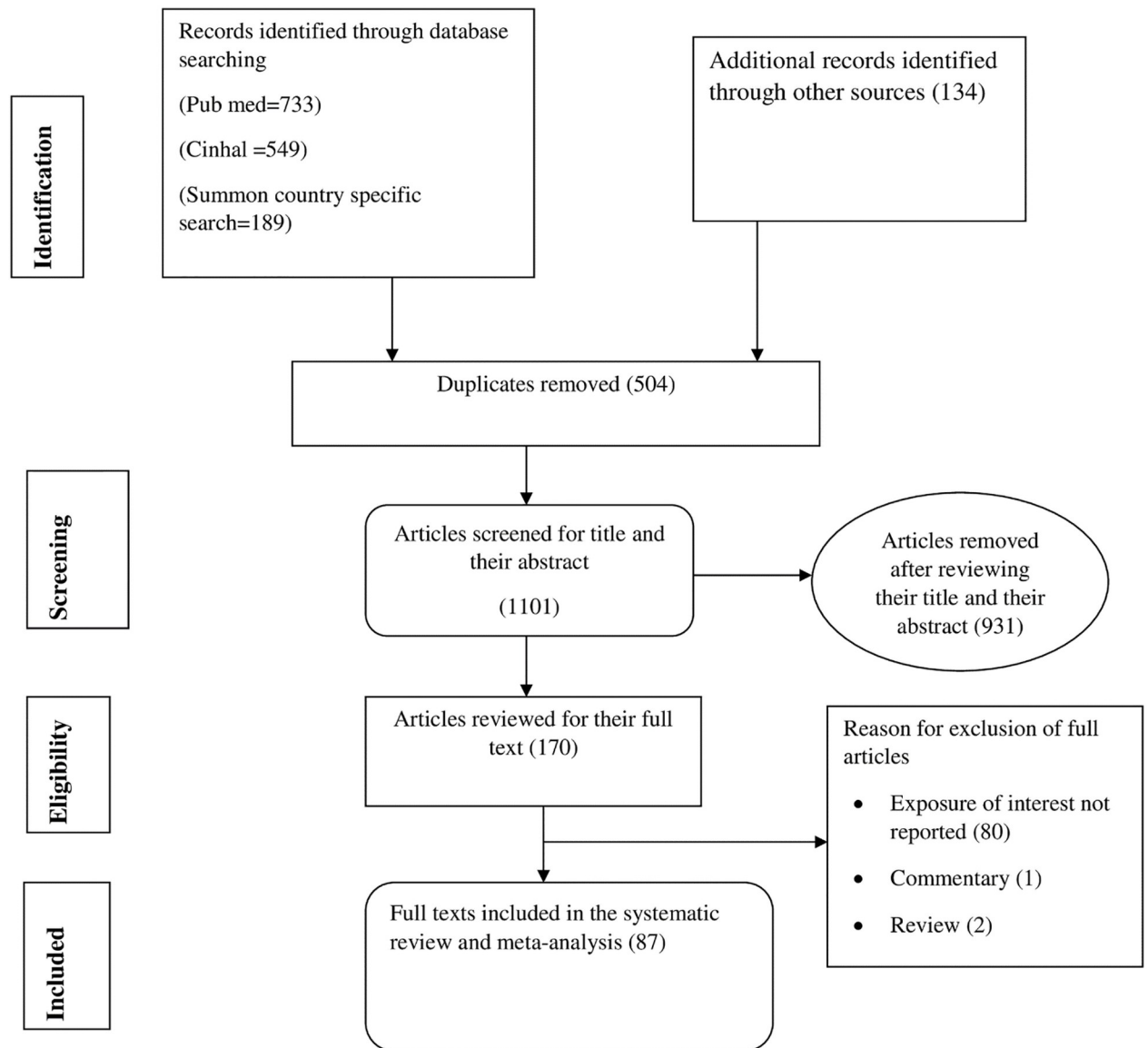


Fig 1. Flow diagram showing the procedures of selecting studies for meta-analysis of the effect of obstructed labor on maternal and fetal outcomes in Ethiopia, 2021.

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disagreements were solved by discussion. Studies that received a score of 6 or above were considered high quality [56]. See (S3 File).

Publication bias and statistical analysis. Egger's tests were used to assess publication bias [57]. Publication bias was declared at a p-value of less than 0.05. I^2 test statistics were used to investigate the presence of heterogeneity across the included studies. The I^2 test statistics of 25, 50, and 75% were declared low, moderate, and high heterogeneity, respectively, and a p-value less than 0.05 was used to declare statistically significant heterogeneity. A random-effect model was used as a method of analysis to test results with the presence of heterogeneity [58,59].

Data were extracted in Microsoft Excel and exported to STATA version 16 for further analysis. A Forest plot was used to present the combined estimate with a 95% confidence interval (CI) of the meta-analysis. Subgroup analysis was conducted for regions of the country. A

meta-regression model was done based on sample size, year of publication, and quality score to identify the sources of random variations among included studies. The effect of obstructed labor on adverse maternal and perinatal morbidity and mortality was analyzed using separate categories of meta-analysis. The meta-analysis findings were presented using a forest plot and Odds Ratio (OR) with a 95% Confidence Interval (CI).

Results

Study selection

A total of 1605 records were retrieved through electronic database searching. Five hundred four (504) duplicate articles were removed. Records were screened using titles, abstracts, and a full article review. Consequently, we excluded 931 articles using their title and abstract review. The remaining one hundred seventy articles were assessed for eligibility, and eighty-five articles were excluded. Finally, eighty-seven articles were included in this meta-analysis (Fig 1).

Characteristics of included studies

The study included sixty-three cross-sectional, twenty-five case-control, and two cohort study designs. The largest sample size was 68,002 from the national survey [60], and the lowest sample was 27 in a study conducted in the Amhara region [61]. Overall, the review was conducted among 104259 women and 4952 newborns. All of the studies were conducted in the six regions of the country. Of these, twenty-two studies were from SNNPR, twenty-two were from the Amhara region, fifteen were from the Tigray region, twelve were from the Oromia region, six were from Addis Ababa, and three were from Harrari city administration. Additionally, seven national reviews were included (see S2 File for a detailed description).

Quality of the included studies. The Newcastle-Ottawa scale (NOS) was used to assess the quality of the included studies. Two studies were assessed using the NOS checklist for prospective cohort, twenty-four case studies were assessed using the NOS checklist for case-control studies, and sixty-one studies were considered the adapted version of cohort study assessment of the NOS scale. None of the studies were excluded based on the quality assessment criteria.

Maternal mortality due to obstructed labor. Seven studies in the review reported the maternal death rate in women diagnosed with OL [31,32,42–44,62,63]. As illustrated in the forest plot, the overall rate of maternal death in women with obstructed labor was estimated to be 14.4% [14.14 (6.91–21.37), $I^2 = 91.4\%$, $P < 0.001$] (Fig 2). The test of publication bias using Egger's test was significant, p -value > 0.034 . Accordingly, a univariate meta-regression was done to identify the source of publication bias. However, a non-significant heterogeneity was found due to sampling size (p -value = 0.513) and year of the study (p -value = 0.23). According to the subgroup analysis, the highest rate of maternal death due to OL was reported from the Oromia region (34.17 (95%CI 25.68, 42.65)), and the lowest rate was reported from the Tigray region (5.64 (95% CI: 0.33, 10.95)) (Fig 2).

Severe maternal morbidity due to obstructed labor. *Uterine rupture due to obstructed labor.* The meta-analysis of 8 studies [29–33,64–66] showed the pooled prevalence of uterine rupture due to OL in Ethiopia to be 41.18% (95% CI: 19.83, 62.54). A random-effects model of analysis was used due to a significant heterogeneity ($I^2 = 98.9\%$, p -value < 0.01) (Fig 3). There was no publication bias based on the Eggers test (p -value = 0.556). However, a univariate meta-regression analysis revealed a non-significant heterogeneity due to the sample size (p -value = 0.487), year of publication (p -value = 0.940), quality score (p -value = 0.402), and study design.

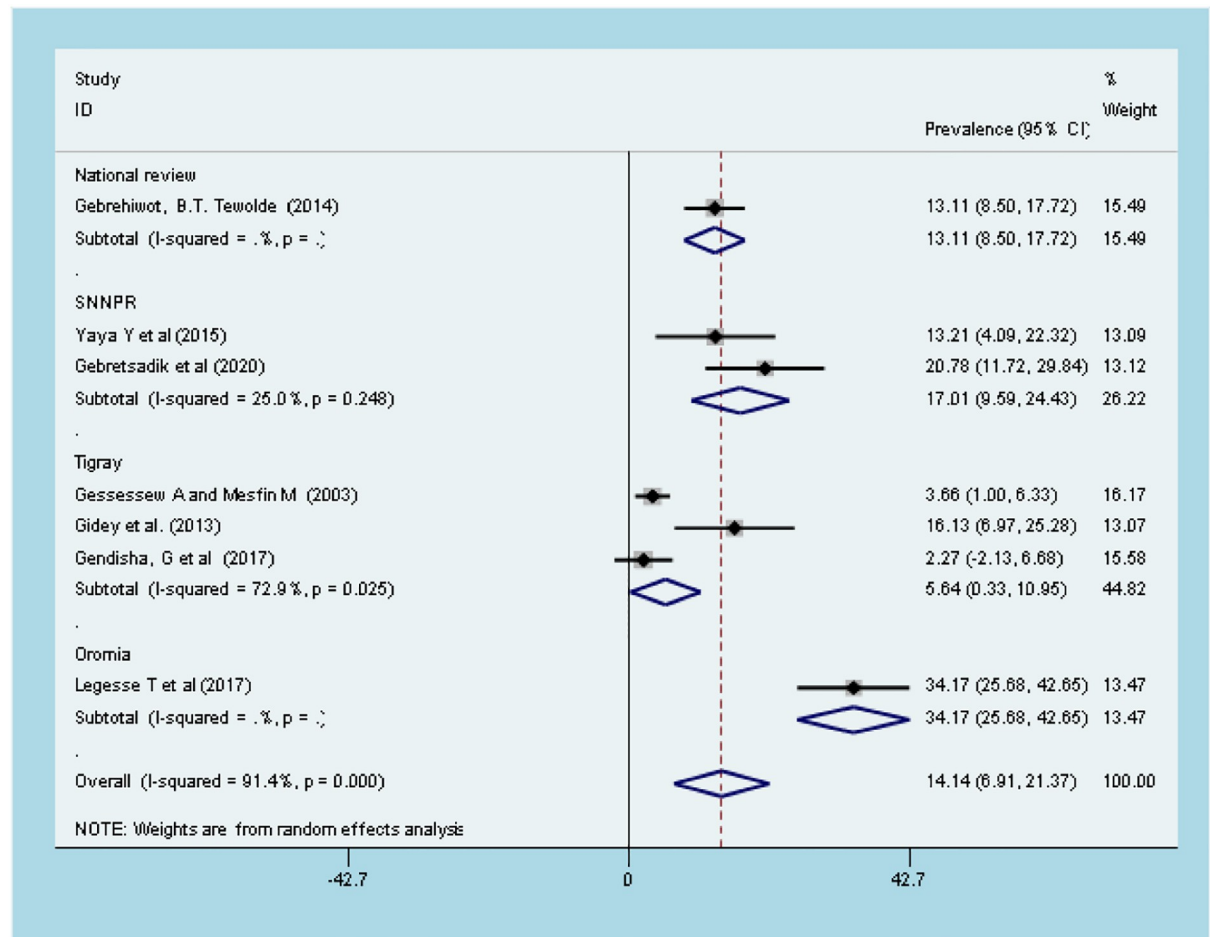


Fig 2. Forest plot of overall incidence of maternal death among obstructed labor women in Ethiopia.

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(P -value = 0.093). The subgroup analysis revealed that the highest prevalence of uterine rupture due to OL occurred in the Oromia region (67.6% (95% CI: 60.74, 74.45)), and the lowest was in the Tigray region (20.8% (95% CI: 16.41, 25.12)) (Table 1).

Maternal near-miss due to obstructed labor. Seven studies reported the prevalence of maternal near-miss due to OL and the pooled prevalence of maternal near-miss was estimated to be 30.5% [30.5 (11.40, 49.59), $I^2 = 99.3\%$, $p < 0.001$] (Fig 3) [40–42,67–70]. Egger's test showed a non-significant publication bias, (p -value > 0.830). The subgroup analysis revealed that the highest prevalence of maternal near-miss due to obstructed labor occurred in the Amhara region (43.7% (95% CI: 29.7, 57.78)) and the lowest was in Addis Ababa city administration (4.20% (95% CI: 1.65, 6.75)) (Table 1).

Postpartum hemorrhage due to obstructed labor. A pooled prevalence of 12.96% [12.96 (7.42, 18.51), $I^2 = 88.4\%$, $p < 0.01$] was estimated for postpartum hemorrhage due to OL from the eight studies [29,31–36,71] that reported the outcome (Fig 3). There was a significant publication bias, (p -value > 0.003) and univariate meta-regression analysis revealed a non-significant heterogeneity due to the sample size (p -value = 0.092), year of publication (p -value = 0.300), and quality score (p -value = 0.319). The subgroup analysis revealed that the highest prevalence of postpartum hemorrhage due to OL occurred in the Tigray region (22.3% (95%

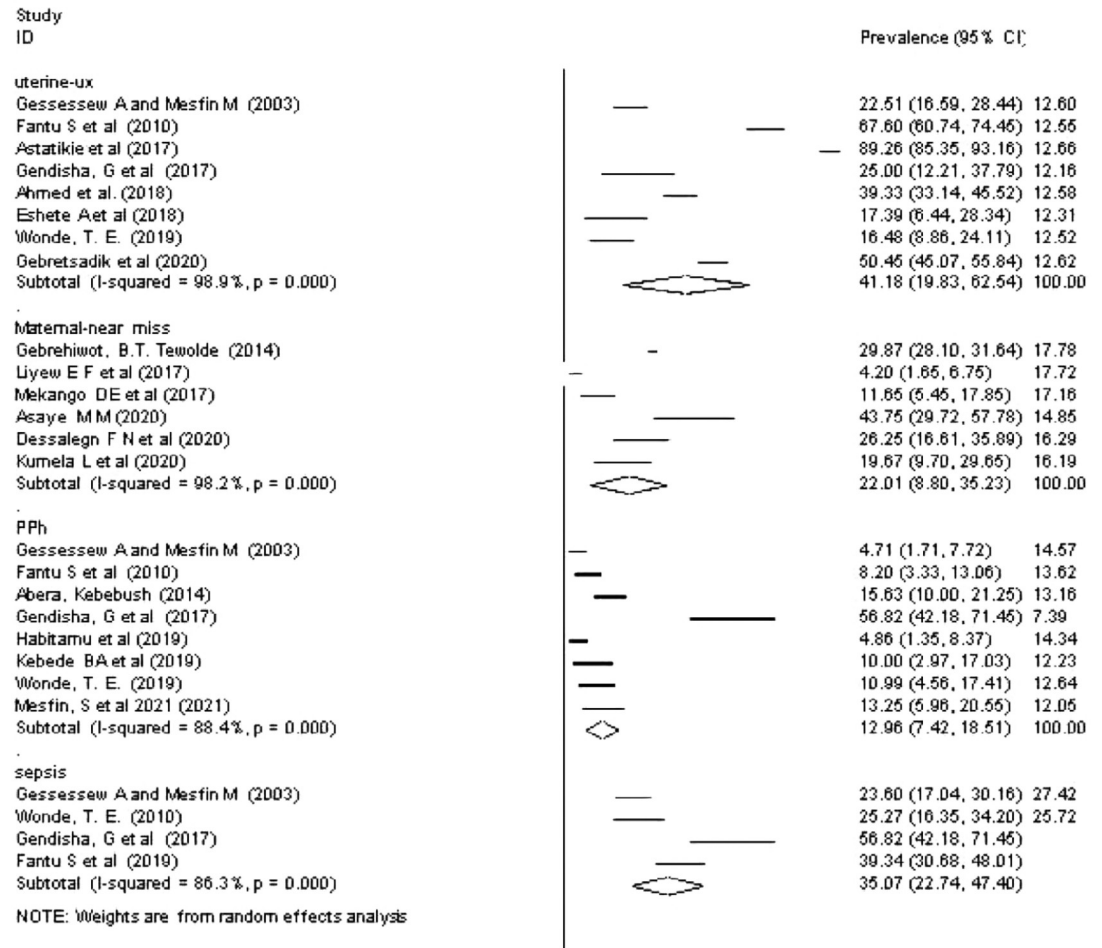


Fig 3. Forest plot of overall prevalence of severe maternal outcomes among obstructed labor women in Ethiopia, 2021.

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CI: 3.58, 41.03), and the lowest was in the Amhara region (4.86% (95% CI: 1.35, 8.37) (Table 1).

Maternal sepsis due to obstructed labor. Four studies [29,31–33] reported the prevalence of maternal sepsis due to OL, and the pooled prevalence of maternal sepsis was estimated to be 35.07% [35.07 (22.74, 47.40), I² = 86.3%, p < 0.001] while there was no significant publication bias (p-value > 0.139) (Fig 3). The subgroup analysis revealed that the highest prevalence of postpartum hemorrhage due to OL occurred in the Tigray region (38.9 (95% CI: 21.75, 56.02), and the lowest was in the Oromia region (25.27 (95% CI: 16.35, 34.2) (Table 1).

Maternal morbidity due to obstructed labor. As demonstrated in the forest plot, the overall rate of fistula in women with OL was estimated to be 3.7% [3.7 (2.12, 5.29), I² = 98.1%, P < 0.001] (Fig 4). Egger’s test was nonsignificant (p-value > 0.176). The sub-group analysis showed that the highest rate of the fistula is reported in the Oromia region (29.9%); and the lowest rate was observed in the Amhara region (0.36) (Table 1). In addition, the pooled prevalence of bladder injury among women with OL was estimated to be 7% [7.15 (2.47–11.83), I² = 72.5%, p < 0.012] (Fig 4). The prevalence of bladder injury was reported in two regions; the highest rate was observed in the Tigray region, 18.2% [31], and 8.8% in the Oromia region

Table 1. Subgroup analysis of adverse maternal morbidity due to obstructed labor by region in Ethiopia.

Adverse maternal mortality	Region	Number of studies	Prevalence [95%CI]	I ²	P-value
Uterine rupture	Amhara	2	64.35 (15.43, 113.23)	99.4%	<0.001
	SNNPR	2	34.28 (1.89, 66.67)	96.5%	<0.001
	Tigray	3	20.8(16.41, 25.19)	0.0%	0.34
	Oromia	1	67.6 (60.74, 74.45)	-	-
Maternal near miss	Addis Ababa	1	4.20 (1.65,6.75)	-	-
	Amhara	1	43.75 (29.7,57.78)	-	-
	National	1	29.87(28.1,31.64)	-	-
	Tigray	1	11.65(5.45,17.85)	-	-
	Oromia	3	41.65(-0.81,1,84.11)	98.9%	<0.001
Postpartum hemorrhage	Harari	1	13.25(5.96, 20.55)		
	Addis Ababa	1	15.63 (10, 21.25)	-	-
	Amhara	1	4.86 (1.35, 8.37)	-	-
	Oromia	1	8.2 (3.33, 13.06)	-	-
	Tigray	3	22.3 (3.58, 41.02)	95.8%	<0.001
	SNNPR	1	10 (2.97, 17.03)	-	-
Sepsis	Oromia	1	25.27 (16.35,34.2)	-	-
	Tigray	3	38.9 (21.75, 56.02)	90%	<0.001
Obstetric Fistula	Oromia	2	29.93(-21.37, 81.23)	98.4%	<0.001
	Tigray	3	8.078 (5.123, 11.027)	0.0%	0.374
	Amhara	1	0.364 (0.008, 0.72)	-	-
	National	2	1.662 (-0.774, 4.098)	99.6%	<0.001

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[33]. As shown in the forest plot, the overall rate of hysterectomy in women with OL was 14.3% [14.3 (8.06–20.60), $I^2 = 52%$, $p < 0.149$] (Fig 4).

Cesarean section due to obstructed labor. The meta-analysis of 17 [53,60,72–86] studies showed the pooled prevalence of cesarean section due to OL in Ethiopia to be 17.67% (95% CI: 12.45, 22.89). A random-effects model of analysis was used due to a significant heterogeneity ($I^2 = 98.8%$, p -value < 0.01) (Fig 5). There was no publication bias (p -value = 0.064) and a univariate meta-regression revealed a non-significant heterogeneity due to the sample size (p -value = 0.346), and study designs (p -value 0.625), but significant heterogeneity due year of publication (p -value = 0.050). Subgroup analysis revealed that the highest prevalence of cesarean section due to OL occurred in national representative reviews (28.32% (95% CI: 17.80, 38.85) and the lowest was in Addis Ababa city administration (4.6% (95% CI: 2.8, 6.39) (Fig 5).

A single study in the SNNPR region reported a 17% incidence of labor abnormalities in a woman with obstructed labor [87].

Perinatal morbidity and mortality due to obstructed labor. Fourteen studies [31,32,49–51,88–93] reported an incidence of perinatal death in women with obstructed labor, and the forest plot in Fig 6 shows the rate of perinatal death among women with obstructed labor was 26.4% (26.4 (95% CI 15.18, 37.7), $I^2 = 95.6%$, $p < 0.001$) (Fig 6). Three studies [33,61,94] separately reported incidence of stillbirth among women with OL, 47% (95% CI: 30.3, 63.84), 37.36% (95%CI: 27.42, 47.3), and 40.74% (95% CI: 22.2, 59.2) from SNNPR, Oromia, and Amhara regions respectively. Egger's test was not statistically significant, p -value = 0.237, and subgroup analysis showed that the highest perinatal death rate due to OL occurred in the Tigray region (Table 2).

Few individual studies reported the incidence of adverse neonatal outcomes among women with OL. A study from Eastern Ethiopia stated a 10.1% incidence of neonatal hypothermia

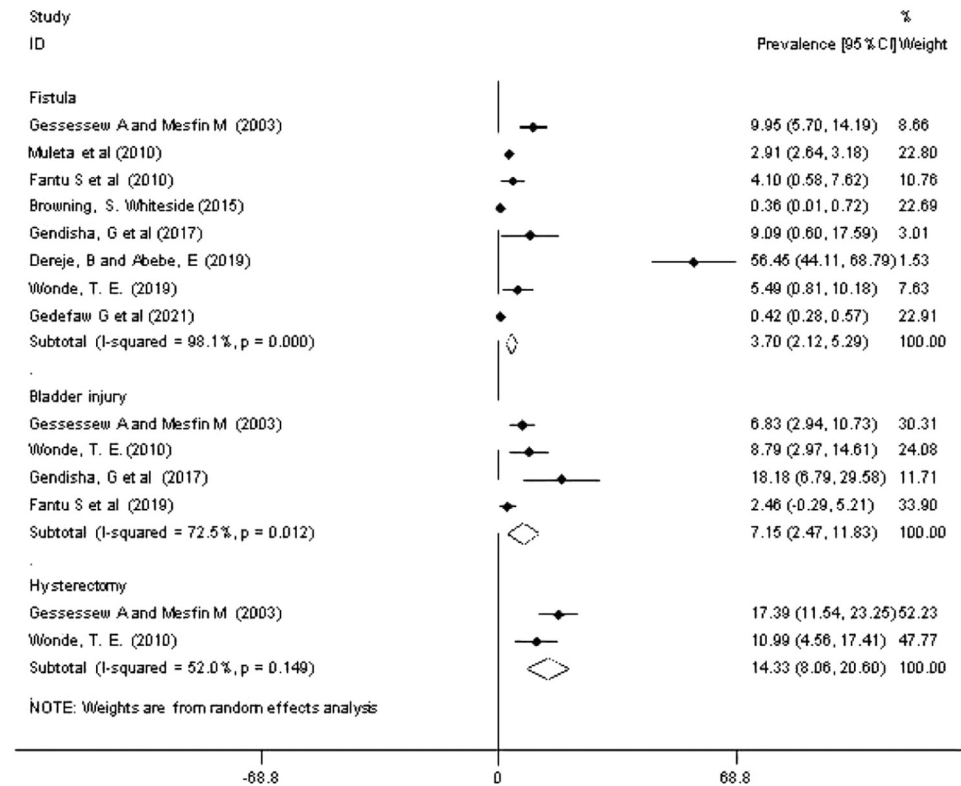


Fig 4. Forest plot of overall prevalence of maternal morbidities outcomes among obstructed labor women in Ethiopia, 2021.

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among newborns born from women with OL [54]. A study from the Amhara region reported a 12.4% prevalence of neonatal sepsis among women with obstructed labor [95]. Similarly, two studies conducted in the Amhara region demonstrated a prevalence of neonatal near miss and non-reassuring fetal heart rate, 19.15% and 20%, respectively [52,53].

Association between obstructed labor and adverse maternal and fetal outcomes. The meta-analysis of 8 studies [96–102] demonstrated that OL significantly predicted uterine rupture. The odds of uterine rupture were 22.67 times higher among women with OL (OR: 22.67; 95% CI: 12.49, 39.91) (Fig 7).

Thirteen studies demonstrated the association between OL and adverse perinatal outcomes. The odds of stillbirth were 2.35 times higher among women with OL (OR: 2.35; 95% CI: 1.56, 3.53) (Fig 8). The meta-analysis of 5 studies demonstrated that OL was a significant predictor of perinatal asphyxia. The odds of perinatal asphyxia were 2.59 times higher among women with OL (OR: 2.59; 95% CI: 1.68, 4). The odds of perinatal mortality were 6.1 times higher among women with OL (OR: 6.1; 95% CI: 4.18, 8.9). Similarly, the odds of meconium-stained amniotic fluid were 4.95 times higher among women with OL (OR: 4.95; 95% CI: 2.23, 11).

Discussion

This study estimated the pooled prevalence of maternal and perinatal morbidity and mortality due to OL among Ethiopian women. In the current review, OL accounted for 14% of maternal deaths in Ethiopia. The high incidence of maternal death in OL can be attributed to a ruptured uterus or puerperal infection [103], as observed in this review. This finding is similar to a study conducted in Nigeria and Pakistan that reported a maternal death rate of 7.7% [104] and 10%

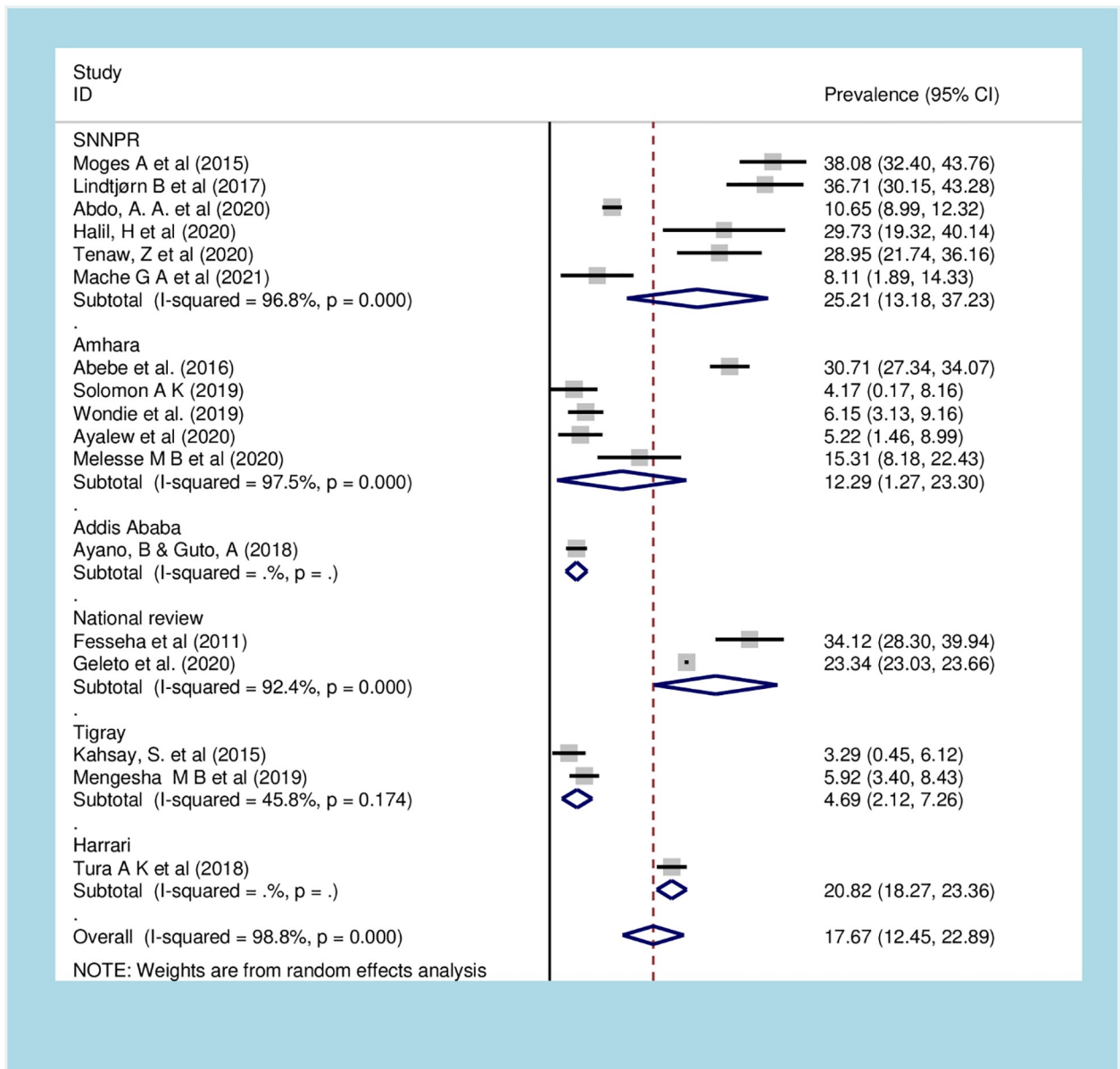


Fig 5. Forest plot of subgroup analysis of cesarean section among obstructed labor women in Ethiopia, 2021.

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[10], respectively. However, the rate of maternal death from this review is much higher than in studies conducted in Nigeria, 6.03–6.07% [105,106], Uganda, 1.21% [107], Sudan, 4.8%, Pakistan, 1.19–2.06% [108,109], and study conducted in developing countries [18]. The possible justification for the discrepancies could be the better provision of services such as antenatal care in maternal health service utilization. Tessema et al. [110] reported that Ethiopia uses the lowest recommended ANC among other African countries. Antenatal care allows early identification and management of obstetric complications [111]. The discrepancy could also be explained by the differences in the quality of maternal and neonatal health care services provided.

In Ethiopia, OL accounts for 30% of maternal near-miss cases. This proportion is higher than the studies reported from Namibia, 9.3% [112], and central Uganda, 11.2% [113]. The

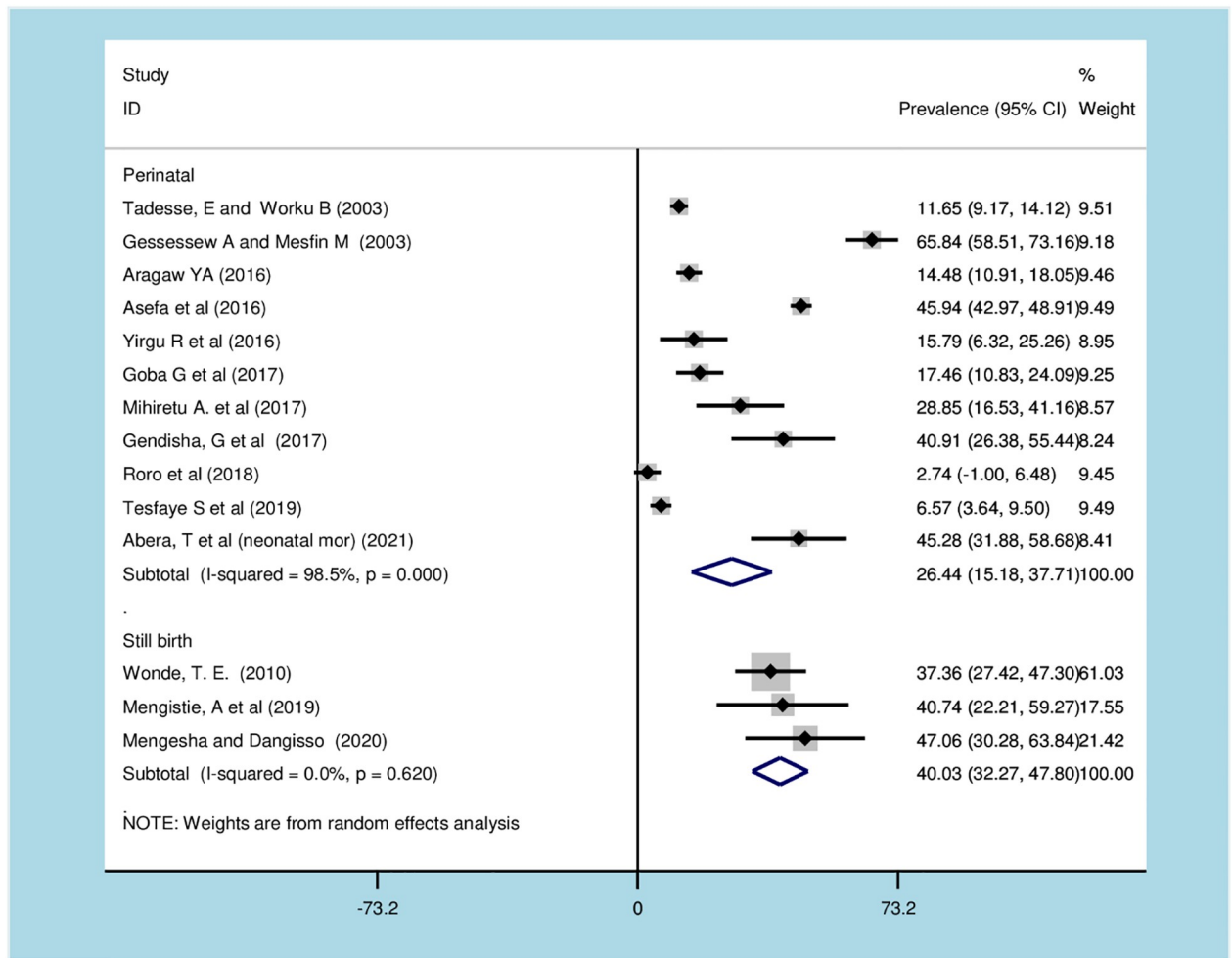


Fig 6. Forest plot of overall prevalence of perinatal death among obstructed labor women in Ethiopia, 2021.

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difference in the presented proportions could be due to the inconstant use of criteria for maternal near-miss in most African countries [114].

In this review, higher proportions of uterine rupture, postpartum hemorrhage, 41.8% and 12.96%, respectively attributed to obstructed labor are reported. The highest incidence of uterine rupture and postpartum haemorrhage in OL could be explained by the prolonged duration of labor, which usually precedes OL. It results in maternal dehydration, infection, ketosis, and exhaustion [103,115]. As a result, a decrease in strength and frequency of contractions contributes to the rupture of the uterus and associated bleeding. In addition, sustained contractions of

Table 2. Subgroup analysis of adverse perinatal outcome due to obstructed labor by region in Ethiopia.

Adverse perinatal outcome	Region	Number of studies	Prevalence [95%CI]	I ²	P-value
Perinatal death	Amhara	1	15.79 (6.3, 25.25)	-	-
	SNNPR	2	16.88 (-4.89, 38.6)	91.6%	<0.001
	Tigray	3	41.39 (7.454, 75.3)	97.8%	<0.001
	Oromia	4	26.78 (3.88, 49.67)	99.2%	<0.001
	Addis Ababa	1	11.6 (9.17, 14.1)	-	-

<https://doi.org/10.1371/journal.pone.0275400.t002>

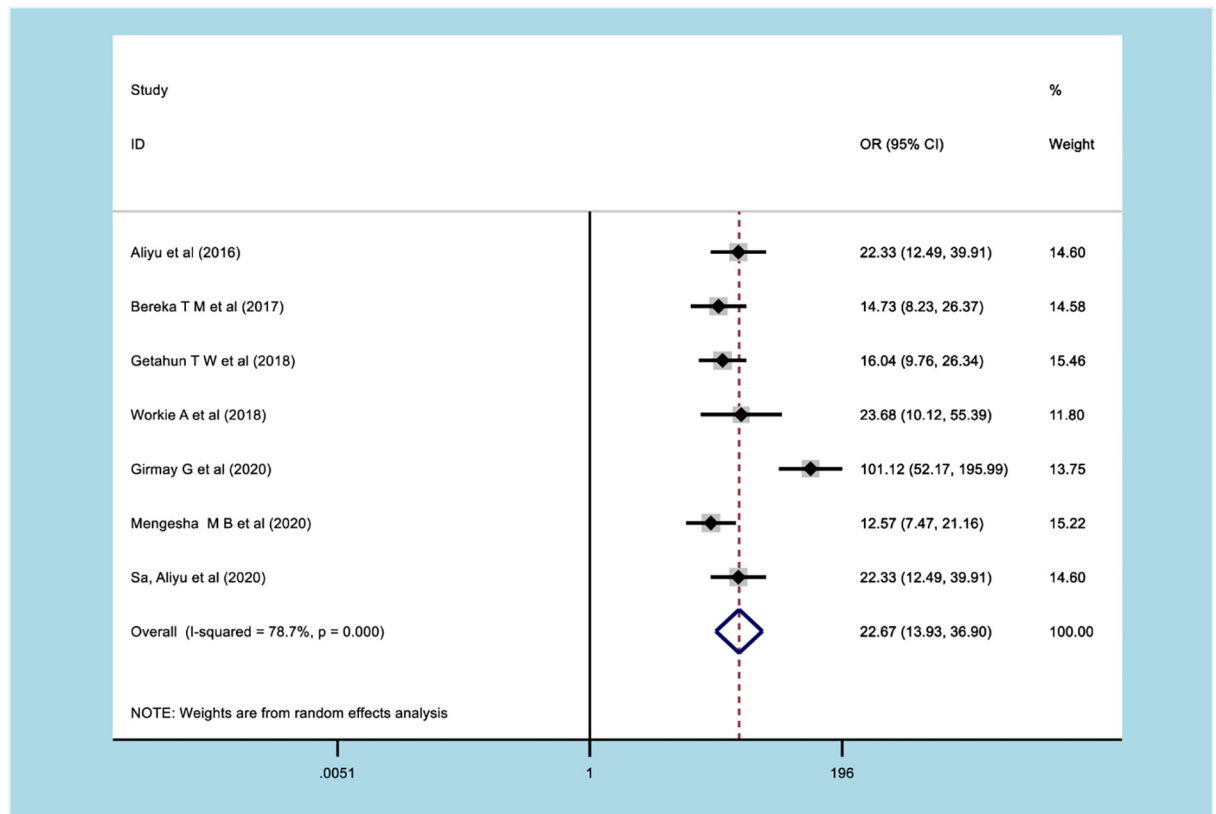


Fig 7. Forest plot of association of obstructed labor with uterine rupture.

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the uterus in myometrial energy depletion and hypoxia are likely to lead to myometrial edema and necrosis, contributing to uterine rupture [103].

The rate of postpartum hemorrhage reported in this review is in line with findings from East African countries [106,116], South Asian countries [108,117], and a study conducted among low and middle-income countries [118]. However, lower than the results reported from Pakistan [109,119], India [12], and Bangladesh [120]. The discrepancy could be due to the high proportion of maternal deaths secondary to obstructed labor in the Asian region [121].

The incidence of uterine rupture due to OL demonstrated in this review is similar to findings from Nigeria [104] and [122]. But, higher than results from India [117], Nepal [123], Bangladesh [120], and Pakistan [108,109,122]. The higher incidence of uterine rupture could be explained by the lack of advancement in technologies or availability of resource, which could help prevent the complications from OL. In low resource settings, the major cause of morbidity and mortality from OL is believed to be constrained resources [10].

Our review demonstrated the high incidence of sepsis, 35% in women with OL. The prolonged rupture of the membranes from a prolonged state of labor accompanied by an open cervix impairs natural, mechanical barriers to ascending infection from the vagina, which results in intrapartum infection [17,124]. This is in agreement with findings from Nigeria [104,105]. The rate of sepsis from this review is much higher than in studies from Sudan [116], Uganda [107], Pakistan [108,109,119], and India [117,125]. In addition, low- and middle-income countries reported a low incidence of sepsis [118]. The inconsistency might be due to

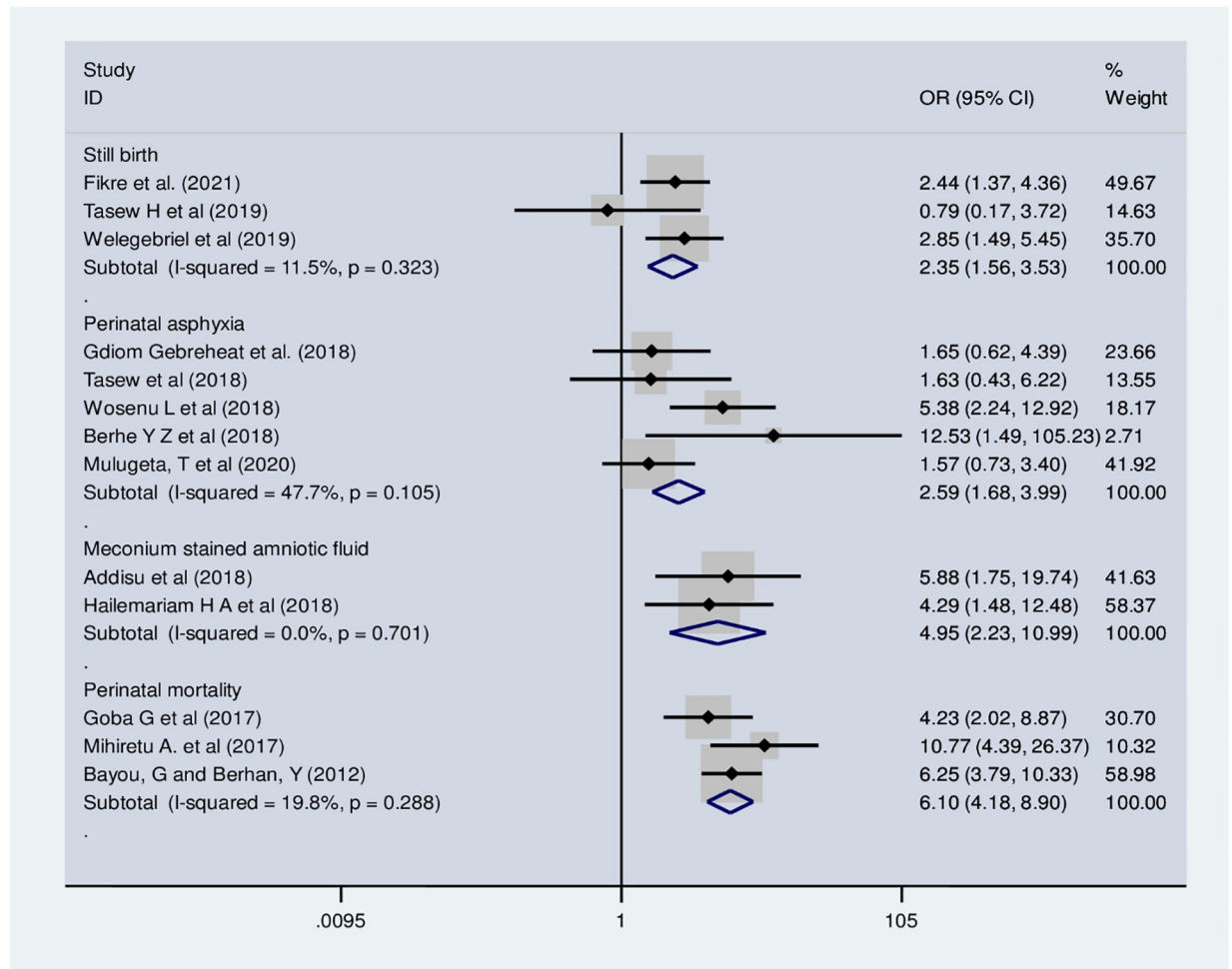


Fig 8. Forest plot of association of obstructed labor with uterine rupture.

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the difference in the adequacy of facilities and equipped staff in managing women with OL. In addition, frequency of vaginal examinations during the prolonged stages of labor could contribute to the highest incidence of intrapartum infection.

Incidence of obstetric fistula (3.7%), bladder injury (7.1%), and hysterectomy (14%) were maternal complications reported by the current review. Damage to the vaginal and bladder tissues confined between the fetal head and the mother's pubic symphysis during prolonged OL results in vesicovaginal fistulas [126,127]. The ruptured uterus and associated damage from the OL result in the observed rate of hysterectomy. The incidence of the fistula is mainly reported in developing countries: Nigeria [104], East African countries [107,116,128], India [117], and Pakistan [109,119,129]. In developed nations, fistula is a rare problem [121]. The incidence of bladder injury due to OL was stated in different research findings [12,109,117,119,120,128]. Similarly, hysterectomy due to obstructed labor was reported in some studies [119,120,130].

We have found that 17.67% of women with OL had a cesarean section. The incidence of cesarean section in a woman with OL is because the OL can be avoided by operative delivery of the fetus [20]. The reported incidence of cesarean section is much lower than in studies conducted in different regions worldwide. The incidence ranged from 82% to 95.23%

[107,108,117,120,131]. The large discrepancies could be due to facilities' availability and adequacy of emergency cesarean sections. In addition, the type of obstruction, whether relative or absolute OL, might determine the indication of cesarean section.

In this review, we have reported an incidence of perinatal death of 26.4% due to OL. The adverse perinatal outcomes attributed to OL are due to the preceding prolonged labor, which results in intrapartum infection. Moreover, the interruption of the placental exchange by strong and continued uterine contraction and retraction [115] often results in the death of the fetus either before delivery or shortly afterward from a combination of asphyxia and infection. These findings are in line with studies from different African countries [104,105,116,132], Bangladesh [120], and India [117,125]. However, there was a lower incidence of perinatal death due to OL in Uganda (14%). The observed variation in the incidence could be due to the difference in the severity of maternal morbidity, which affected the neonatal outcome. In addition, the difference in readiness for the management of immediate neonatal complications could be the reason.

We have also investigated the association between OL and perinatal outcomes. The odds of perinatal asphyxia were 2.6 more likely to occur among babies born from mothers with obstructed labor. The possible explanation could be the prolonged interruption of the placental exchange secondary to OL. This finding is supported by studies from Nigeria [133] and Pakistan [108]. Likewise, the odds of meconium-stained amniotic fluid were almost five times higher among women with OL. This finding is in line with a study from Nigeria [134]. Similar studies also reported the rate of meconium-stained amniotic fluid in women with obstructed labor [108,117,120].

Strength and limitations of the study

The review included several articles to investigate the effect of OL on maternal and fetal outcomes. In this review, we have included studies that show the causal relationship. By doing so, the review provides valuable evidence that may contribute to the filling the gaps in research related to adverse outcomes associated with OL and informing practice and policy about the most frequent complications of OL. The review also included studies conducted in the community setting. However, the results of this review should be interpreted with some limitations. There is a high level of heterogeneity among the included studies that may have led to insufficient power to detect statistically significant associations, which should be considered while using the results of the review. In addition, outcomes such as hysterectomy, the incidence of labor abnormalities, neonatal hypothermia, neonatal sepsis, neonatal near miss, and stillbirth are represented by a small number of studies that may not be representative to conclude. The studies were conducted only in the country's six regions, which may reduce its representativeness.

Conclusion and recommendations

The systematic review and meta-analysis demonstrated that obstructed labor is associated with adverse maternal and neonatal morbidities and mortalities. In addition, further severe morbidities such as uterine rupture, postpartum hemorrhage, maternal sepsis, maternal near-miss, obstetric fistula, high incidence of cesarean section, bladder injury, hysterectomy, labor complications, perinatal asphyxia, meconium-stained amniotic fluid, neonatal sepsis, and non-reassuring fetal heart rate were also reported.

The advocacy for preventing the catastrophic effect of obstructed labor should be collaborative interactions amongst a range of stakeholders, and interest groups working on promoting maternal and child health. Policies and programs targeting maternal and child health should

emphasize the different levels and places where the complications happen, and typical example could be advocating the three-delay model, which has been proven to avert adverse obstetric outcomes at different stages. Addressing the three delay models: enhancing communities' health-seeking behavior, improving transportation for obstetric emergencies with other stakeholders, and strengthening the capacity of health facilities to hand over obstetric emergencies. Moreover, at health facilities enhancing the use of Partograph, a low-cost tool for monitoring labor progress and reducing the occurrence of prolonged/obstructed labor to provide an early warning system with evidence-based references is recommended. In resource-constrained areas, Partograph has practical benefits in terms of ease of use, time resourcefulness, continuity of care, and educational assistance. These positive aspects may contribute to improving maternal and fetal outcomes. Furthermore, comprehensive and targeted community education about obstructed labour combined with a wide range of activities at health facilities, including welcoming system of maternal health services, and accessible emergency obstetric services, are fundamental in reducing the incidence and complications associated with obstetric labor.

Supporting information

S1 Checklist. PRISMA 2020 flow diagram for new systematic reviews, which included searches of databases, registers, and other sources on Obstructed labor and its effect on adverse maternal and fetal outcomes in Ethiopia: A systematic review and meta-analysis.
(DOCX)

S1 File. The search strategy used for the systematic and meta-analysis on obstructed labour and its effect on adverse maternal and fetal outcomes in Ethiopia.
(DOC)

S2 File. Characteristics of included studies.
(DOC)

S3 File. Quality assessment of studies included in this systematic review and meta-analysis on the effect of obstructed labour on perinatal outcome in Ethiopia: A systematic review and meta-analysis.
(DOC)

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Author Contributions

Conceptualization: Yordanos Gizachew Yeshitila.

Data curation: Yordanos Gizachew Yeshitila.

Formal analysis: Yordanos Gizachew Yeshitila, Getachew Mullu Kassa.

Funding acquisition: Yordanos Gizachew Yeshitila.

Investigation: Yordanos Gizachew Yeshitila.

Methodology: Yordanos Gizachew Yeshitila, Beniam Daniel, Melaku Desta, Getachew Mullu Kassa.

Project administration: Yordanos Gizachew Yeshitila, Beniam Daniel.

Resources: Yordanos Gizachew Yeshitila, Getachew Mullu Kassa.

Software: Yordanos Gizachew Yeshitila, Beniam Daniel, Melaku Desta, Getachew Mullu Kassa.

Supervision: Yordanos Gizachew Yeshitila, Melaku Desta.

Validation: Yordanos Gizachew Yeshitila.

Visualization: Yordanos Gizachew Yeshitila.

Writing – original draft: Yordanos Gizachew Yeshitila, Getachew Mullu Kassa.

Writing – review & editing: Yordanos Gizachew Yeshitila, Beniam Daniel, Melaku Desta, Getachew Mullu Kassa.

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