

Neonatal hypothermia and its associated factors in East Africa: a systematic review and meta-analysis

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Abstract

Background : Neonatal hypothermia is a global health problem and a major contributing factor for neonatal morbidity, mortality, and for new-born survival, especially in low and middle-income countries. High prevalence of hypothermia has been reported from countries with the highest burden of neonatal mortality. Therefore, the aim of this systematic review and meta-analysis was to assess the prevalence of neonatal hypothermia and its associated factors in Eastern Africa.

Methods: Using PRISMA guideline, we systematically reviewed and meta-analyzed studies that examined the prevalence and associated factors of neonatal hypothermia from PubMed, Cochrane library, and Google Scholar. Heterogeneity across the studies was evaluated using the Q and the I² test. A weighted inverse variance random-effects model was applied to estimate the national prevalence and the effect size of associated factors. The subgroup analysis was conducted by country, study design, and year of publication. A funnel plot and Egger's regression test were used to see publication bias.

Result: A total of 12 potential studies with 20,911 participants were used for analysis. The pooled prevalence of neonatal hypothermia in East Africa was found to be 57.22% (95%CI: 39.48–74.95). Delay in initiation of breastfeeding (AOR=2.83; 95%CI: 1.398-4.259; I² = 49.2%; P=0.097), having neonatal health problem (AOR=2.68; 95%CI: 1.21-4.15; I² = 0.0%; P=0.98), being low birth weight (AOR =2.16; 95%CI: 1.03-3.29; I² =3.3%; P=0.005), being preterm(AOR=4.01; 95%CI: 3.02-5.00; I² = 0.0%; P=0.457), and night time delivery (AOR=4.01; 95%CI:3.02-5.00; I² =0.0%; P=0.457) were identified associated factors which significantly increase the risk of neonatal hypothermia.

Conclusions : The prevalence of neonatal hypothermia in Eastern Africa remains high. Delay in initiation of breastfeeding, having neonatal health problem, being low birth weight, preterm, and nighttime delivery were identified associated factors which significantly increase the risk of neonatal hypothermia. It is recommended that early initiation of breast feeding should be promoted and emphasis should be given towards low birth weight, preterm and neonates with neonatal problems to prevent burdens of hypothermia in East Africa.

Introduction

According to World Health Organization(WHO), neonatal hypothermia is an abnormal thermal state in which the newborn's body temperature is below 36.5°C [1]. It is a global health problem with higher rate in countries with low resource settings [3]. In sub-Saharan countries, hypothermia increases neonatal death by 80% for every 1 degree Celsius decrease of body temperature [3].

Hypothermia occurs usually with severe infections, prematurity, and asphyxia paying much for the least drop in neonatal death rate of the African regions [6]. It leads to diverse neonatal health consequences, and its prevalence in hospitals varies from 32 to 85% and at homes from 11 to 92%, including in the tropical environments[4]. Hypothermia is one of the important causes for neonatal death and morbidity in developing countries, which rises neonatal mortality by five times. Previous studies had revealed that

every 1°C reduction of neonate's body temperature raises the mortality by 80% [3, 7, 8]. The prevalence is high among countries with the highest burden of neonatal morbidity and mortality. Hence, increasingly, it is documented as a contributor for newborn survival [9, 10].

In developed countries neonatal hypothermia takes for 28% of the world burden. More than 98% of yearly neonatal mortality occur in developing countries [11]. Despite this fact only limited progress has been made towards risk for neonatal mortality [11]. To solve the major neonatal problems secondary to hypothermia, identifying its determinants is needed; which have greater input to attain sustainable development goal (SDG) 3 of ensuring healthy lives and promote well-being for all at all age.

Indeed, approaches that can prevent and treat neonates with hypothermia are vital to hasten the advancement of newborn survival. In East Africa, variety of studies was conducted to estimate the prevalence of neonatal hypothermia. However, prevalence of neonatal sepsis ranges from 1.3% [14] to 79% [15] which indicated a great inconsistencies across different geographical settings and different time periods. In addition, there are some opposing or inconsistent findings on risk factors and mortality predictors of neonates due to hypothermia. Moreover, there is no regionally denoted pooled data of neonatal hypothermia in East Africa. Therefore, this systematic review and meta-analysis was aimed; to estimate the pooled prevalence of neonatal hypothermia and the effect size of its associated factors in East Africa context.

Methods And Materials

Reporting

The results of this review were reported based on the Preferred Reporting Items for Systematic Review and Meta-Analysis statement (PRISMA) guideline (Supplementary file 1: PRISMA checklist) and, it is registered in the Prospero database: (PROSPERO 2019: CRD42019131654) Available from:
[https://www.crd.york.ac.uk/prospero/display_record.php?ID = CRD42019131654](https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42019131654).

Searching strategy and selection criteria

We identified studies providing data on the prevalence and/or potential risk factors for neonatal hypothermia with the search focused on Eastern Africa. PubMed, Google Scholar, and Cochrane library were retrieved. The search included keywords and MeSH terms, combinations, and snowball searching in references of relevant papers for linked articles. The core search terms and phrases were “newborn”, “neonate”, “infant”, “hypothermia”, “low body temperature”, “thermoregulation”, Body Temperature

Regulation, and Eastern Africa. The search strategies were developed using different Boolean operators. Notably, to fit advanced PubMed database, the following search strategy was applied: (prevalence OR magnitude) AND (causes OR determinants OR associated factors OR predictors) AND (newborn [MeSH Terms] OR neonate OR infant OR child OR children) AND (hypothermia [MeSH Terms] OR low body temperature OR thermoregulation OR Body Temperature Regulation) AND (Eastern Africa). We also screened at the reference lists of the remaining papers to identify additional relevant studies to this review.

Study selection / Eligibility criteria

Retrieved studies were exported to Endnote version 8 reference manager software, to remove duplicate studies. Two investigators (BBA and AMK) independently screened the selected studies using article titles and abstracts before retrieval of full-text papers. We used pre-specified inclusion criteria to further screen the full-text articles. Disagreements were discussed during a consensus meeting with other reviewers (MWK and MAR) for the final selection of studies to be included in the systematic review and meta-analysis.

Inclusion and exclusion criteria

Cross-sectional, case-control, and cohort studies were included. Those studies had reported the prevalence and/or at least one associated factor for neonatal hypothermia and published in English language from 2000 up to 2019 were considered. Citations without abstract and/or full-text, anonymous reports, editorials, and qualitative studies were excluded from the analysis.

Quality assessment

Three authors independently appraised the quality of the studies by using the Joanna Briggs Institute (JBI) quality appraisal checklist was used [16]. The disagreement was resolved by the interference of the fourth reviewer. The following items were used to appraise cohort studies: (1) similarity of groups, (2) similarity of exposure measurement, (3) validity and reliability of measurement, (4) identification of confounder, (5) strategies to deal with confounder, (6) appropriateness of groups/participants at the start of the study, (7) validity and reliability of outcome measured, (8) sufficiency of follow-up time, (9) completeness of follow-up or descriptions of reason to loss to follow-up, (10) strategies to address incomplete follow-up, and (11) appropriateness of statistical analysis. The items used to appraise case-control studies were: (1) comparable groups, (2) appropriateness of cases and controls, (3) criteria to identify cases and controls, (4) standard measurement of exposure, (5) similarity in measurement of exposure for cases and controls, (6) handling of confounder, (7), strategies to handle confounder, (8) standard assessment of outcome, (9) appropriateness of duration for exposure, and (10) appropriateness of statistical analysis. Studies got 50% and above of the quality scale were considered low risk. The following items were used to appraise cross-sectional studies: (1) inclusion criteria, (2) description of

study subject and setting, (3) valid and reliable measurement of exposure, (4) objective and standard criteria used, (5) identification of confounder, (6) strategies to handle confounder, (7) outcome measurement, and (8) appropriate statistical analysis. Studies were considered low risk when it scored 50% and above of the quality assessment indicators.

Data extraction

Two reviewers independently extracted the data using a structured data extraction form. Whenever variations of extracted data observed, the phrase was repeated. If discrepancies between data extractors continued, the third and fourth reviewer was involved. The name of the first author and year of publication, study country, study design, the target population, sample size, prevalence of neonatal hypothermia, and AOR of associated factors were extracted

Outcome measurement

Neonatal hypothermia was considered, when neonate's body temperature was less than 36.5 degree centigrade or neonates who are diagnosed as hypothermia by attending physician and fulfill hypothermia criteria within 0–28 days of life.

Statistical analysis

We pooled the overall prevalence estimates of neonatal hypothermia by a random effect meta-analysis model [17]. We examined the heterogeneity of effect size using Q statistic and the I^2 statistics [17]. In this study, the I^2 statistic value of zero indicates true homogeneity, whereas the value 25, 50, and 75% represented low, moderate and high heterogeneity respectively [18, 19].

For the data identified as heterogeneous, we conducted our analysis by random-effects model analysis. Subgroup analysis was done by the study country, design, and year of publication. Sensitivity analysis was employed to see the effect of a single study on the overall estimation.

Publication bias was checked by funnel plot and more objectively through Egger's regression test.

Results

A total of 3496 studies were identified; 2252 from PubMed, 12 from Cochrane Library, 1210 from Google Scholar and 22 from other sources. After duplication removed, a total of 1034 articles remained. Finally, 201 studies were screened for full-text review and, only 12 articles with (n=20,911 patients) were selected for the prevalence and/ or associated factors analysis (Fig.1)

Characteristics of included studies

Table 1 summarizes the characteristics of the 12 included studies in the systematic review [14, 15, 20-29]. Eight studies were found in Ethiopia [14, 21-27], 2 in Kenya [28, 29], while 2 were from Uganda [15, 20]. Nine studies were cross-sectional, while the others used either case-control (n=1) or cohort (n=2) study design. Most of the studies 8/12 (66.7%) were published between 2010 and 2017. The studies included participants, ranging from 136, [29] to 15191 [28] (Table 1).

Meta-analysis

Prevalence of neonatal hypothermia

Most of the studies (n=10) had reported the prevalence of neonatal hypothermia [14, 15, 20-25, 27, 29]. The prevalence of hypothermia were ranged from 13% [14] up to 79 % [15]. The random-effects model analysis from those studies revealed that, the pooled prevalence of neonatal hypothermia in East Africa was found to be 57.2% (95%CI; 39.48–74.95; $I^2=99.5\%$; $p<0.001$) (Fig. 2).

Subgroup analysis of the prevalence of neonatal hypothermia in Eastern Africa

The subgroup analysis was done through stratified by country, study design, and year of publication. Based on this, the prevalence of neonatal hypothermia was found to be 55.3% in Ethiopia, 62.6% in Uganda, and 60.0% in Kenya (Fig 3 and Table 2). Based on the study design, the prevalence of neonatal hypothermia was found to be 63.5% in cross-sectional studies and 32.98% in cohort studies (Fig 4 and Table 2). Based on the year of publication, the prevalence of neonatal hypothermia was found to be 65.06% from 2000-2015, while it was 57.90% from studies conducted from 2016-2019 (Fig 5, Table 2).

Publication bias

A funnel plot showed asymmetrical distribution. Egger's regression test p-value was 0.019, which indicated the presence of publication bias. Due to presence of publication bias we employed a leave-one-out sensitivity analysis to identify the potential source of heterogeneity in the analysis of the prevalence of neonatal hypothermia in Eastern Africa. The results of this sensitivity analysis showed that our findings were not dependent on a single study. Our pooled estimated prevalence of neonatal hypothermia varied between 54.79 (36.47–73.12) and 62.26 (55.22–69.30) after deletion of a single study. Byaruhanga R, 2005 (23), Mekonnen Tilahun, 2018 (34) had shown an impact on the overall estimation.

Factors associated with neonatal hypothermia in East Africa

See Table 3.

Delayed initiation of breast feeding

Five studies found significant association between delayed initiation of breast feeding and neonatal hypothermia. Birhanu et al (2017) revealed that neonates with delayed initiation of breast feeding were 4.39 times at risk of having neonatal hypothermia compared to neonates with timely initiation of breast

feeding. G/silasea et al revealed that neonates with delayed initiation of breast feeding were 2.42 times at risk of having neonatal hypothermia (95% CI: 1.45, 4.02) compared to neonates with timely initiation of breast feeding. Tewodros *et al*/ revealed that neonates with delayed initiation of breast feeding were 7.58 times at risk of having neonatal hypothermia compared to neonates with timely initiation of breast feeding. Hagos *et al* revealed that neonates with delayed initiation of breast feeding were 7.23 times at risk of having neonatal hypothermia compared to neonates with timely initiation of breast feeding. Wubet revealed that neonates with delayed initiation of breast feeding were 1.63 times at risk of having neonatal hypothermia (95% CI: 0.88, 2.99) compared to neonates with timely initiation of breast feeding.

Regarding heterogeneity test, galbraith plot showed homogeneity and combining the result of five studies, the forest plot showed the overall estimate of AOR of home delivery was 2.83(95%CI: 1.398-4.26; $I^2=49.2\%$;P=0.097).I-Squared (I^2)and P-value also showed homogeneity (fig 6).

Regarding publication bias, a funnel plot showed an asymmetrical distribution. During the Egger's regression test, the p-value was 0.016, which indicated the presence of publication bias. Due to presence of publication bias trim and fill analysis was done and 2 studies were added, and the total number of studies becomes 7. The pooled estimate of AOR of home delivery was found to be 2.463.

Neonatal health problems

Five studies (G/silasea et al 2019, Tewodros S et al 2015, Hagos T 2018, Wubet A et al 2019 and ANNA BM et al 2005) found significant association between neonatal health problems and neonatal hypothermia. G/silasea et al revealed that neonates with health problem were 2.46 times at risk of having neonatal hypothermia (95% CI: 1.07, 5.66) compared to neonates without health problems. Tewodros *et al* revealed that neonates with health problem were 3.1 times at risk of having neonatal hypothermia compared to neonates without health problem. Hagos *et al* revealed that neonates with health problem were 2.282 times at risk of having neonatal hypothermia compared to neonates without health problem. Wubet A revealed that neonates with health problems were 4.24 times at risk of having neonatal hypothermia (95% CI: 1.92, 9.34) compared to neonates without neonatal health problems. ANNA BM et al revealed that neonates with health problems were 4.24 times at risk of having neonatal hypothermia compared to neonates without health problems(table 3)

Regarding heterogeneity test for neonatal health problems, galbraith plot showed homogeneity and combining the result of five studies the forest plot showed the overall estimate of AOR of home delivery was 2.68(95%CI: 1.21-4.15; $I^2=0.0\%$;P=0.98).I-Squared (I^2)and P-value also showed homogeneity (fig 7)

Regarding publication of bias for neonatal health problems analysis, the funnel plot analysis showed asymmetrical distribution. During the Egger's regression test, the p-value was 0.068, which indicated the absence of publication bias. Trim and fill analysis was done, and 1 study were added and the total number of studies become 6 .the pooled estimate of AOR of preterm becomes 2.49.

We employed a leave-one-out sensitivity analysis to identify the potential source of heterogeneity in the analysis of the prevalence of neonatal hypothermia in Eastern Africa. The results of this sensitivity analysis showed that our findings were not dependent on a single study. Our pooled estimate of neonatal health problems varied between 2.49(95%CI,0.88-4.09) and 2.75(95%CI, 1.15-4.34) after deletion of a single study.

Low birth weight

Five studies (Birhanu W et al 2017, G/silasea et al 2019, Tewodros S et al 2015, Hagos T 2018, Wubet A et al 2019) found significant association between low birth weight and neonatal hypothermia. Birhanu W et al revealed that neonates with low birth weight were 1.33 times at risk of having neonatal hypothermia compared to neonates with normal birth weight. G/silasea et al revealed that neonates with low birth weight were 3.61 times at risk of having neonatal hypothermia (95% CI: 2.1, 6.18) compared to neonates with normal birth weight. Tewodros S et al revealed that neonates with low birth weight were 3.75 times at risk of having neonatal hypothermia compared to neonates with normal birth weight. Hagos T revealed that neonates with low birth weight were 8.51 times at risk of having neonatal hypothermia compared to neonates with normal birth weight. Wubet A revealed that neonates with low birth weight were 1.2 times at risk of having neonatal hypothermia (95% CI: 0.51,2.82) compared to neonates with neonatal birth weight.

Regarding heterogeneity test, galbraith plot showed heterogeneity and combining the result of five studies the forest plot showed the overall estimate of AOR of low birth weight was 2.16(95%CI: 1.027-3.293; $i^2= 3.3\%$;P=0.005).I-Squared (i^2)and P-value also showed heterogeneity(fig 8).

Regarding publication bias a funnel plot showed a symmetrical distribution. Egger's regression test p-value was 1.98, which indicated the absence of publication bias.

Trim and fill analysis was done, and 2 studies were added and the total number of studies become 7. The pooled estimate of AOR of low birth weight becomes 1.85.

Preterm

Five studies (Birhanu W et al 2017, G/silasea et al 2019, Tewodros S et al 2015, Hagos T 2018, Wubet A et al 2019) found significant association between preterm and neonatal hypothermia. Birhanu W et al revealed that preterm neonates were 4.39 times at risk of having neonatal hypothermia compared to term neonates. G/silasea et al revealed that preterm neonates were 4.61times at risk of having neonatal hypothermia (95% CI: 2.1, 8.18) compared to term neonates. Tewodros et al revealed that term neonates were 1.5 times at risk of having neonatal hypothermia compared to preterm neonates. Hagos revealed that term neonates were 3.689 times at risk of having neonatal hypothermia compared to preterm neonates. Wubet revealed that term neonates 3.37 times at risk of having neonatal hypothermia (95% CI: 1.53,7.44) compared to preterm neonates (Table 3).

Regarding heterogeneity test, the galbraith plot analysis showed homogeneity and combining the result of five studies the forest plot showed the overall estimate of AOR of home delivery was 4.01 (95%CI: 3.02, 5.00; $I^2 = 0.0\%$; $P = 0.457$). I-Squared (I^2) and P-value also showed homogeneity (figure 9)

Regarding publication bias a funnel plot showed a symmetrical distribution. Egger's regression test p-value was 0.131, which indicated the presence of publication bias.

Nighttime delivery

Five studies (Birhanu W et al 2017, G/silasea et al 2019, Tewodros S et al 2015, Hagos T 2018, Wubet A et al 2019) found significant association between night delivery and neonatal hypothermia. Birhanu W et al revealed that neonates delivered at night were 1.32 times at risk of having neonatal hypothermia compared to neonates who delivered at day. G/silasea et al revealed that neonates delivered at night 1.68 times at risk of having neonatal hypothermia (95% CI: 1.01, 2.83) compared to neonates who delivered at day. Tewodros et al revealed that neonates delivered at night 6.61 times at risk of having neonatal hypothermia compared to neonates who delivered at day. Hagos revealed that neonates delivered at night 6.25 times at risk of having neonatal hypothermia compared to neonates delivered at day.

Wubet revealed that neonates delivered at night were 3.18 times at risk of having neonatal hypothermia (95% CI: 0.51, 2.82) compared to neonates delivered at day.

Regarding heterogeneity test, the galbraith plot showed homogeneity and combining the result of five studies the forest plot showed the overall estimate of AOR of low birth weight was 4.01 (95%CI: 3.018–5.002; $I^2 = 0.0\%$; $P = 0.457$). I-Squared (I^2) and P-value also showed homogeneity (figure 10).

Regarding publication bias, the funnel plot analysis showed a symmetrical distribution. During the Egger's regression test, the p-value was 0.131, which indicated the absence of publication bias.

Discussion

In this systematic review and meta-analysis, we explored the prevalence and determinants of neonatal hypothermia in Eastern Africa. 14 studies were included in the final analysis. Based on the meta-analysis a significant proportion (more than 1 in 2) of neonates had neonatal hypothermia in Eastern Africa. This shows that neonatal hypothermia is a significant public health problem in Eastern Africa. We also identified factors that were significantly associated with neonatal hypothermia in Eastern Africa. In this study, the pooled prevalence of neonatal hypothermia in Eastern Africa was 57.22 % (95%CI: 39.48–74.95). The results of this meta-analysis were in line with other systematic review, prevalence of hypothermia ranges from 32% to 85% (33).

The results of this meta-analysis were higher than review conducted in Iran which was 7.48 to 53.3 percent (34).

Lower than a review in sub Saharan Africa, a prevalence rate of 62% (35). These differences might be due to the socioeconomic and cultural differences between the countries. Moreover, the other obvious reason for the various might be the sample size, a collection of data from different settings (community and institution setting) as well as different study periods.

Delay in initiation of breastfeeding, having neonatal health problem, being low birth weight, being preterm, and night time delivery were identified factors which significantly increase the risk of neonatal hypothermia. Similar finding was also reported from the meta-analysis [30–32].

Conclusion

The prevalence of neonatal hypothermia in Eastern Africa remains high. Delay in initiation of breastfeeding, having neonatal health problem, being low birth weight, being preterm, and nighttime delivery were identified factors which significantly increase the risk of neonatal hypothermia. It is recommended that early initiation of breast feeding should be promoted and emphasis should be given towards low birth weight, preterm and neonates with neonatal problems to prevent burdens of hypothermia in East Africa.

This review may help policy-makers and program officers to design neonatal sepsis preventive interventions.

Strength and limitations

This study has several strengths: First, we used a pre-specified protocol for search strategy and data abstraction and conducted quality assessment two independent investigators to lessen the possible assessor bias; second, we employed subgroup and sensitivity analysis based on study country, study design, and publication year to identify the small study effect and the risk of heterogeneity. Nevertheless, this review had some limitations: The result in this meta-analysis is derived from studies conducted in hospital settings, and this limits the generalizability of the review findings.

Recommendations

Hypothermia prevention messages and interventions into evidence-based, cost-effective packages for maternal and newborn care should be introduced. Attention is needed for thermal care of newborn especially those preterm, low birth weight and newborns with health problems on early initiation of breastfeeding immediately after delivery. It is also important to give attention babies delivered during nighttime.

Abbreviations And Acronyms

WHO: World Health Organization; *CI*: Confidence interval; *DHS*: Demographic and Health Surveys; *EDHS*: Ethiopian Demographic and Health Survey; *AOR*: Adjusted odds ratio; *ENBC*: Essential newborn care; *RR*:

Declarations

Ethics approval and consent to participate

Not applicable because no primary data were collected

Consent for publication

Note applicable.

Availability of data and materials

Data is available and it can be accessed from the corresponding author when asked with a reasonable inquiry.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

BBA conceives the study idea, and conducted the data analysis; *AMK*, *MWK* and *MAR* established the search strategy, and involve the meta-analysis. All authors read the and approve the manuscript for publication.

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Tables

Table 1: Distribution of studies on the prevalence and determinants of neonatal hypothermia in East Africa, 2000-2019.

Author	Year	Country	Study design	Sample size	Prevalence (%)	Quality status	Reference
Obunga R,	2005	Uganda	cross-sectional	300	79	Low risk	[15]
Atum A,	2005	Uganda	case-control	249	46	Low risk	[20]
Adom Akiristos ,	2017	Ethiopia	cross-sectional	1152	53	Low risk	[21]
Abel Girma et al,	2017	Ethiopia	cross-sectional	769	71	Low risk	[22]
Adnu Imeneh et al,	2018	Ethiopia	cross-sectional	356	64	Low risk	[23]
Abelase et al,	2019	Ethiopia	cross-sectional	354	50.3	Low risk	[24]
Adros Seyum,	2015	Ethiopia	cohort	421	69.8	Low risk	[25]
Adas Tasew	??	Ethiopia	cross-sectional	264	???	Low risk	[27]
Adet Alebachew et al,	2019	Ethiopia	cross-sectional	403	66.3	Low risk	[14]
Adnen et al,	2018	Ethiopia	cross-sectional	1316	13	Low risk	[14]
Adi Talbert	2009	Kenya	cohort	15 191	-	Low risk	[28]
Adhenko N,	2017	Kenya	cross-sectional	136	60	Low risk	[29]

Table 2: Subgroup analysis of the prevalence of neonatal hypothermia in Eastern Africa by country, design and year of publication

Variables	Characteristics	Pooled prevalence (95% CI)	I ² (P-value)
By country	Ethiopia	55.32(33.74-76.90)	99.6%(<0.001)
	Uganda	62.57(30.23-94.91)	98.6%(<0.001)
	Kenya	60.00(51.77-68.23)	99.5%(<0.001)
By design	Cross-sectional	63.49(56.42-70.57)	94.2% (<0.001)
	Cohort	32.98(6.22-72.18)	99.8%(<0.001)
By year of publication	2000-2015	65.06(47.89-82.23)	97.2% (<0.001)
	2016-2019	57.90(32.41-75.40)	99.6%(<0.001)

Table 3: Identified associated factors for neonatal hypothermia from studies in East Africa, January 2000 - 2019.

Determinants	Odds ratio (AOR)	Author	Year of publication	Reference
Delay in initiation of breastfeeding	4.39	Birhanu <i>et al</i>	2017	[23]
	2.42	G/silasea <i>et al</i>	2019	[24]
	7.58	Tewodros <i>et al</i>	2015	[25]
	7.23	Hagos <i>et al</i>	2018	[26]
	1.63	Wubet <i>et al</i>	2019	[27]
Neonatal health problem OR	2.46	G/silasea <i>et al</i>	2019	[24]
	3.1	Tewodros <i>et al</i>	2015	[25]
	2.28	Hagos <i>et al</i>	2018	[26]
	4.24	Wubet <i>et al</i>	2019	[27]
	4.24	ANNA <i>et al</i>	2005	[20]
Low birth weight	1.33	Birhanu <i>et al</i>	2017	[23]
	3.61	G/silasea <i>et al</i>	2019	[24]
	3.75	Tewodros <i>et al</i>	2015	[25]
	8.51	Hagos <i>et al</i>	2018	[26]
	1.2	Wubet <i>et al</i>	2019	[27]
Preterm	4.81	Birhanu <i>et al</i>	2017	[23]
	4.61	Gebresilasea <i>et al</i>	2019	[24]
	1.5	Tewodros <i>et al</i>	2015	[25]
	3.69	Hagos <i>et al</i>	2018	[26]
	3.37	Wubet <i>et al</i>	2019	[27]
Nighttime delivery	1.32	Birhanu <i>et al</i>	2017	[23]
	1.68	G/silasea <i>et al</i>	2019	[24]
	6.61	Tewodros <i>et al</i>	2015	[25]
	6.25	Hagos <i>et al</i>	2018	[26]
	3.18	Wubet <i>et al</i>	2019	[27]

Figures

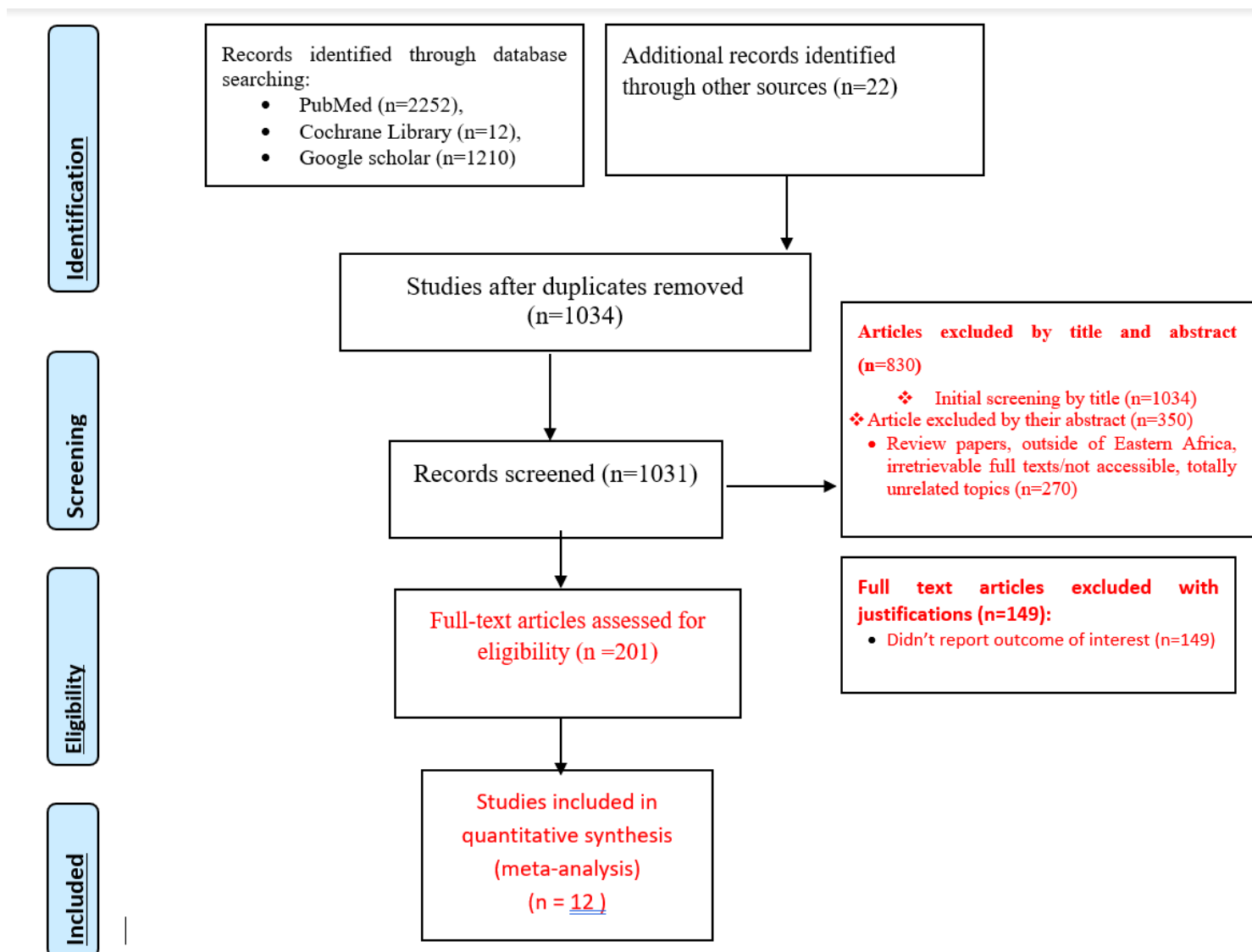


Figure 1

PRISMA flow diagram showed the results of the search and reasons for exclusion.

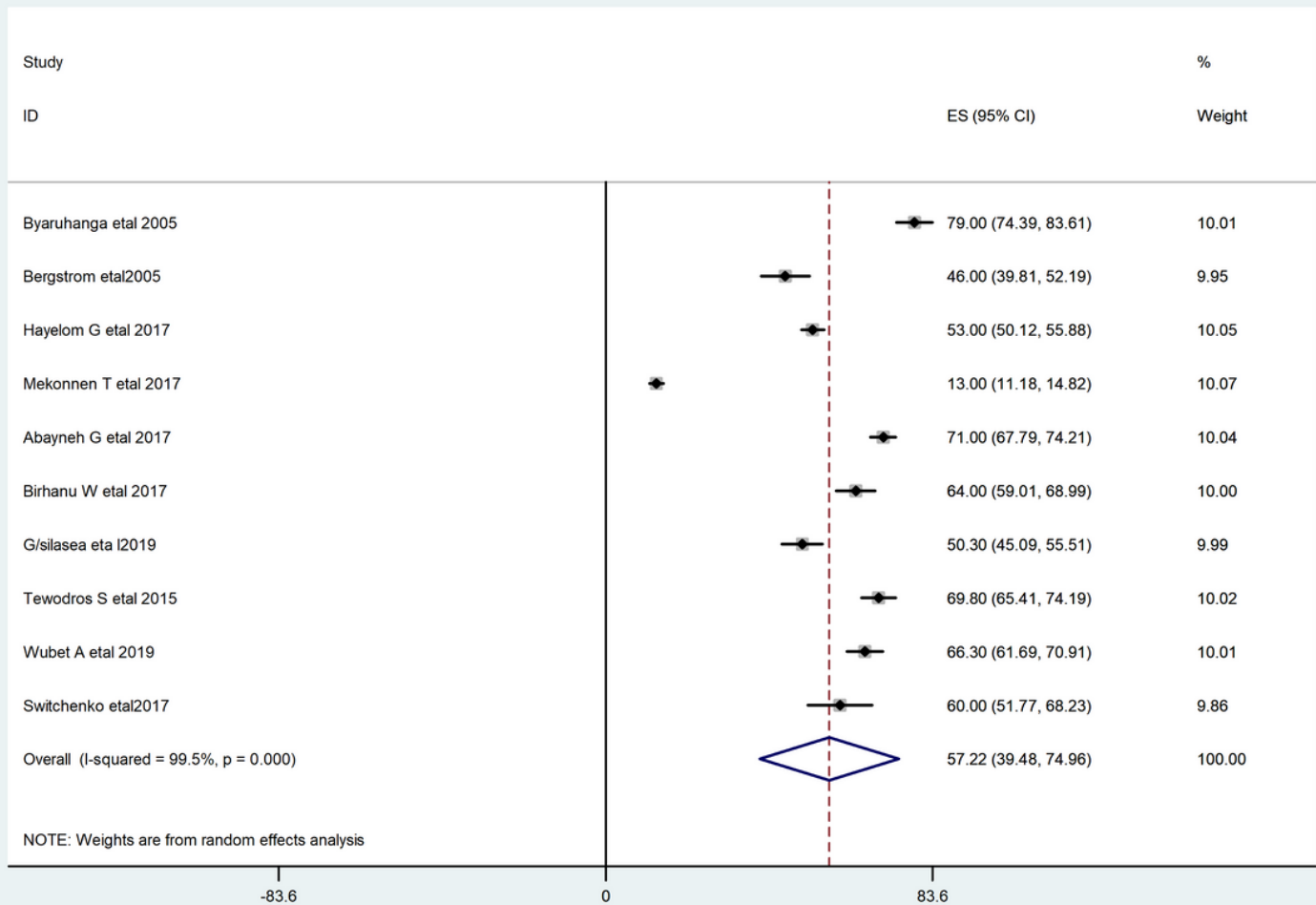
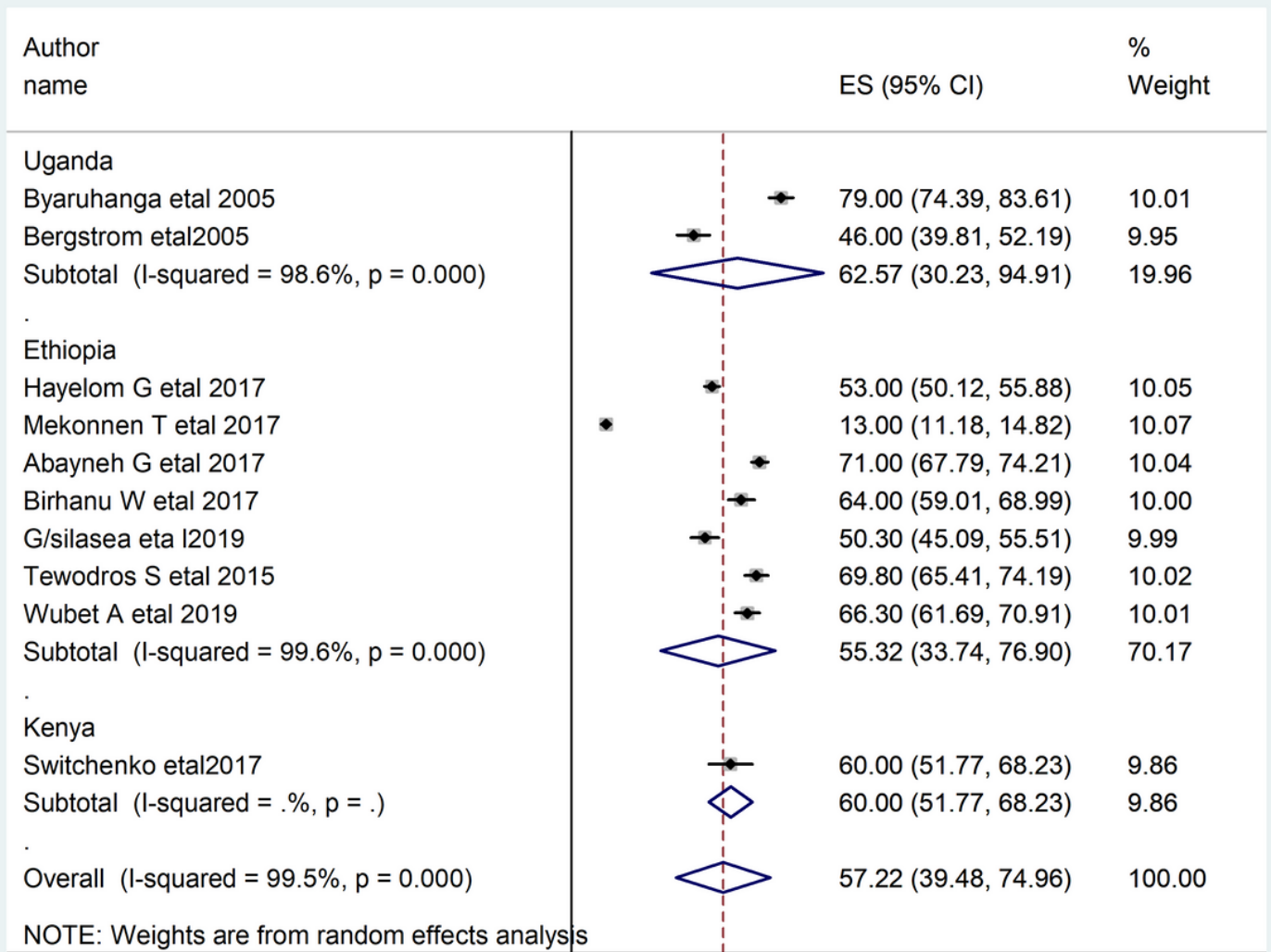


Figure 2

Prevalence of neonatal hypothermia



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Figure 3

Subgroup analysis of the prevalence of neonatal hypothermia by country.

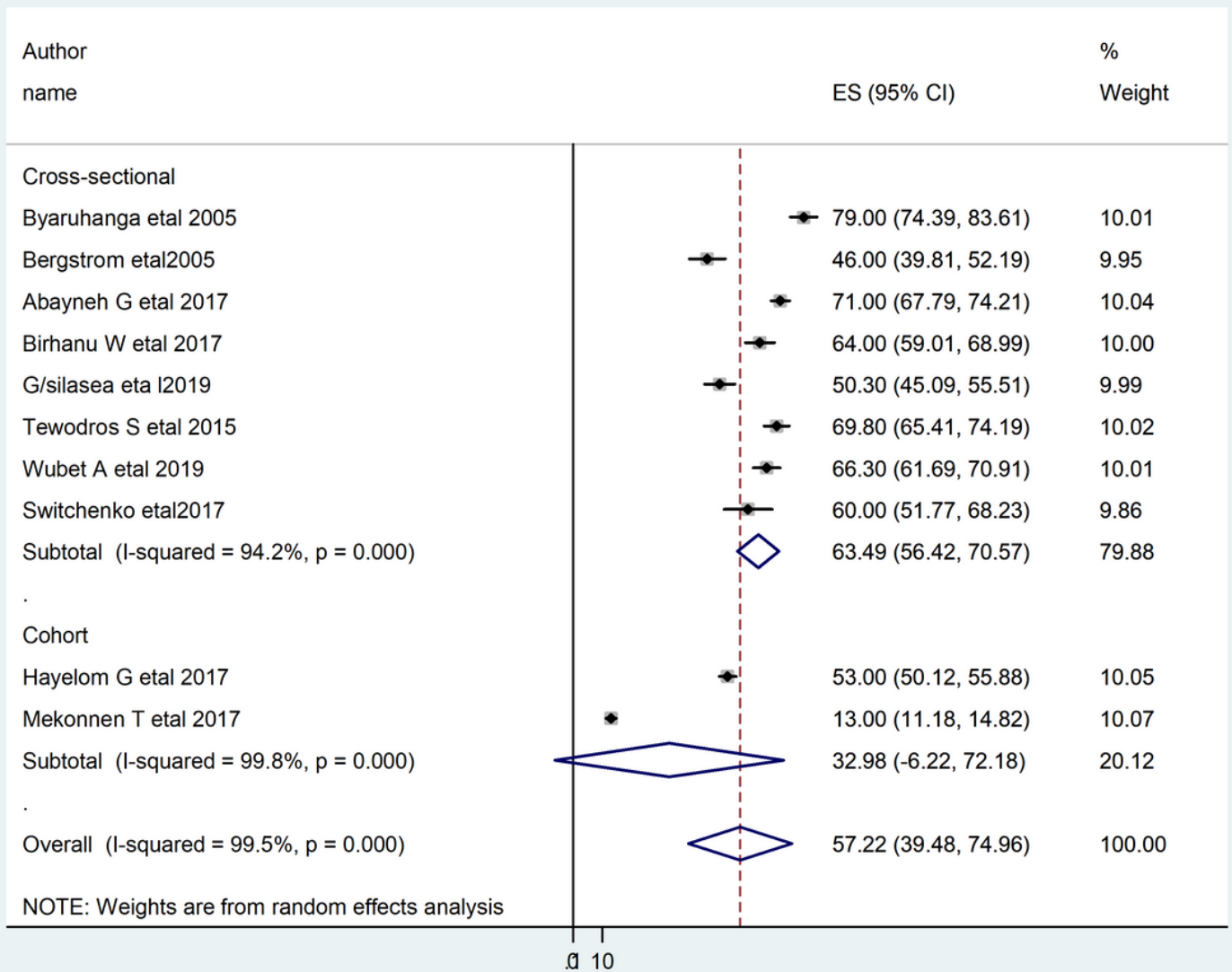


Figure 4

Subgroup analysis of the prevalence of neonatal hypothermia by study design.

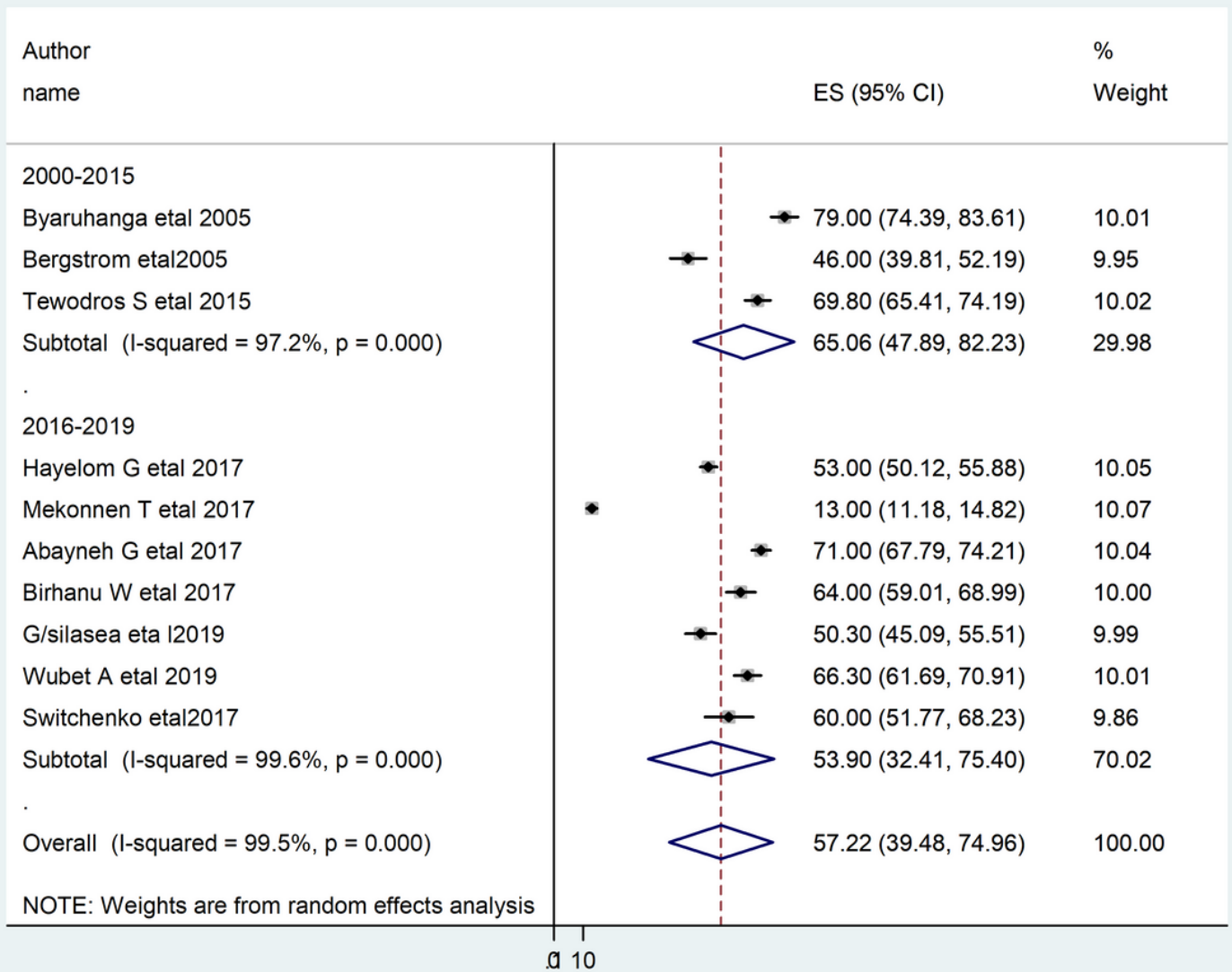


Figure 5

Subgroup analysis of the prevalence of neonatal hypothermia by year of publication.

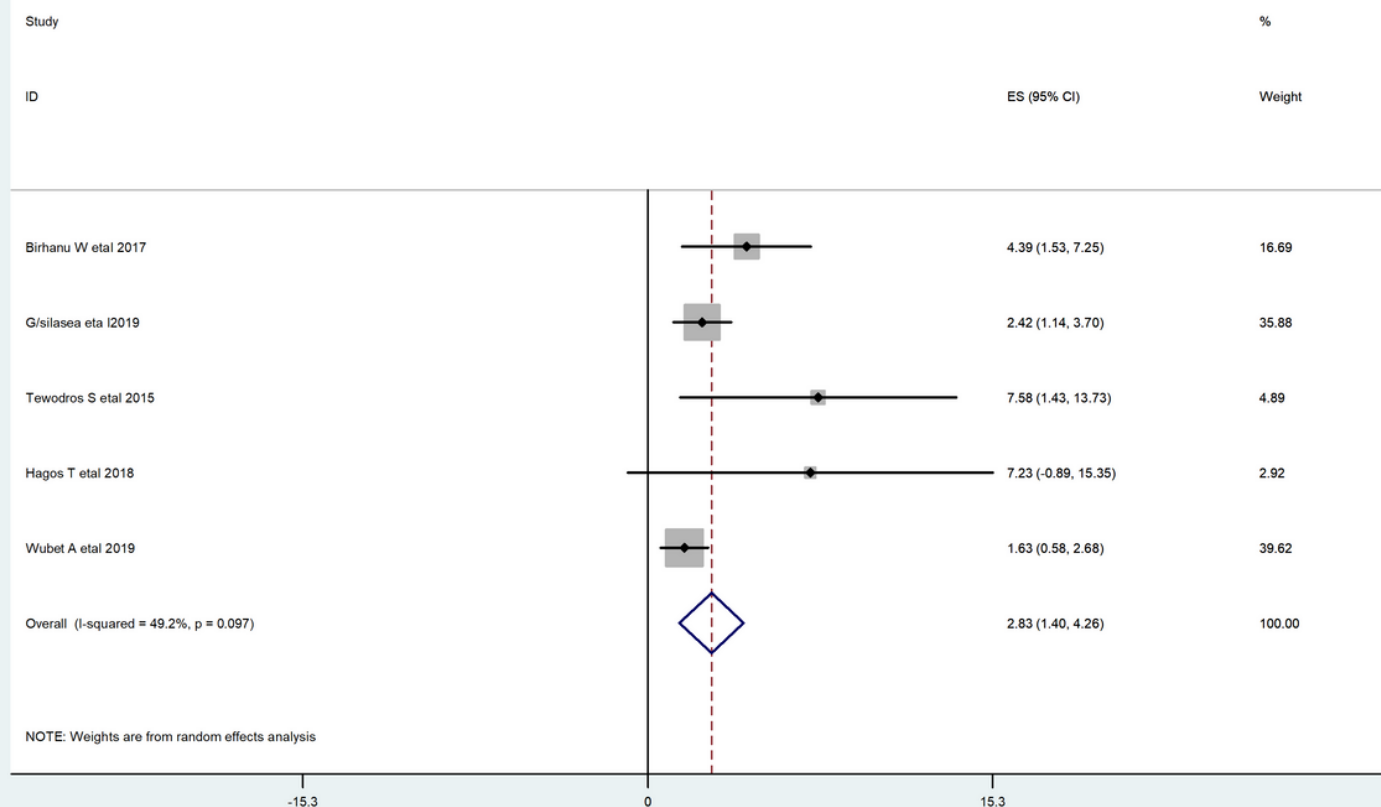


Figure 6

Forest plot for pooled estimate of delayed initiation of breast feeding

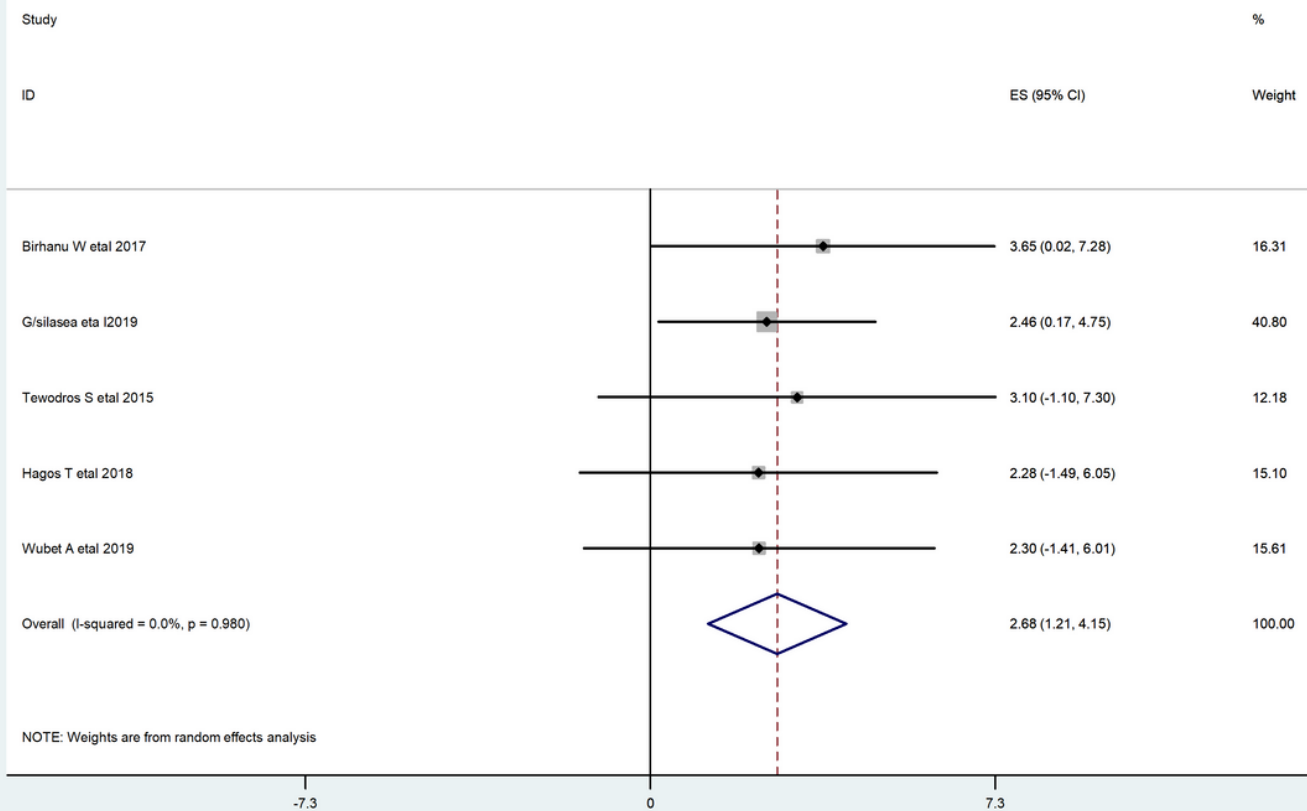


Figure 7

Forest plot for pooled estimate of neonatal health problems in East Africa, 2000-2019.

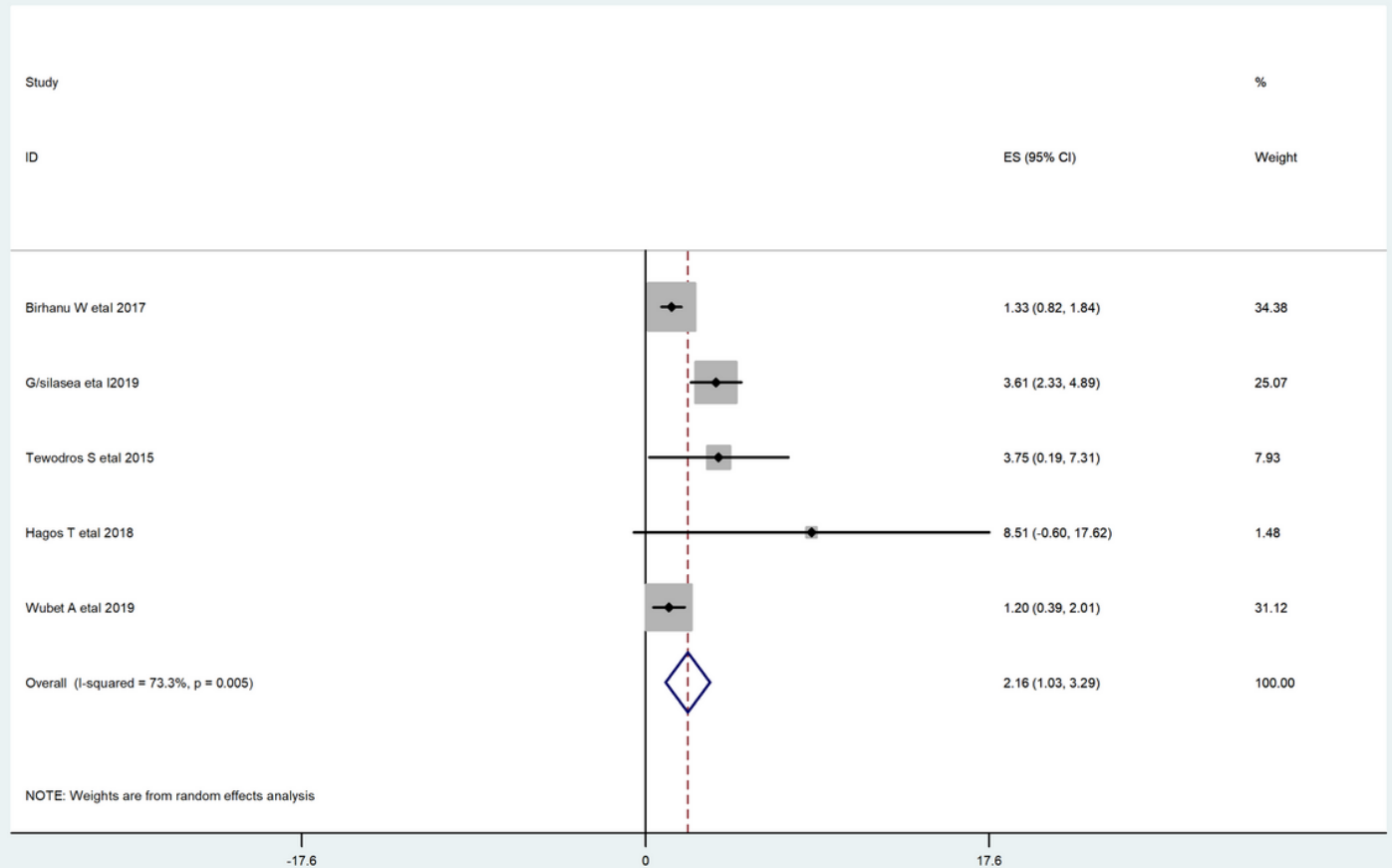


Figure 8

Forest plot for pooled estimate of neonatal health problems

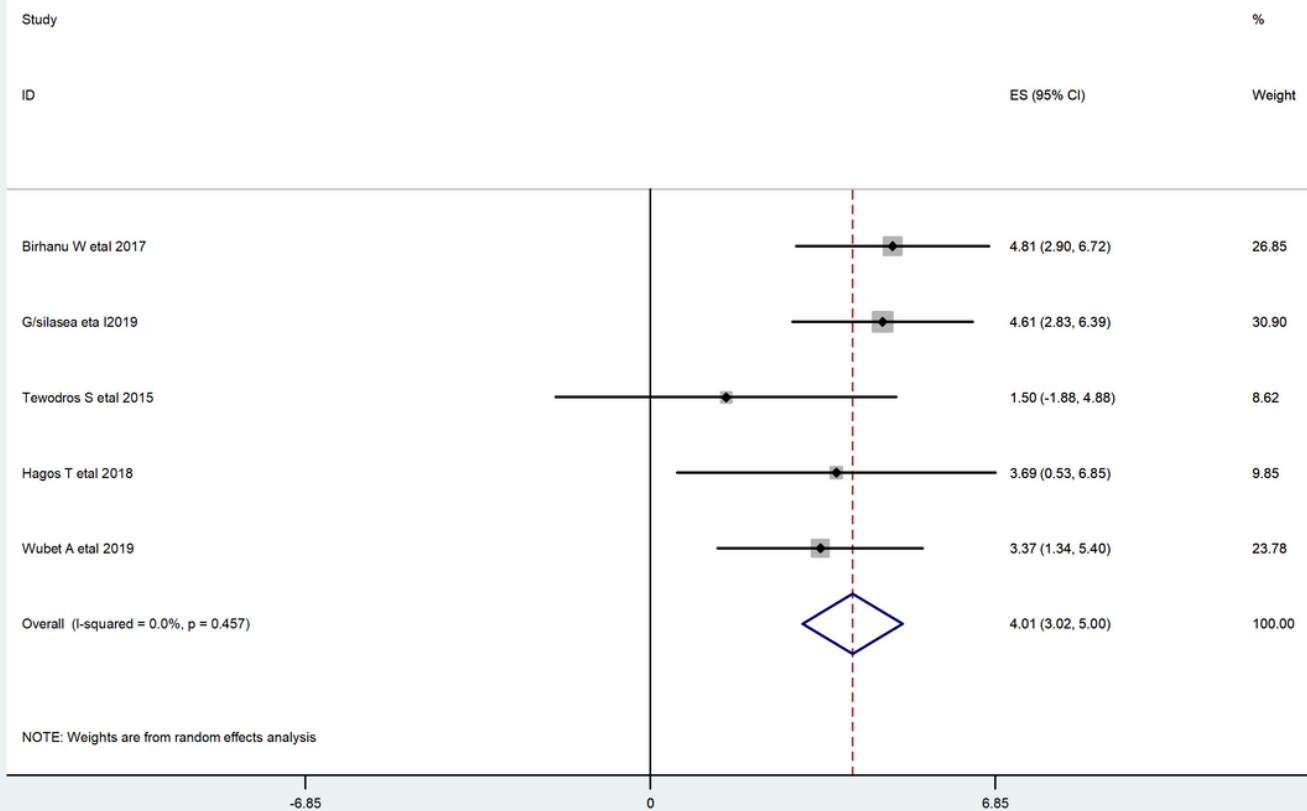


Figure 9

Forest plot for pooled estimate of preterm

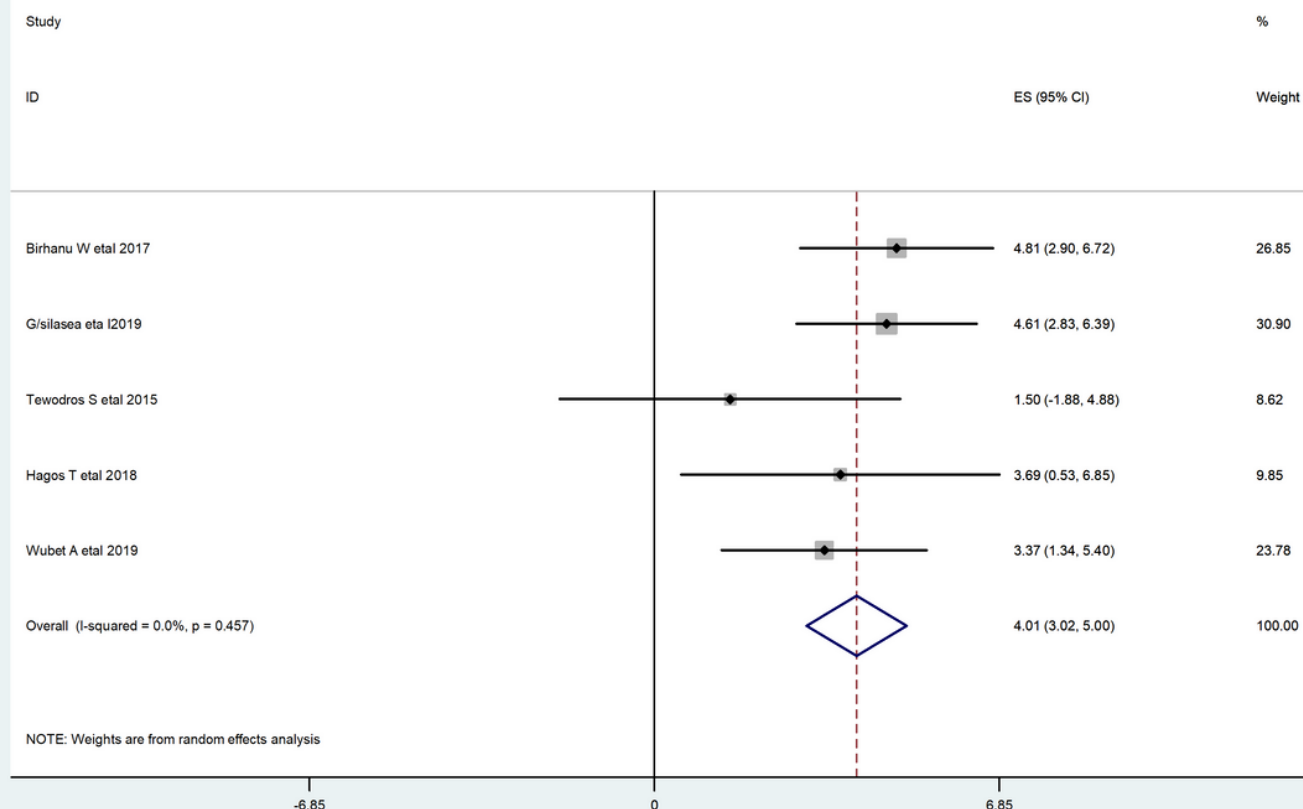


Figure 10

Forest plot for pooled estimate of nighttime delivery of neonates in East Africa, 2000-2019.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [fFPRISMAchecklistHYPOTHERMIA.doc](#)