

# Determinants of perinatal mortality in Ethiopia from 2012 up to 2020: systematic review and meta-analysis

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## Research Article

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# Abstract

**Background:** The perinatal mortality is defined as neonatal deaths of less than seven days of age and fetal deaths after 28 weeks of gestation for developing countries. Perinatal mortality is a worldwide health problem even if variation exists among countries. Despite the presence different studies done on the determinants of perinatal mortality in Ethiopia, there is no comprehensive and currently updated study in this time period in Ethiopia. The objective of this study was to determine the determinants of perinatal mortality in Ethiopia from 2012 up to 2020 time period.

**Method:** The articles were identified through electronic search of reputable databases: Google scholar, PubMed, Cochrane library, MIDLINE, EMBASE and Ovid Maternity and Infant Care Databases. Nine studies were selected based on a comprehensive list of inclusion and exclusion criteria. Analysis was done by using STATA 14 statistical software. To assess heterogeneity, the Cochrane Q test statistic and  $I^2$  tests were used and a random effect model was also used to estimate the pooled prevalence of perinatal mortality rate.

**Results:** The determinant factors for perinatal mortality were gestational age less than 37weeks , birth weight greater than or equal 2500 gram , had not history of previous abortion, had not history of perinatal death, illiterate maternal education, not using partograph , not vaccinated women about TT vaccine, had not history of obstetric complication ,level of hemoglobin greater than or equal to 11mg/dl ,women who had no prenatal visit ,child birth interval less than two years and non-vertex fetal presentation were significantly associated with perinatal mortality.

**Conclusion:** Government should give especial emphasis for women's with previous history of abortion, perinatal death and child birth interval less than two years.as well as strengthen all the above associated variables.

## Background

Perinatal mortality is total number of deaths in the perinatal period. This includes still birth and early Neonatal death that is death of live newborn before the age of 7 completed days [1-3]

Large numbers of children die soon after birth: many of them in the first four weeks of life (neonatal deaths) and most of those during the first week (early neonatal deaths). For every baby who dies in the first week after birth, another is born dead (fetal deaths or stillbirths). Causes and determinants of neonatal deaths and stillbirths differ from those causing and contributing to post neonatal and child deaths [4]

Each year 10.7 million children under the age of five years die. Among those 4 million during the first four weeks of life and 3.3 million are stillborn. less developing countries account for 98 and 97 percent Neonatal deaths and stillbirths respectively [5].

Every year about 7.5million perinatal deaths occur across the worldwide, 3.5 million are stillbirths and the remaining are early neonatal deaths [3, 6, 7]. These deaths are a major public health problems in many developing countries and have enormous economic, social and health implications for families and society[6]

Unlike neonatal mortality that only accounts for deaths of live births, perinatal mortality accounts for stillbirths in addition to neonatal mortality making it a comprehensive indicator for estimating the true level of mortality around the time of delivery [9, 10]

The prevalence of perinatal mortality in Ethiopia is the highest in Sub Saharan Africa and it has been in the range of 66 to 124 per 1000 and 37 to 52 per 1000 total births in the hospital and community setting, respectively[11]

Even though there is a national decrease in under-five mortality rate in Ethiopia, there is increase in neonatal Mortality rates (NMRs) from EDHS 2016 to 2019 which is 29 to 30 respectively[12]

Even though there are many studies done in Ethiopia about the prevalence of perinatal mortality and determinant factors in different parts of country in both facility and community based, there is no updated and comprehensive study done in national level

### **The objectives of the study**

To identify the pooled effects of determinants of perinatal mortality in Ethiopia from 2012 to 2020

## **Methods**

### **Reporting of the review findings**

We developed this protocol in accordance with the Preferred Reporting Items for Systematic review and Meta-analysis Protocols (PRISMA-P) statement [13]. We have used the Preferred Reporting Items for Systematic review and Meta-analyses (PRISMA-2009) statement to report the findings [14].

### **Inclusion criteria**

We included cross-sectional, case-control, and cohort studies that have reported determinants of perinatal mortality and have published in peer-reviewed journals and none published as well. We included studies that have been conducted in Ethiopia. Our focus has been on studies reporting factors of perinatal mortality in both facility and community based studies. Studies of similar title but that does not reported determinants or factors of perinatal mortality were not included in this study.

### **Exclusion criteria**

We excluded studies which studied about single risk factors of perinatal mortality because of difficulty to get pooled effects of risk factors. We also excluded studies that included only either of early neonatal or still mortality and studies published before 2013.

### **Search strategy**

We have been developed an appropriate and comprehensive search strategy with relevant search terms. The pilot test was also done before the final search. We have been searched PubMed, Google Scholar, MEDLINE, EMBASE, and Ovid Maternity and Infant Care Databases. We included articles published from start of 2012 to 2019. We used Medical Subject Heading (Mesh), keywords and free text search terms. As the search terms, we included alternative terms for perinatal mortality and combined them using Boolean operators. Note key words perinatal mortality, perinatal mortality rate, stillbirths, stillbirth rate, neonatal mortality rate, early neonatal mortality, early neonatal mortality, causes of perinatal mortality, causes of early neonatal mortality ,risk factors for perinatal mortality .

We also utilized snowballing to screen the references of identified articles for potentially relevant studies.

**Selection of studies:** two authors (SD and DS) reviewed the studies, based on inclusion and exclusion criteria. The review has been followed the three stages. During the first stage, we have assessed the titles of the studies identified from the search. Then abstract screening, abstracts of these selected titles has been included for the final stage of full-text screening. During full-text screening, we screened the full texts of abstracts selected in the previous stage. In the review, we included those studies approved by both authors.

The authors resolved the disagreements through discussion or consultation with a third reviewer (MA). We provided reason for exclusion for all excluded studies.

## **Data extraction and management**

Using the Joanna Briggs Institute (JBI) data extraction form for observational studies[15] . We extracted relevant data and pretested the data extraction form on four studies of each type, to ensure that it adequately facilitates the collection of all necessary data required for an effective systematic review and meta-analysis. Two review authors (DS and SD) extracted the data independently. Discrepancies between data extractors has been discussed to reach consensus. For consensus that cannot be reached, the third author consulted (MA). For each included articles, we recorded the first author's last name, year of publication, the setting where the study was conducted, study design, study period, sample size, the response rate, the population, and outcome.

## **Quality assessment**

Three authors (DS, SD, and WG) will independently conduct quality assessment of included studies, by using the checklist of the Newcastle-Ottawa Scale (NOS) [16]

We used the adapted version of NOS for cross-sectional studies. Based on NOS, we awarded studies a maximum of four stars within the selection, two stars within comparability, and three

Stars within outcome categories.

## **Operational definition**

In this review and meta-analysis, the perinatal mortality stands for neonatal deaths in the first 7-days of life after birth and stillbirths (fetal loss after 28 weeks of gestation)

The denominator used for PMR determination was total births after 28 weeks of gestation. Except one study reported as perinatal mortality in percentile (per 100), the rest of all studies included reported PMR as per 1000 total births.

## **Data synthesis and analysis**

We performed a narrative description of the study population, the studies included, the risk factors identified, and the cause for mortality as well as the outcome characteristics. We used tables and figures to summarize the selected studies and results. Using STATA 14 statistical software, we carried out the data entry and statistical analysis. To examine the possible risk of publication bias, we used funnel plots and Egger's test [17] . We assessed heterogeneity by using chi-squared test on Cochran's Q statistic with a 5% level of statistical significance [18] and I<sup>2</sup> statistic, assuming that I<sup>2</sup> value of 25%, 50%, and 75% being representative of low, moderate, and high heterogeneity, respectively[19] . We used random effect model for the studies for all variables.

# **Results**

## **Identification of eligible studies**

From the outset, we searched a total of 19635 records by the electronic search through a search engine of PubMed, MEDLINE Google scholar, EMBASE, worldwide web of science and Cochrane Library. , 62 of them were removed due to duplication from the inclusion. After the remaining 19635 retrievals, 8120 records were excluded due to publication year, they were published before 2012. then from the remaining 11515 records 11471 were excluded since they were not related to study in general. Then in the last 44 full text studies were considered and tested for the eligibility based on the

pre-set eligibility criteria. In the last 09 studies were considered to be eligible and included in this meta-analysis and systematic review analysis, in detail see study selection process (see figure 1). From a total of 44 full text studies accessed, we removed 31 of them because they were based on single exposure to study outcome articles, characteristics of original studies.

**Description of original included studies**

Table 01 summarizes the descriptive characteristics of the 13 studies included in this meta-analysis and systematic review. The studies were conducted in health facility and community setups. Four of them were conducted in community set up [20-23] and the remaining were in facility set up [1-3, 24-28]. When we see by design two of them cross sectional ,one of them prospective and one retrospective cohort ,four of them un matched case control ,two of them nested case control and three case control study design and conducted in different parts of Ethiopia with a sample size ranging from 219 in north shewa zone , Oromia region [21] to 3786 in dabat demography and health surveillance center , central Gondar, Amhara region [20].The included studies have been conducted in the four regions of Ethiopia: one included study was carried out in Addis Ababa: [3], three studies were conducted in Amhara region [20, 22, 28],four were from oromia region [21, 23, 27, 29] ,one from Tigre region[2] and four from Southern Nations, Nationalities and peoples’ region (SNNPR) SNNP [1, 24-26]

The original studies included in this study and reporting response rate had a response rate of 100% showing that all the studies had good response rate. The quality of the articles were done and all of them had low risk. Among included studies two unpublished and eleven published studies were included. The studies included in the meta-analysis were identified by exhaustive search from reputable journals

**Table 1: Characteristics of original articles included in studies**

Author	Publication year	Setting	Region	Study area	Design	Sample	Response rate	Quality
Goba etal	2018	Health facility	Tigray	Southern zone	Case – control	378	100%	Low risk
Tesfaye etal	2019	Health facility	SNNP	Arbaminch	Case-control	821	100%	Low risk
Yirgu etal	2016	Community	Amhara	West Gojam zone	Nested case control	306	100%	Low risk
Roro etal	2018	Community	Oromia	North Showa Zone,	Nested case control	219	100%	Low risk
Getiye etal	2017	Health facility	Addis Ababa	Addis Ababa	Unmatched case- control	1113	100%	Low risk
Mihiretu etal	2017	Health facility	SNNP	Wolaita sodo	Crossectional	300	100%	Low risk
Bayou etal	2012	Health facility	SNNP	Hawassa	Unmatched case – control	1356	100%	Low risk
Andargie etal	2013	Community	Amhara	Dabat	Prospective cohort	1752	100%	Low risk
Aragaw etal	2016	Health facility	Oromia	Jimma	Crossectional	3786	100%	Low risk
Tebeje etal	Not published but study year 2018	Health facility	SNNPR	Tercha	Unmatched case-control	366	100%	Low risk
Neme etal	2020	Health facility	Oromia	Jimma	Retrospective	186	100%	Low risk
Mihretie etal	Not published and Study year 2020	Health facility	Amhara	Bahirdar	Unmatched case control	459	100%	Low risk
Debelew etal	2020	Community	Oromia	Jimma	case control	480	100%	Low risk

## Meta-analysis

### Associated factors of perinatal mortality

We reviewed and meta-analyzed the factors associated in bivariate logistic regression in the included articles and reported in multivariate logistic regression with dependent variable of perinatal mortality in original articles .By using 13 relevant studies included in this study the following variables were entered in meta-analysis: History of previous abortion ,presence of obstetric complication ,history of previous perinatal death, partograph use ,prenatal visit, birth weight ,child birth interval ,level of hemoglobin, TT vaccination , education status of mother, gestational age, fetal presentation ,mode of delivery , number of deliveries and sex of the new born were meta analyzed. Among those History of previous abortion ,presence of obstetric complication ,history of previous perinatal death, partograph use ,prenatal

visit, birth weight, child birth interval, level of hemoglobin, TT vaccination of mother, education status of mother, fetal presentation and gestational age were significantly associated variables with perinatal mortality.

The pooled effect size of three studies showed that Mothers without history of previous abortion had 50% times less risk of losing their newborn in perinatal period as compared to those who had a history of abortion (OR= 0.50(95%CI: 0.29, 0.85), in detail see (figure 2,e)

The effect of seven studies about the mothers with no history of previous perinatal death had 79% times less risk of losing their newborn as compared to mothers with history of perinatal death (OR=0.21,95% CI:0.14 -0.32), in detail see (figure 2, k)

The pooled effects of six studies about fetal presentation revealed that fetus with vertex presentation had 64% less risk of perinatal death as compared to fetus with non-vertex (OR=0.36(0.21,0.60),in detail see (figure 2,c)

The pooled effect of the seven studies about mothers without obstetric complication had 85% times less risk of perinatal deaths as compared to mothers with obstetric complications (OR=0.15,95%CI: 0.06, 0.37), in detail see (figure 2,i).

The pooled effects of five studies revealed that women who delivered without the support of a partograph had an 4.68 times higher odds of experiencing perinatal mortality as compared with those delivering with support of a partograph (OR=4.68,95%, 2.75,7.94),in detail see (figure 2, j). The pooled effect of the eight studies showed that mothers who had no ante partum follow up were 2.57 times higher odds of experiencing perinatal loss as compared to those who had follow-up (OR=0.46, 95%CI, 2.08, 3.17), see (figure 2, f).

The pooled effects of the six studies revealed that Mothers who gave birth to birth weight greater than 2500 gram were 85% times less likely to had perinatal death as compared to those who gave birth to less than this birth weight baby (OR= 0.15, 95% CI (0.07, 0.32),in detail see (figure 2,a).

The pooled results of the five studies showed that the odds of perinatal mortality were 2.57 times higher among mothers whose previous delivery was within two years of current delivery as compared to mothers whose child delivery was more than or equal to two years (OR 2.57; 95% CI (1.56,4.22),in detail see (figure 2 ,b).

The pooled effects of three studies revealed that perinatal mortality were 52% times less likely among women's with hemoglobin level of greater than or equal to 11g/dl mothers as compared to hemoglobin level less than 11 g/dl (OR =0.48; 95%CI (0.36,0.65)) ,see (figure 2, g).

The effects of four studies showed that not immunized mothers for TT vaccine during pregnancy had 2.23 times risk of losing their baby as compared to immunized mothers (OR =2.23;95%CI(1.51,3.30), see (figure 2,i).

The pooled effects of five studies showed that mothers with illiterate education status had 1.99 times more likely to lose newborns in perinatal period as compared to mothers whose educational status was primary and above (OR=1.99;95%CI(1.52,2.61),in detail see (figure 2,h).

The pooled effects of ten studies revealed that the odds of perinatal mortality were 6.61 times higher among preterm deliveries than term deliveries (OR= 6.61; 95%CI (4.58, 9.55), in detail see (figure 2, d)

## Discussion

This study revealed that History of previous abortion ,presence of obstetric complication ,history of previous perinatal death, partograph use ,prenatal visit ,birth weight ,child birth interval ,level of hemoglobin, TT vaccination of mother, education status of mother , gestational age and fetal presentation are significantly associated with perinatal mortality.

Mothers with history of previous abortion had higher risk of losing their newborn as compared to those who had no a history of abortion. Other studies done in Denmark ,Jerusalem and French indicates that repeated abortion is significantly associated with adverse pregnancy outcomes such as preterm birth, bleeding in the first trimester, low birth weight and perinatal mortality[30-32]

History of perinatal mortality was significantly associated with perinatal mortality .This finding is consistent with study done in Tanzania,Jamica, Sweden,South Florida 2010 and South Florida 2011 USA,[33-37]. The possible reason might be when a mother loses a new born soon after birth there is a desire to replace the lost baby in short birth interval, this leads to also risk of newborn death.

Use of partograph during labour was significantly associated to decrease perinatal mortality. This finding is consistent with study done in Uganda [38] .The possible reason might be proper use of partogagraph guides health professionals to understand any abnormalities during the course of labor process. It is best tool to identify whether labor is progressing normally or not and warn as soon as possible if there are signs of any complications like fetal distress or if the mother's vital signs deviate from the normal range

Maternal education was associated with perinatal mortality and higher in mothers with educational status of illiterates as compared to mother's educated primary and above. The finding is similar to studies done other developing countries [39]. Increased levels of mother's education was observed to be associated with improved chances of infant survival [40]. Since Education can improve knowledge and economic status, access to health care, and birth spacing contraceptive information which are known to reduce the risk of perinatal mortality[41].

Gestational age less than 37 weeks had significantly higher perinatal death as compared to gestational age of greater than 37 weeks, this finding is consistent with studies done in different parts of countries [42-50].This is explained as preterm birth is associated with anatomic and physiologic underdevelopments of all the systems of the baby which may aggravate the risk of perinatal death. Pulmonary immaturity, respiratory distress syndrome and vulnerability to infections due to the underdeveloped immune system are among the leading causes of death for preterm newborns[51].

Obstetric complication was associated with perinatal mortality and had higher perinatal death as compared to non-obstetric complications during labor and delivery. This finding is consistent with other studies done in Zimbabwe [42] and studies done by WHO. The risks of perinatal death is higher in the presence of severe maternal complications[52]

Prenatal visit of mothers at least once during pregnancy had decreased perinatal mortality as compared to women who had not prenatal visit. This finding is similar to study done in Zimbabwe and Nigeria [42, 50, 53] . The possible explanation might be antenatal visit has many opportunities to contact with health workers and in different pregnancy, labor and delivery issues and this may reduce risk of pregnancy complications. In addition there are counseling about nutritional information for following a healthy diet and iron supplementation and this is also opportunity to take certain very important tests like VDRL and blood group. All of them are very important for maternal and newborn health.

Newborns with weight less than 2.5 kg had higher mortality as compared to newborns greater than 2.5 kg. This finding is similar with other studies [42, 50, 54]. The possible reason might be a low birth weight or less than 2.5 kg can be born too small, before term, or in both circumstance and this situation can happen for many different health problems, like health problems in mother, genetic factors, problems with the placenta and others. So low birth weight newborn can be vulnerable for perinatal death as compared to normal weight.



In this study, Child birth interval less than two years had higher perinatal mortality as compared to two children's born greater than two years, this finding consistent with other studies [55-60]. The possible explanation might be long birth spacing mother's body has enough time to replace different nutrients stores before getting pregnant again, more attention, more energy, more contact time to newborn, less stressed out and even less economic stress can make more healthier than short birth spacing new born .

Labels of hemoglobin less than 11 mg/dl or maternal anemia had higher perinatal mortality as compared to greater than this value. This finding is supported by other studies [61]. Maternal anemia has significant effect in still birth and early neonatal period[62, 63].

This is explained as maternal anemia causes low birth weight, prematurity, intrauterine growth restriction and preterm birth which causes death of newborn in perinatal period [64, 65]

Women's with TT vaccination at least twice during pregnancy had decreased their perinatal mortality as compared to non-vaccinated women's .This finding is supported by different studies conducted in different countries [5, 66-71] . The possible explanation might be most deliveries in this country take place in unclean circumstance and umbilical cord care, putting mothers and their newborn babies at risk of maternal and neonatal tetanus which is life threatening.

This study revealed that non vertex fetal presentation had increased perinatal mortality as compared to vertex fetal presentation. This finding is supported by studies done in Israel [72] and Netherlands [73]. The possible reason might be complications associated with no vertex presentation like preterm delivery, abnormal amniotic fluid levels, congenital malformations, placental abruption, cord prolapse ,premature rupture of membranes ,chorioamionitis ,caesarean section and placenta previa or cornual implantation of the placenta that leads to fetal death[72, 74].

## Conclusion

Gestational age, history of abortion, history of perinatal death, maternal education, partograph use, TT vaccination, obstetric complication, and levels of hemoglobin, prenatal visit, child birth interval, birth weight and fetal presentation were significantly associated with perinatal mortality in Ethiopia. As result the great emphasis should be given to health facility delivery.

## Declarations

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### Availability of data and materials

Data will be available upon request.

### Authors' contributions

DS: Conception of research protocol, literature review, study design, data

Extraction, data analysis, interpretation and drafting the manuscript. SD, MA and WG: Data extraction, analysis and reviewing the manuscript.

### Consent to publish

Not applicable

**Quality assessment.** All authors read and approved the manuscript.

### Ethics approval and consent to participate

Not applicable.

### Competing interests

The authors declare that they have no competing interests.

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## Abbreviations

NMR: neonatal mortality rate, PRISMA: Preferred Reporting Items of Systematic Reviews and Meta-Analysis, TT: tetanus toxoid, SNNP: Southern Nations, Nationalities and peoples, WHO: World Health Organization, USA: United States of America, EDHS: Ethiopian demographic health survey, NOS: Newcastle -Ottawa scale, PMR: perinatal mortality rate.

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## Figures

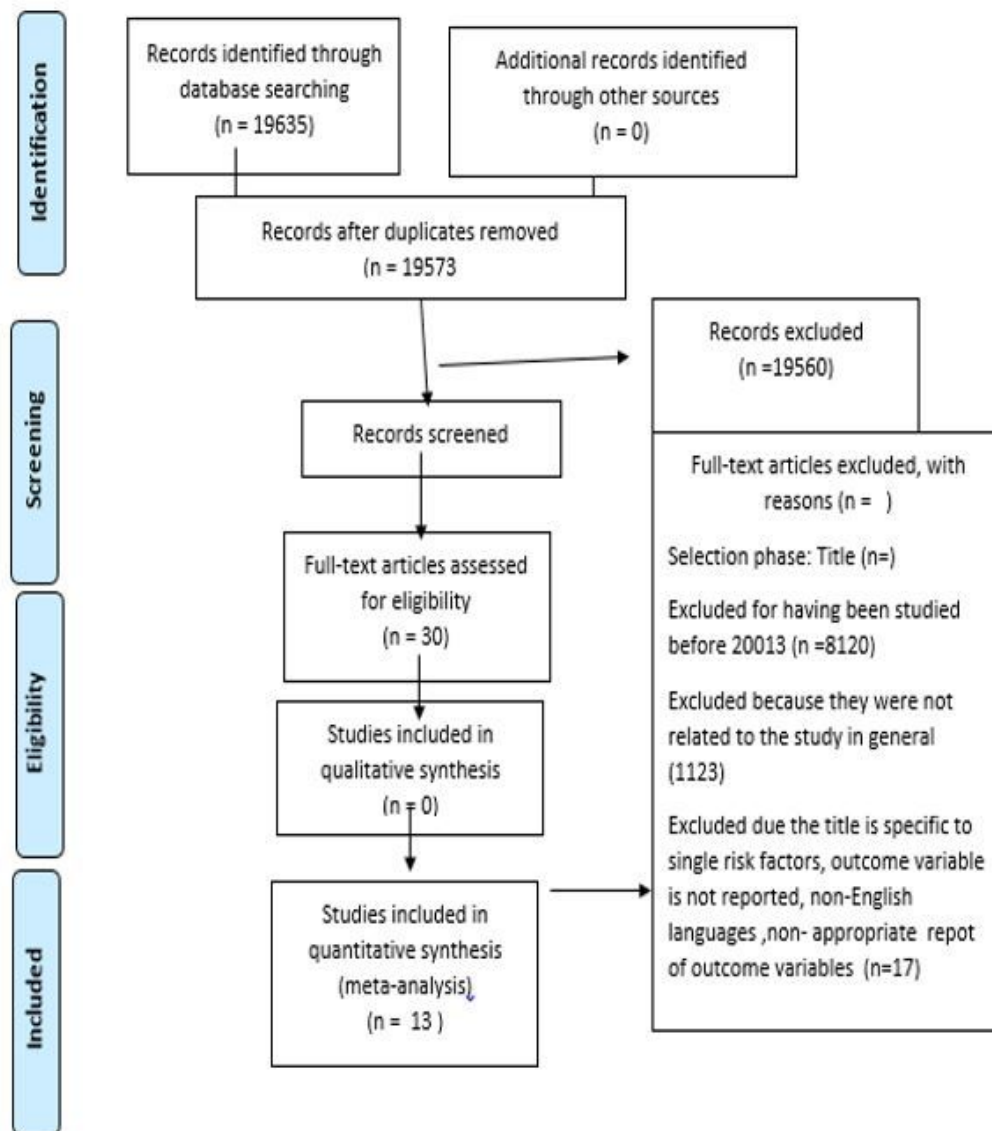
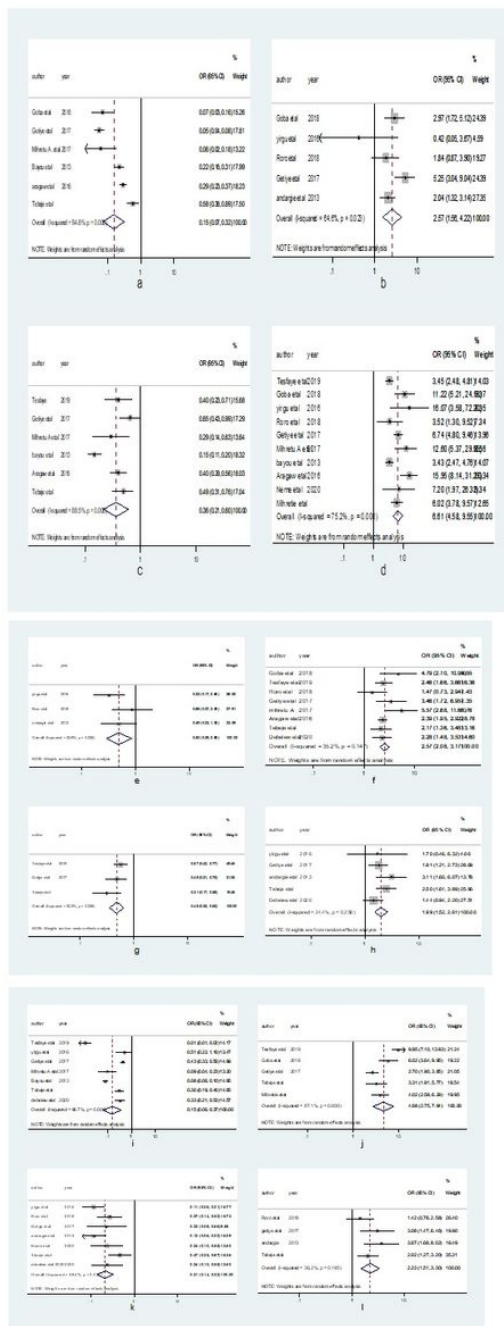


Figure 1: study selection process

## Study selection process



**Figure 2**

Determinants of perinatal mortality. Key : a:birth weight, b:child birth interval ,c:fetal presentation , d:gestational age ,e:history of abortion ,f:perinatal visit ,g:level of hemoglobin ,h:maternal education ,i:obstetric complication ,j:partograph use ,k:history of perinatal death,