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Research Article

Birth Asphyxia and its Determinants in Ethiopia: A Systematic Review and Meta-analysis

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Abstract

Background: About 45% of under-five children death occurs during the neonatal period globally which accounts 23% neonatal deaths in low-income countries. Birth asphyxia is one of the leading causes of neonatal morbidity and mortality, constituting 34% in Ethiopia. Birth asphyxia occurs in association with maternal, fetal, and maternofetal factors. However, the magnitude and associated factors of birth asphyxia are not well studied in Ethiopia. Therefore, the main objective of this review was to estimate the pooled prevalence of birth asphyxia and its associated factors in Ethiopia.

Methods: The international databases include MEDLINE/PubMed, EMBASE, Web of Sciences, Scopus, and Grey literature databases, Google Scholar, Science Direct and Cochrane library were scientifically explored. All primary studies reporting the prevalence of birth asphyxia and associated factors in Ethiopia were considered. We retrieved all necessary data by using a standardized data extraction format, spreadsheet. STATA 14 statistical software was used to analyze the data and Cochrane Q test statistics and I^2 test was used to assess the heterogeneity between the studies and a random effect model was computed.

Results: The pooled estimate prevalence of birth asphyxia from included studies in Ethiopia was 22.50%. Prolonged labour (> 12 hours) [OR = 3.10], meconium stained [OR = 6.80], assisted vaginal delivery (vacuum or Forceps) and C/S delivery [OR = 3.42], gestational age < 37 weeks [OR = 3.72], non-cephalic presentation (OR: 2.43), cord prolapse [OR = 2.95], Premature Rupture of Membrane [OR = 12.27] were predictors variables.

Conclusion: Birth asphyxia in Ethiopia was relatively higher as compared to those reported by other studies done in different countries. Prolonged labor (> 12 hours), meconium-stained, assisted vaginal delivery, gestational age < 37 weeks, non-cephalic presentation, cord prolapse and Premature Rupture of Membrane were associated risk factors variables. Hence, appropriate holistic care of pregnancy, labor and delivery and post-natal care is recommended to prevent those risk factors.

Keywords: Associated Factors; Birth Asphyxia; Ethiopia

Abbreviations

Apgar: Appearance, Pulse, Grimace, Activity, and Respiration; CI: Confidence interval; OR: Odds Ratio; PROM: Prolonged Rupture of Membranes; SNNP: South Nations Nationalities Peoples

Background

Birth asphyxia can be defined as the failure of neonates to initiate and sustain breathing at birth which is characterized by a marked impairment of gas exchange; if prolonged leading to progressive hypoxemia, hypercapnia, and significant metabolic acidosis [1,2]. Birth asphyxia is one of the most causes of morbidity and mortality in neonates in developing countries, with an incidence rate of 100 - 250/1000 live births compared to 5 - 10/1000 live births in the developed world [2,3]. Globally, 45% of under-five children death occurs during the neonatal period, accounting for about one-fourth of the 4 million neonatal deaths, which is responsible for 23% neonatal deaths in low-income countries [4-6]. In developing countries, neonatal deaths accounted for 52% of all under-5 child mortality in South Asia, 53% in Latin America and the Caribbean, and 34% in sub-Saharan Africa due to preventable causes including perinatal asphyxia [7,8]. In Ethiopia, birth asphyxia is one of the driving causes of neonatal mortality, constituting 34% [8]. Studies conducted in Osogbo, Southwestern Nigeria [9], Southern Nepal [10], and Khulna Urban Slum, Bangladesh [11] also suggest that birth asphyxia is responsible for about 23.9%, 30%, and 39% of the deaths, respectively. Common outcomes after birth asphyxia include multisystem organ dysfunction, neonatal neurological problems such as seizure, coma, and hypotonic (neonatal encephalopathy) [5,12]. The effect of birth asphyxia is not limited only to death but also has to lead to physical, mental and social incapability in newborns due to severe hypoxic-ischemic organ damage [13]. Birth asphyxia is caused by a complex range of factors, grouped as occurring before birth (antepartum factors) (50 - 70%), during birth (intrapartum factors) (20 - 40%) and after birth (post-partum factors) (10%) [14,15]. Common risk factors of birth asphyxia include maternal age under 16 or over 35 years old, gestational age < 37 or > 41 weeks, diabetes, utilization of illicit drugs and alcohol, hypertensive disorders, bleeding in the second or third trimester and labor > 24 hours spontaneous vertex delivery, cesarean section, prolonged and premature rupture of membranes, meconium staining, maternal infection and anemia at delivery [16,17].

In Ethiopia, contradicted and inconsistency studies have been conducted to assess the prevalence of birth asphyxia and associated factors. The impact is still higher and with abundant discrepancy and inconstancy across regions related to the prevalence of birth asphyxia and its associated factors. However, the overall prevalence and its determinants of birth asphyxia in Ethiopia have not yet been investigated. So that assessing the pooled prevalence of birth asphyxia and its associated factors at a national level is very important and will provide a pooled estimated figure in order to reduce the impact. Therefore, the main objective of this systematic review and meta-analysis was to estimate the pooled prevalence of birth asphyxia and its associated factors in Ethiopia. The findings of this review will be used as an input for policymakers and program planners who work on the area to inform, plan, implement and evaluate health promotion policies and strategies. The study also will provide baseline information for future researchers. The review question is: what is the prevalence of birth asphyxia and its associated factors in Ethiopia?

Methods

Searching strategies

This review was considered to evaluate the combined prevalence and associated factors of birth asphyxia in Ethiopia. In this review, we searched databases without limit to date of publication and study design. To confirm the scientific accuracy, the Preferred Reporting Items of Systematic Reviews and Meta-Analysis Protocol (PRISMA- P) guideline was used [18]. The protocol was registered on an International Prospective Register of Systematic Review (PROSPERO), York University Review and Dissemination Center PROSPERO 2020 CRD42020157419 Available from: https:/www.crd.york.ac.uk/prospero/ display ID=2020157419. The international databases include MEDLINE/PubMed, EMBASE, Web of Sciences, Scopus, and Grey literature databases, Google Scholar, Science Direct and Cochrane library were scientifically searched. Also, we assessed reference lists of identified studies to retrieve additional articles. Unpublished studies were retrieved from the official websites of international and local organizations and universities. The search was performed by keywords, medical subject headings (MeSH) terms, and exploded headings. We used the search terms independently and/or in combination using "OR", "AND" or "NOT". Keywords/search terms were "Prevalence" OR "Epidemiology" AND "asphyxia" AND/OR "Birth asphyxia" AND "factors" AND/OR "associated factors" AND/OR "risk factors" AND/OR "determinants" AND/OR "predictors" AND 'Ethiopia'. All articles were conducted from 2017 up to 2019 and all accessible studies up to November 30, 2019, were incorporated in our meta-analysis and systematic review.

Identification and selection of studies

Inclusion criteria

In this review, we considered all studies which were conducted at any sites of Ethiopia that reported the prevalence of birth asphyxia and associated factors in Ethiopia. This review included all articles published in peer-reviewed journals and the primary studies reported both the prevalence and associated factors of birth asphyxia were included regardless of their publication time restriction, study design. This review included all articles published in peer-reviewed journals, that were written in English.

Exclusion criteria

Based on the eligibility criteria, we read their titles and abstracts. If studies are relevant for our review, we examined the full texts. Those papers which didn't fully access at the time of our search process were excluded from this review after contact the primary author two times through email. Also, if our outcome of interest did no reported in the primary studies we excluded from this review.

Outcome of measurement

The main outcome of this study was to estimate the pooled prevalence and to identify associated factors of birth asphyxia in Ethiopia.

Data extraction and synthesis

Data were retrieved by two independent reviewers (YM and TY) by using a standardized data extraction spreadsheet format. The data abstraction format includes the author, the study year, region, study design, sample size, prevalence, and associated factors. We used the data only once where results were published several times, uncertainties during the extraction process were resolved by joint discussions between the two reviewers. In the case of incomplete data, two attempts were made to contact the corresponding author by email. Also, the two authors (YM and TY) performed the quality assessment of studies independently. Any discrepancy was resolved by discussion and agreement.

Quality assessment of the studies and risk of bias assessment

To assess the quality of each study, we applied Newcastle-Ottawa quality assessment tool scale adopted for cross-sectional studies [19]. The modified Newcastle - Ottawa scales consists of three sections. The first section tool is rated from five stars for methodological evaluation. The second section tool is ranked from three stars for comparability assessment. The third section tool is evaluated from two points that deal with the statistical analysis and the outcome of each study. The original study was assessed by two reviewers independently and any disagreement between the reviewers was solved by taking the mean score of the two reviewers. Finally, the original studies with the scale of >_ 6 out of 10 were considered as high quality after reviewing different literature.

Data synthesis and statistical analysis

For farther analysis, we imported the data to STATA version 14.0 statistical software after extracting the data using Microsoft Excel format. Using the binomial distribution formula, Standard error was calculated for each study. We identify the heterogeneity between the studies using Cochrane's Q statistics (Chi-square), inverse variance (I^2) and p-values [20]. The statistical output showed that there was significant heterogeneity among the studies (I^2 = 98.0%, P ≤ 0.001) so that we used a random-effects meta-analysis model to estimate the Der Simonian and Laird's the pooled prevalence and associated factors of birth asphyxia in Ethiopia. Also, we used a forest plot to detect the presence of heterogeneity. Furthermore, subgroup analysis and meta-regression were used to identify the possible source of heterogeneity. The evidence of publication bias was checked using funnel plot symmetry. Besides, the statistical significance of publication bias was assessed using both Egger's and Beggar's test, subsequently, a trim-and-fill analysis was performed, with the p-value, less than 5% was used to declare the presence of publication bias [21,22]. A sensitivity analysis was done to identify outlier studies. According to the analysis, no influential studies were detected so that all of the studies were included in the final analysis. In this review, Point prevalence, as well as their 95% confidence interval, were presented in a forest plot. In this plot, the size of each box showed the weight of the study, while each crossed line refers to a 95% confidence interval. For the second outcome Logs, the odds ratio was used to determine the association of birth asphyxia.

Results

Study selection and data extraction

In the first step of our search, a total of 382 studies were identified using electronic searches (through Database searching (n = 372)) and other sources (n =10)) that were conducted from 2017 up to 2019. Of these, 225 studies were excluded due to duplication. From the remaining 157 studies, after reviewing the title and abstract 140 studies were excluded as they were irrelevant for this

systematic review and meta-analysis. The remaining 17 full-text articles were assessed for eligibility criteria based on the pre-defined criteria. Among these seven articles are excluded due to they are not in line with the preset criteria. Finally, 10 studies were fulfilled the eligibility criteria and included in this systematic review and meta-analysis (Figure 1).

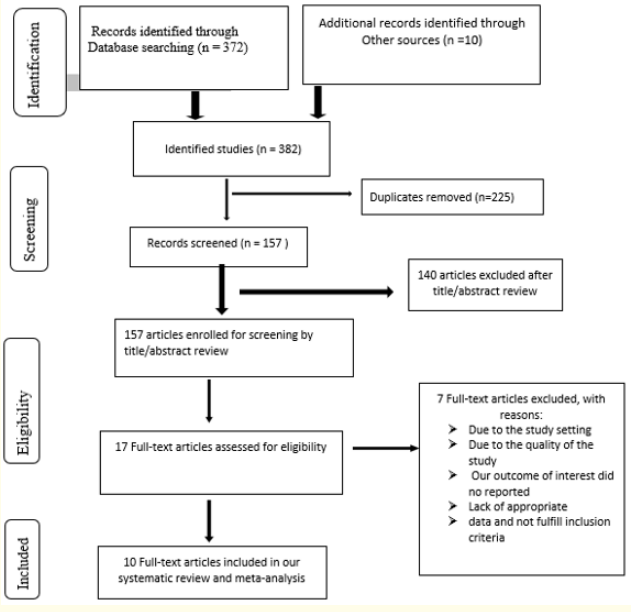

Figure 1: PRISMA flow diagram of included studies to estimate the pooled prevalence and associated factors of birth asphyxia in Ethiopia, 2019.

Characteristics of the studies

A total of 2930 Study participants included in this systematic review with a range of 105 to 421 Tigray [23,24] in individual studies, and studies were carried out from 2017 to 2019 (Table 1).

Meta-analysis

The birth asphyxia from included studies ranged between 3.1% and 32.9% (Table 1). As indicated in the forest plot, the pooled estimate for birth asphyxia from 6 studies in Ethiopia was 22.50% (95% CI: 10.77, 34.24) (Figure 2). We identified a significant heterogeneity between studies (I^2 = 98.0%; P ≤ 0.001), indicating great variability across studies, random effect analysis model was used to estimate the pooled prevalence of the birth asphyxia in Ethiopia (Figure 2). The evidence of publication bias was checked using funnel plot symmetry. Besides, the statistical significance of publication bias was assessed using both Egger's and Beggar's test, subsequently, a trim-and-fill analysis was performed, with the p-value, less than 5% was used to declare the presence of publication bias. However, the result of the Begg and Egger tests were not statistically significant. We performed univariate and categorical meta-regression for the included studies to identify sources of heterogeneity. However, there was no statistical significance value from the meta-regression (Table 2).

No.	Author (Year Publication)	Study Area	Study Design	Sample Size	Quality Score
1	Gdiom., *et al.* (2018)	Tigray	Cross-sectional	421	8
2	Asfere., *et al.* (2018)	Amhara	Cross-sectional	154	9
3	Jebessa., *et al.* (2017)	Oromia	Cross-sectional	368	7
4	Ritbano., *et al.* (2019)	SNNP	Cross-sectional	279	8
5	Alemu., *et al.* (2019)	SNNP	Cross-sectional	262	9
6	Ibrahim., *et al.* (2017)	Dire Dawa	Cross-sectional	302	7
7	Hailu G., *et al.* (2017)	Amhara	Case-control	380	8
8	Tasew., *et al.* (2018)	Tigray	Case-control	105	7
9	Alemwork., *et al.* (2019)	Amhara	Case-control	386	7
10	Wosenu., *et al.* (2018)	Amhara	Case-control	386	8

Table 1: Characteristics of 10 studies reporting birth asphyxia and its associated factors in Ethiopia, 2019.

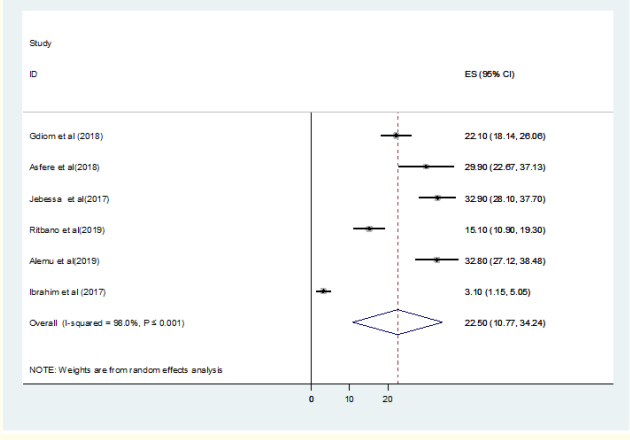

Figure 2: Forest plot for the prevalence of birth asphyxia in Ethiopia, 2019.

Associated factors of birth asphyxia

In this review, a total of 10 studies were included for analysis of an associated factor of birth asphyxia. We identified seven main associated factors with the pooled odds ratio ranging from 1.67 to 12.27. These associated factors were Educational status, cord prolapse, mode of delivery, premature rupture of membrane, prolonged labor, meconium staining, gestational age, and fetal position. A newborn born after prolonged labor (>12 hours) was also associated statistically with birth asphyxia as compare to the normal duration of labor (<=12 hours) [OR = 3.10, 95% CI: 1.84, 5.22]. Neonates who are born meconium-stained are 6.80 times more likely to have birth asphyxia than their counterparts [OR = 6.80, 95% CI: 4.91, 9.41]. Assisted vaginal delivery (vacuum or Forceps) and C/S delivery poses 3.5 times higher risk of having an asphyxiated newborn when compared to mothers that had a spontaneous vaginal delivery [OR = 3.42, 95%CI: 1.68, 6.94]. Preterm birth and gestational age < 37 weeks were 3.72 times more likely to be asphyxiated as compared to normal gestation (37-42 weeks) [OR = 3.72, 95%CI: 1.67, 8.28]. Regarding fetal presentations, newborns with the non-cephalic presentation were 2.43 times more susceptible to develop birth asphyxia than those with cephalic presentation (OR: 2.43, 95%CI: 1.25, 4.71). Additionally, cord prolapse was 2.95 times more likely to develop birth asphyxia respect to their counterpart [OR = 2.95, 95%CI: 1.64, 5.30]. Premature Rupture of Membrane was showed a significant association with birth asphyxia [OR = 12.27; 95% CI: 2.41, 62.38] (Table 3).

No.	Variables	OR (95% CI)
1.	Educational Status	1.67 (1.28, 2.7)
2.	Cord Prolapse	2.95 (1.64, 5.30)
3.	Mode of Delivery	3.42 (1.68, 6.94)
4.	Premature Rupture of Membrane	12.27 (2.41, 62.38)
5.	Prolonged Labor (>12 hours)	3.10 (1.84, 5.22)
6.	Meconium Staining	6.80 (4.91, 9.41)
7.	Gestational Age (<37 weeks)	3.72 (1.67, 8.28)
8.	Fetal Presentations	2.43 (1.25, 4.71)

Table 3: Associated factors of birth asphyxia in Ethiopia, 2019.

Discussion

In this meta-analysis, we systematically reviewed studies assessing the prevalence of birth asphyxia and its determinants in Ethiopia. This systematic review and meta-analysis aimed to estimate the pooled prevalence of birth asphyxia and its predictors in Ethiopia. The pooled estimate for the prevalence of birth asphyxia in Ethiopia was 22.50% (95% CI: 10.77, 34.24). Our findings were higher than the studies done in Canada 0.24% [25], in the Netherlands 0.85% [26], in Nepal 2.69% [27]. In contrast, this study found a lower prevalence of birth asphyxia as compared to studies done in Nigeria 29.4% [28], Zambia 23% [29]. This discrepancy in our study could be due to differences in study design and sample size, setting, accessible maternal health care services, the level of quality care provided during antenatal, natal, or postnatal period. This study also showed that mothers encountering prolonged labor, the odds of birth asphyxia were 3.10 folds' greater in the newborn after prolonged labor with respect to their counterparts. This finding is supported by a study done in Cameroon, Colombia, and Pakistan [30-32]. This may be due to prolonged labor makes the baby a higher risk of birth trauma and in addition and umbilical cord problems or the stress of too many contractions [33].

Regarding mode of delivery, Newborn delivered after assisted vaginal birth was 3.42 folds at higher risk to develop Birth Asphyxia as a comparison to spontaneous vaginal delivery. This study is a study done in Turkey, China, Nepal, and Cameroon [30,34-36]. This could be due to that instrumental delivery causing birth trauma which in turn leads to birth asphyxia.

Meconium-stained amniotic fluid also found a contributing factor to birth asphyxia which is similar to what was reported in Thailand [37]. This may be due to the presence of meconium in the amniotic fluid may cause to aspiration of meconium-stained amniotic fluid, and this can block small airways, resulting in birth asphyxia. Newborns who were born with a gestational age of < 37week 3.72 time more likely develop birth asphyxia as compared to the neonate with gestational age within 37 - 42 weeks. This finding is in line with a study conducted in Brazil [17]. This is may be due to an insufficient amount of surfactant in the lungs. There was also a strong relationship between low birth weight, prematurity and birth asphyxia. Previous studies reported similar results in Iran, Thailand, and Nigeria [37-39].

There was also a strong relationship between low birth weight, prematurity and birth asphyxia.

Previous studies reported similar results in Iran, Thailand, and Nigeria [37-39]. The possible reason might be that premature and low-birth-weight neonates usually have pulmonary immaturity and limited respiratory muscle strength, resulting birth asphyxia.

We also identified that newborns who were born with cord presentation were 2.95 more likely develops birth asphyxia as compared with non-cord presentation, and this finding was supported by other studies done in Cameron an Iran [16,37]. The possible explanations might be related to tight nuchal cord cords can interrupt normal blood, nutrient, and oxygen exchange by compressing the umbilical cord, or restricts arteries and veins in the fetal neck, this can lead to birth asphyxia. Newborns with a non-cephalic presentation during labor were 2.43 times more susceptible to develop birth asphyxia than those with cephalic presentation (OR: 2.43, 95%CI: 1.25, 4.71). These findings were supported by the study done in Cameron, Uganda, Nigeria, Thailand [37-40]. Premature Rupture of Membrane was 12 times more likely develops birth asphyxia [OR = 12.27; 95% CI: 2.41, 62.38]. our findings were supported by the study done in Indonesia [41].

Strengths and Limitations

Primarily, this systematic review and meta-analysis used internationally accepted tools for a critical appraisal system for quality assessment of individual studies. It included both published and unpublished articles.

Conclusion

The prevalence rate of birth asphyxia obtained in this review was relatively higher in Ethiopia relative to those reported by other studies from different countries. Prolonged labor (> 12 hours), meconium-stained, assisted vaginal delivery (vacuum or Forceps) and C/S delivery, gestational age < 37 weeks, non-cephalic presentation, cord prolapse and Premature Rupture of Membrane were associated risk factors variables. Hence, appropriate holistic care of pregnancy, labor and delivery and post-natal care is recommended to prevent those risk factors.

Ethics Approval and Consent to Participate

Not applicable.

Consent for Publication

Not applicable.

Availability of Data and Material

The datasets analyzed during the current study are available from the corresponding author upon reasonable request.

Competing Interests

We have confirmed that we have no competing interests.

Funding

No funding was obtained for this study.

Authors' Contributions

- YM and TY: Developed the study design and protocol, literature review, selection of studies, quality assessment, data extraction, statistical analysis, interpretation of the data and developing the initial drafts of the manuscript.
- YM, AA and AD: Involved in statistical analysis and interpretation, quality assessment, prepared the final draft of the manuscript.
- All authors read and approved the final manuscript.

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