Prevalence and Determinants of Low Birth Weight in Ethiopia: *A Systematic Review and Meta-Analysis*

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Summary

INTRODUCTION

Low birth weight was defined as weight at birth less than 2500 grams. This had numerous negative outcomes such as fetal and neonatal mortality and morbidity. It was estimated that between year 2000 to 2018, twenty million (15% to 20%) of all births worldwide had low birth weight yearly. Data analyzed from the Swedish Childhood Diabetes Register (SCDR) indicated that, low birth weight infants. were 24% higher odds of developing type-1 diabetes, hypertension, obesity and *dyslipidemia* in future compared to normal birth weight infants. In Ethiopia, the proportion of births weighing less than 2.5 kg at birth in the past three DHS surveys was 14% in 2005, 11% in 2011, and 13% in 2016. That differed with WHO 2025 goal of achieving 30% reduction in the number of infants born with weight lower than 2500g.

OBJECTIVES

This systematic review study was aimed to explicitly assess and determine the contributing factors of low birth weight in Ethiopia for intervention.

METHODOLOGY

Cross-sectional, case-control and cohort studies were conducted in English language. A search of studies in the main databases; PubMed, EMBASE, CINAHL, Web of Science, Scopus, and other gray literature sources was conducted. In respect to eligibility criteria, the investigators included observational studies that had been conducted at a facility setting in different parts of Ethiopia on the prevalence and factors associated with low birth weight, published and accessible from 2000 - 2018 then written in English. Articles with irretrievable full text records with unrelated outcome measures with missing or insufficient outcomes, reviews, commentaries, editorial, case series/reports, and patient stories were excluded. Meta-analyses with random effects, subgroup analyses, and meta-regression were performed. Publication bias was measured using the Egger regression test and visual funnel plot inspection. Pooled odds ratio was done by using RevMan 5.3 software. 16 studies fulfilled the eligibility criteria.

RESULT

The underlying causes were multi-factorial. Antenatal Care(ANC) and pregnancy complication increased the risk of low birth weight of infants in Ethiopia. Maternal harmful substance exposure(pesticide, noise, radiation and alcohol consumption), undernutrition, infections, poor socioeconomic status, history of chronic diseases, hepatitis B carriers, intrauterine growth restrictions (IUGR) were reported. The pooled prevalence of low birth weight was 18% (95% CI: 13.9%, 22.2%). Gestational age less than 37weeks was (AOR,7.8; 95% CI: 4.7, 12.95), no antenatal care (AOR,3.39; 95% CI: 1.65, 6.98), rural residence (AOR,2.44; 95% CI: 1.94,

3.08) and women with medical illness during pregnancy (AOR,4.36; 95% CI: 2.55, 7.44) that was significantly associated with low birth weight in Ethiopia.

CONCLUSION

The pooled prevalence of low birth weight was high in Ethiopia. Most rural mothers were unable to follow antenatal care and maternal medical illnesses during pregnancy were significantly contributing factors. The meta-regression confirmed that the sample size and the methodological quality could partially explain the statistical heterogeneity.

RECOMMENDATIONS

Almost all these factors can be prevented by scaling up Antenatal Care (ANC) with the help of Community Health Workers/ Volunteers(CHW/Vs), quality health facilities and improve on the socioeconomic status of the population. Policy makers to assimilate and take action to the multiple abnormalities found by formulating a management plan for patients with multiple organ disease in the maternity mortality reports.

Keywords: low birth weight; prematurity; Ethiopia; systematic review; meta-analysis

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Introduction

Low birth weight was defined by the World Health Organization (WHO) as weight at birth less than 2500g (grams). It was estimated that 15% to 20% of all births worldwide had low birth weight. Representing more than 20 million births a year, over 95% infants born in low and middle-income countries Sub-Saharan African countries carry a high burden of 13% next to South-East Asian countries with 28% [1] Low birth weight as a result of;

a. Preterm birth (PTB, short gestation <37 completed weeks)

b. Intrauterine growth restriction (IUGR), (fetal growth restriction), or both [2].

Low birth weight had numerous negative outcomes such as fetal and neonatal morbidity, mortality, growth restrictions and cognitive development as well as chronic diseases later in life. That related to; the infant, the mother or the physical environment playing a significant role in determining the birth weight and future health of the infant [3].

Studies showed that, low birth weight infants will have a higher chance of developing chronic diseases such as; diabetes, hypertension, obesity, and *dyslipidemia* in future compared to normal birth weight infants [4-8]. Data analyzed from the Swedish Childhood Diabetes Register (SCDR) indicated that, low birth weight infants were 24% higher odds of developing type-1 diabetes[9].

The underlying causes of low birth weight were multi-factorial. Maternal harmful substances exposure (pesticide, noise, radiation and alcohol consumption) and undernutrition (no intake of fresh vegetables), bacterial infections, poor socioeconomic status, history of chronic diseases, hepatitis B carriers before conception and placental abnormalities. Lack or inadequate Antenatal Care (ANC) and pregnancy complication increased the risk of low birth weight in the infants (P<0.05)[10-17].

In Ethiopia, the proportion of births weighing less than 2.5 kg at birth in the past three DHS surveys was 14% in 2005, 11% in 2011, and 13% in 2016 [18]. The trend showed that, Ethiopia was not reducing the proportion of low birth weight infants, and this differs with WHO 2025 goal of achieving 30% reduction in the number of infants born with a weight lower than 2500g. This would translate into 3% relative reduction per year between 2012 and 2025.

This failure to reduce the proportion both with low birth weight may be associated with the failure to explicitly determine the contributing factors for policymakers and program implementers for

intervention. Therefore, the aim of this review was to find out the prevalence and identify determinant factors for low birth weight in Ethiopia.

Methodology

Study protocol

The protocol for this systematic review and meta-analysis was registered in the International Prospective Register of Systematic Reviews (PROSPERO) with ID: CRD42018109433 and the published methodology is available at:
http://www.crd.york.ac.uk/PROSPERO/display_record.php?ID=CRD42018109433
The methodology of this systematic review and meta-analysis was developed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) report 2009 Checklist [19].

Eligibility Criteria

The investigators included observational studies (cross-sectional, case-control and cohort) that had been conducted at a facility setting in different parts of Ethiopia on the prevalence and factors associated with low birth weight. In addition, studies that were published and accessible from January 1, 2000 until October 30, 2018 and written in English were eligible for this systematic review and meta-analysis.

Articles with irretrievable full texts (after requesting full texts from the corresponding authors via email and/or Research Gate), records with unrelated outcome measures and articles with missing or insufficient outcomes were excluded. Reviews, commentaries, editorial, case series/reports, and patient stories were also excluded from the systematic review.

Sources of Studies and Searching Strategies

The authors conducted systematic literature searches from the legitimate major electronic databases such as MEDLINE (Ovid), PubMed, EMBASE (Ovid), CINAHL (EBSCOhost), Web of Science, Scopus, and other gray literature sources including Google, Google Scholar, World Cat, Research Gate, and Mednar. In addition, the hand (manual) search of various repositories was accomplished in order to retrieve unpublished studies. We used MeSH terms, key terms, text words and search strings by extracting from the review questions for all the searches.

Advanced search strategies were applied in major databases to achieve relevant findings closely related to the prevalence and associated factors with low birth weight. The search was conducted with the aid of carefully selected keywords and indexing terms. The search strategy included:

a. “Associated factors OR Determinants OR Predictors AND "infant, low birth weight"[MeSH Terms] AND ("Ethiopia"[MeSH Terms] for the systematic identification of records for the research question.

b. All authors constructed the search strings (TT, TW, AA, and HU).

c. The investigators consulted an information specialist on the appropriateness of search strings and applied them according to the specific requirement of the databases. Details regarding the searching strategies are available upon request. The overall search result was compiled using EndNote X8 citation manager software [20].

The Selection Process of Studies

All searched articles were exported to the EndNote X8 citation manager and duplicated studies were removed. Studies were then screened through, by careful reading of the title and abstract. Two authors (TT and TW) screened and evaluated studies independently. The titles and abstracts of studies that clearly mentioned the outcomes of the review (factors associated /determinants/predictors/ low birth weight) were considered for further evaluation to be included in the systematic review and meta-analysis.

Full text of the studies was further evaluated based on objectives, methods, participants / population and key findings (Factors associated / affecting/ determinants / predictors / low birth weight. Two authors (AA and HU) independently evaluated the quality of the studies against the checklist. The discrepancy for the inclusion of articles was resolved through discussion and through consulting an expert.

The overall study selection process was presented using the PRISMA statement flow diagram [21] ***(Figure 1).***

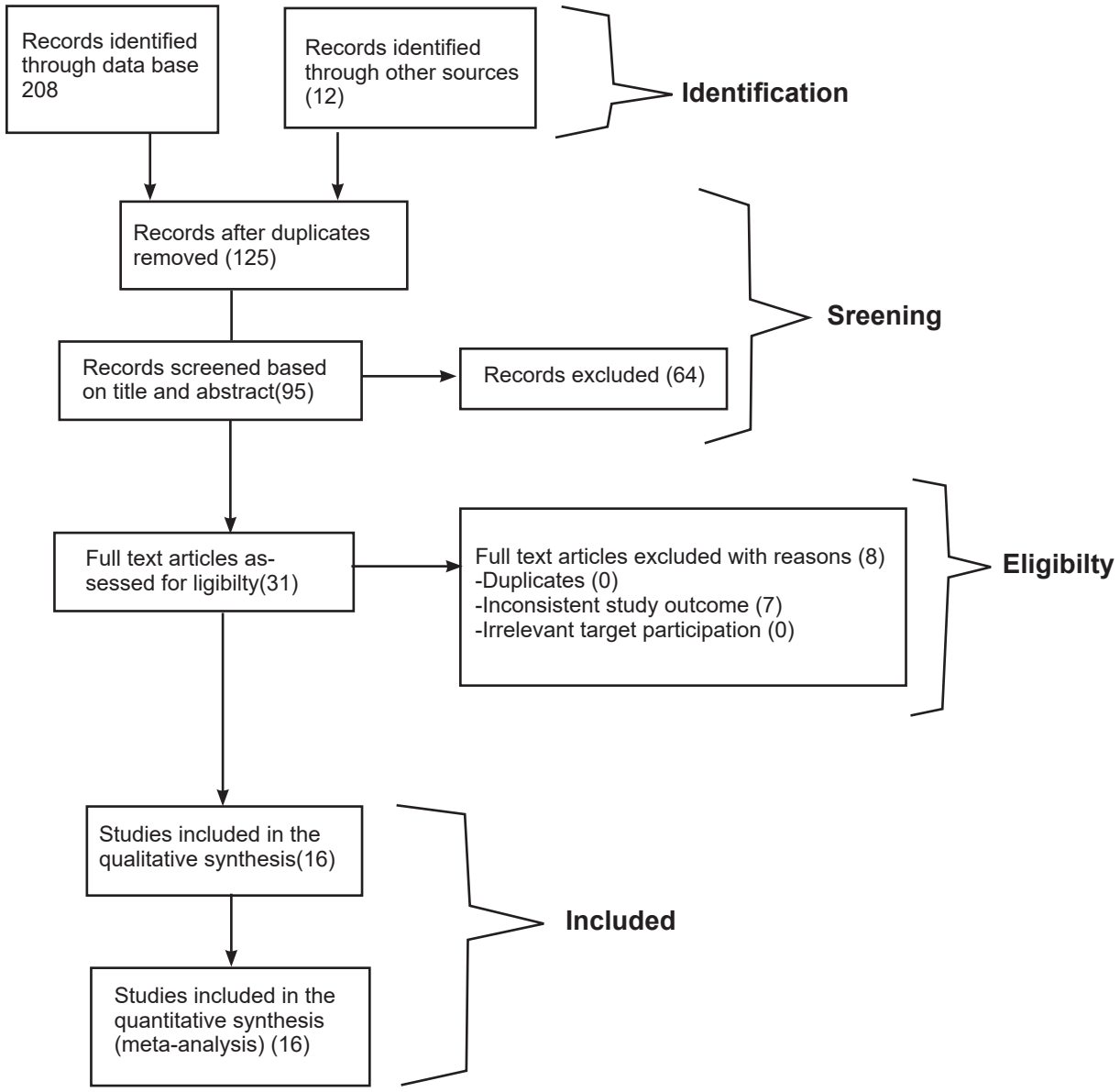


Figure 1: *Description of The Schematic Presentation of The Prisma Flow Diagram To Select and Include Studies, 2018.*

Data Extraction and Recording

After the selection of appropriate articles, data was extracted by two investigators independently (TW and HU) using a data extraction template and presented through Microsoft word 2016 (containing author & year, setting, study design, sample size, study subject, data collection methods, primary outcome of interest and specific factors associated with low birth weight) ***(Table 1 pag 54).*** The accuracy of the data extraction was verified by comparing the results by the second two investigators (TT and AA), who independently extracted the data in a randomly- selected subset of papers (30% of the total).

The quantitative data (the total sample size (*n)* and specific factors associated with low birth weight) were extracted from the included articles and summarized in the Microsoft Excel sheet. For the prevalence of low birth weight, we used unconverted proportional data to calculate the proportion/prevalence of low birth weight in percentage using OpenMeta software. Most of the associated factors of low birth weight summary measures were done by the pooled odds ratio using RevMan 5.3 software.

Critical Appraisal of Studies

The methodological reputability and quality of the findings of the included studies were critically evaluated using the quality assessment tool for observational studies(cross-sectional, case-control and cohort studies) developed by the Joanna Briggs Institute (JBI) [22].

The two group authors (TT and TW) and (AA and HU) independently evaluated the quality of the studies. The mean score of the two group authors was taken for a final decision. The differences in the inclusion of the studies were resolved by consensus. The cross-sectional studies checklist was graded out of 8 points, the case-control studies checklist was graded out of 10 points and the cohort studies checklist was graded out of 11 points.

The included studies were evaluated against each indicator of the tool and categorized as high, moderate and low quality. A high-quality score above 80%, moderate-quality between 60%-80%, and low-quality below 60%. Studies with a score greater than or equal to 60% were included. This critical appraisal was conducted to assess the internal validity (systematic error) and external validity (generalization) of studies and to reduce the risk of biases.

Data Items

The prevalence and determinants of low birth weight were the main outcome variables that were achieved by this systematic review and meta-analysis. The outcome variables were measured either by a direct report from the included studies or indirectly based on the statistics reported in the individual studies. To quantify the outcome "Factors associated with low birth weight" the investigators considered studies which reported as determinants of low birth weight in their statistics differently and specifically, gestational age of pregnancy, maternal age, lack of antenatal care follow up, having any medical illness and the setting of residence and others to comprehensively quantify the determinants. The results were interpreted by odds ratio.

Risk of Bias (Quality) Assessment

To ensure quality, the investigators conducted the search for studies using a comprehensive strategy (electronic databases, and manual search) which included published and/or unpublished; facility-based studies. To minimize bias, the two authors independently screened the studies using clear objective and eligibility criteria. Publication bias was explored using visual inspection of the Begg's funnel plot. Additionally, Egger's regression test with a significance level of 5% [23] was carried out to check the statistical symmetry of the funnel plot.

Strategy for Data Synthesis

The findings of the included studies were first presented using a narrative synthesis. Study descriptions and summary (author-year, country, aim, design and population, sample size, and key findings) were compiled using Microsoft word. The raw numerical data (low birth weight prevalence (*n*)) and total sample size (N)) from each study was extracted and recorded on Microsoft word then exported to an Excel Spreadsheet.

The authors conducted data synthesis and statistical analysis. Meta-analysis was conducted using, Revman version 5.3, OpenMeta and CMA version 2 software to compute the pooled prevalence and factors associated with the low birth weight. The meta-analysis of observational studies was conducted, based on recommendations made by Higgins et al. (An I^2 of 75/100%, suggesting considerable *heterogeneity*). In the meantime, *heterogeneity* between the included studies was examined using the I2 statistic [24].

The presence of *heterogeneity* between studies was assumed if the I2 statistic was greater than75%. A random-effects model was used to determine the pooled prevalence and associated factors with low birth weight. Sensitivity analysis, subgroup analyses and meta-regressions were performed to verify the source of *heterogeneity* in the studies used in the review.

Results

Description of Review Studies

A total of 220 articles were identified through the major electronic databases and other relevant sources. From all identified studies, 125 articles were removed due to duplication while 95 studies were reserved for further screening. Out of these, 64 were excluded after being screened according to titles and abstracts. The 31 remaining articles, 15 studies were excluded due to inconsistency with the inclusion criteria set for the review. Finally, 16 studies that fulfilled the eligibility criteria qualified for the systematic review and meta-analysis. General characteristics and descriptions of the studies selected for the meta-analysis were outlined in ***(Table 1) on page 54 next.....***

Table 1: *Description of Study Participants and Characteristics of Studies Included in the Systematic Review and Meta-Analysis.*

No.	Authors & years	The setting of the study	Design of the study	Sample size	Data collection methods	The primary outcome of interest	Prevalence	Specific factors associated with low birth weight
1.	**Aboye, et al [25] 2018**	Facility-based	Cross-sectional	308	Structured Interviewer	Low birth weight	27	Gestational age, Antenatal care, Drinking alcohol
2.	**Alemu, T.[26], 2011**	All regions of the country with representative samples	Survey	11872	Structured interview	Small size babies at birth	3455	Maternal age, anemia, antenatal care, residence Maternal literacy level
3.	**Asmare, G., et al [27], 2018**	Institutional based	case-control	429	Structured interview	Low birth weight	143	Sex of born baby, Lack of iron supplementation, Maternal MUAC, Health problems during the current pregnancy, Antenatal, Gestational Age
4.	**Assefa, N [28], 2012**	Institutional based	Cohort	956	Took weights, head and chest circumferences measurements within 24 hours.	Low birth weight	271	Poverty, maternal (MUAC), Mother's experience of physical violence during pregnancy, Longer time to walk to the health facility, Not attending ANC, residence
5.	**Demelash, H [29], 2015**	Institutional based	Case-control	387	Structured interview	Low birth weight	136	Monthly income, education Residence, Health problems during pregnancy, maternal body mass index, Maternal height, Inter-pregnancy interval, Absence of antenatal care, History of Khat chewing
6.	**Gebregzabiherher, Y [30], 2017**	Institutional based	Cross-sectional	424	Interview	Low birth weight	45	Mothers age, those whose pregnancy was desired, those with a history of abortion, and Mothers with normal hemoglobin, Iron with folic acid

cont. ***Table 1:*** *Description of Study Participants and Characteristics of Studies Included in the Systematic Review and Meta-Analysis.*

No.	Authors & years	The setting of the study	Design of the study	Sample size	Data collection methods	The primary outcome of interest	Prevalence	Specific factors associated with low birth weight
7.	**Gebremariam, A [31], 2005**	Institutional based	Cross-sectional	1441	Interview	Low birth weight	147	Mothers age, Short stature Complications during pregnancy
8.	**Gebremedhin, M., et al.[32], 2015**	Community-based	cross-sectional mixed study	308	Interview	Low birth weight	45	Residence, Gestational age, Presence of any chronic medical illness, Maternal weight
9.	**Gizaw, B [33], 2018**	Institutional based	case-control	470	Interview	Low birth weight	94	Education, History of nutrition counseling during pregnancy,antenatal care
10.	**Hailu, L.D [34] 2018**	Institutional based	case-control	441	Review of birth records	Low birth weight	147	Preterm birth, History of any physical trauma during pregnancy, History of any pregnancy complication, Maternal history of chronic diabetes
11.	**Kastro, S [35] 2018**	Facility-based	Cross-sectional	432	Structured interview	Low birth weight	35	Educational status, Occupation Housewife, Residence
12.	**Kumlachew, W.[36] 2018**		Cross-sectional	375	Structured interview	Low birth weight	, 56	Preterm, Number of ANC, Malaria during pregnancy, Anemia during pregnancy Taken iron supplementation
13.	**Mengesha, H.G., et al.[37], 2017**	Facility-based	Cross-sectional/ cohort	1152	Structured interview	Low birth weight	121	Residence, Preterm, No antenatal follow-up, Sex of new born,
14.	**Teshome, D., et al.[38] 2006**	Facility-based	Prospective cohort	810	Structured interview	Low birth weight	146	NA
15.	**Zeleke, B.M.[39] 2012**	Facility-based	Cross-sectional	305	Structured interview	Low birth weight	52	Preterm, Antenatal care follow up,Illness during pregnancy
16.	**Zeleke, B.M.,[40] 2012**	Facility-based	Prospective cohort study,	374	Structured interview	Low birth weight	34	NA

Prevalence of Low Birth Weight in Ethiopia

From all delivered babies from 2000-2018, the prevalence of low birth weight was a critical condition in Ethiopia. The included studies in this systematic review and meta-analysis showed that, this prevalence ranged from 8.1% to 29.1% [25, 26, 28-32, 35-39]. Based on those findings, the pooled prevalence of the low birth weight in Ethiopia was 18% (95% CI: 13.9%, 22.2%). The result of the analysis for the prevalence of the low birth weight based on the studies that reported the outcome variable with low birth weight (<2500g) ***(Figure 2).***

Study	Estimate (95% C.I)		Ev / Trt
(Aboye et al., 2018	0.088	(0.056, 0.119)	27 / 308
(Gebregzbiher et al., 2017)	0.106	(0.077, 0.135)	45 / 424
(Gebremedhin et al 2015)	0.146	(0.107, 0.186)	45 / 308
(Mengesha et al., 2017)	0.105	(0.087, 0.123)	121/1152
Subgroup Tigray (1^2=43.01 %, P=0.153)	**0.108**	**(0.090, 0.127)**	**238/2192**
(Asmare et al., 2018)	0.333	(0.289, 0.378)	143/429
(Hailu and Kebede, 2018)	0.333	(0.289, 0.377)	147/441
(Teshome et al.,2006)	0.180	(0.154, 0.207)	146 / 810
(Zeleke et al., 2012)	0.170	(0.128, 0.213)	52/305
Subgroup Amhara (1^2-95.24%, P-0.00)	**0.253**	**(0.166, 0.341)**	**488/ 1985**
(Assefa et al., 2012)	0.283	(0.255, 0.312)	271/956
(Demelash et al., 2018)	0.351	(0.304, 0.399)	136/387
(Gebremariam., 2005)	0.102	(0.086, 0.118)	147/1441
(Gizaw and Gebremedhin., 2018)	0.200	(0.164, 0.236)	94/470
(Zerfu et al., 2018)	0.091	(0.062, 0.120)	34/374
Subgroup Oromia (1^2=98.11%, P=0.000)	**0.204**	**(0.112, 0.296)**	**682 / 3628**
(Kastr et al., 2018)	0.081	(0.055, 0.107)	35/ 432
(Kumlachew et al., 2018	0.149	(0.113, 0.185)	56 / 375
Subgroup SNNPR&Benshangul Gumuz (1^2=89.05%, P=0.003)	**0.114**	**(0.047, 0.181)**	**91 /807**
Overall (1^2=96.7%, P=0.00)	**0.180**	**(0.139, 0.221)**	**1499 / 8612**

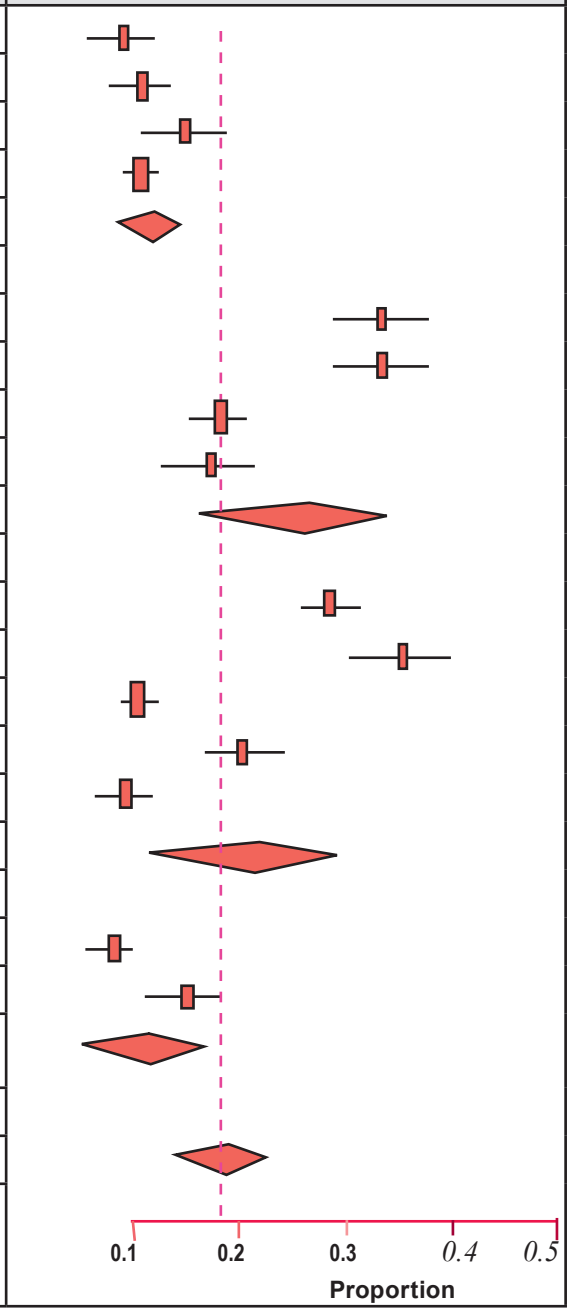


Figure 2: *Prevalence of Low Birth Weight in Ethiopia, 2018.*

Determinants of Low Birth Weight Gestational Age

The gestational age was significantly associated with low birth weight. Women who gave birth before completing 37 weeks of gestation were more likely to deliver low birth weight babies than their counterparts (OR = 7.8; 95% CI: 4.7, 12.95, P < 0.0001). The heterogeneity test indicated I^2 = 75%, to adjust, heterogeneity result was analyzed by subgroup analysis in different regions. Hence the random-effect model and subgroup analysis were assumed in this analysis because the confidence interval was wide ***(Figure 3)***.

Study or Subgroup	GA< 37 Weeks		GA ≥ 37 Weeks		Weight	Odds Ratio M-H, Random, 95% CI
	Event	Total	Event	Total		
1.1.1 Ambara						
(Asmare et al., 2018)	48	85	95	344	17.1%	3,40 [2.08, 5.55]
(Hailu and Kebede, 2018)	47	72	86	328	16.5%	5.29 [3.07, 9.11]
(Kumlachew et al., 2018)	32	89	24	286	15.8%	6.13 [3.36, 11.19]
(Zeleke et al., 2012)	13	21	39	284	11.9%	10.21 [3.97, 26.22]
Subtotal (95% CI)		**267**		**1242**	**61.3%**	**5.22 [3.51, 7.77]**
Total events	140		244			
Heterogeneity: Tau² = 0.07 Chi² =5.08, df = 3 (P =0.17);1² = 41%						
Test for overall effect: Z=8.15 (P< 0.00001)						
1.1.2 Tigray						
Aboye et al 2018	10	27	17	281	12.1%	9.13 [3.63, 22.97]
(Gebremedhin et al 2015)	10	14	35	294	294%	18.50 [5.51, 62.17
(Mengesha et al., 2017)	49	93	72	1059	17.3%	15.27 [9.52, 24.48]
Subtotal (95% CI)		**134**		**1634**	**38.7%**	**14.17 [9.53, 21.08]**
Total events	**69**		**124**			
Heterogeneity: Tau² = 0.00; Chi² = 1.15, df = 2 (P = 0.56); 1² 0%						
Test for overall effect: Z =13.08 (P < 0.00001)						
Total (95% CI)		**401**		2876	100%	7.83 [4.73, 12.95]
Total events	**209**		**368**			
Heterogeneity: Tau² = 0.32; Chi² 23.91, df = 6 (P = 0.0005); 1² = 75%						
Test for overall effect: Z = 8.01 (P < 0.00001)						
Test for subgroup differences: Chi² = 12.12, df = 1 (P = 0.0005), 1² =91.7%						

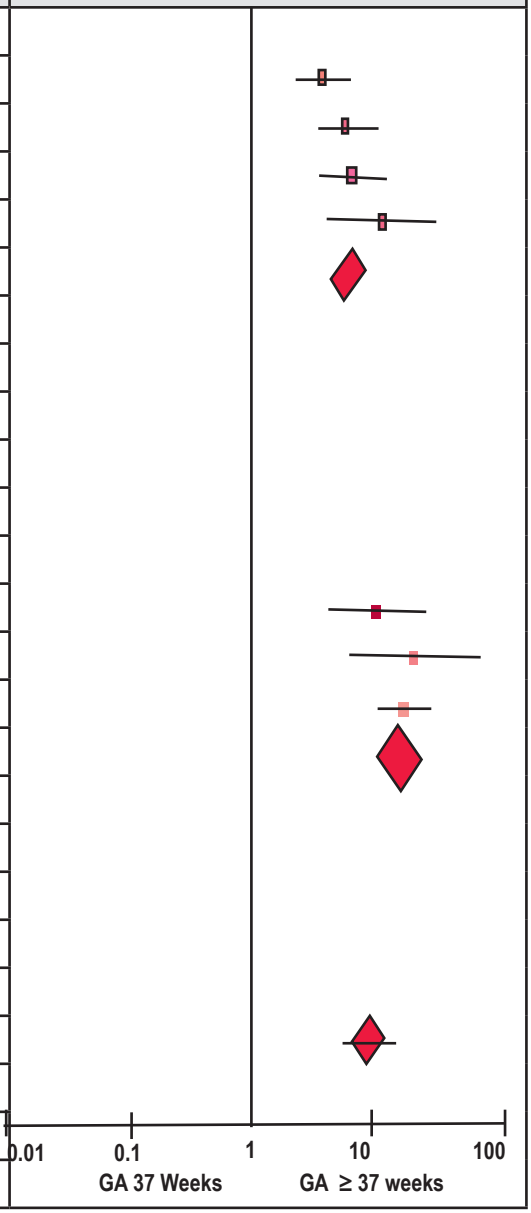


Figure 3: *Association Between Gestational Ages with Low Birth Weight in Ethiopia, 2018, (n = 8).*

Antenatal Care (ANC)

This review demonstrated that there was a significant association between antenatal care and low birth weight in the random effect model (OR = 3.39; 95% CI: 1.65, 6.98; P < 0.03). Women who were not attending antenatal care were 3.39-times more likely to have low birth weight babies as compared to women who had antenatal care. But considerable *heterogeneity* was found too high (I^2 = 86%), hence the random effect model was assumed in the analysis. Sensitivity of analysis was done but did not bring significant change in the overall summary results of OR ***(Figure 4).***

Study or Subgroup	Not attending ANC		Attending ANC		Weight	Odds Ratio M-H, Random, 95%CI
	Events	Total	Events	Total		
Alemu and Umeta, 2016	1523	4474	1946	7328	18.9%	1.4 [1.32, 1.55]
Asmare et al., 2018	119	370	24	59	14.0%	0.69 [0.39, 1.21]
Assef et al., 2012	213	672	58	281	16.9%	1.77 [1.27, 2.47]
Demelash et al., 2015	31	61	98	326	14.1%	2.40 [1.38, 4.19]
Gizaw and Gebremedhin, 2018	70	394	24	76	14.2%	0.47 [0.27, 0.81]
Kumlachew et al., 2018	33	75	23	300	0.0%	9.46 [5.07, 17.65]
Mengesha et al., 2017	8	21	113	1131	9.9%	5.54 [2.25, 13.66]
Zeleke et al., 2012	15	42	37	263	12.0%	3.39 [1.65, 6.98]
Total (95% CI)		6037		9464	100%	1.56 [1.04, 2.35]
Total events	1979		2300			

Heterogeneity: Tau² = 0.23; Chi² = 41.50, df = 6 (< 0.00001); I²

Test for overall effect: Z = 2.13 (P = 0.03)

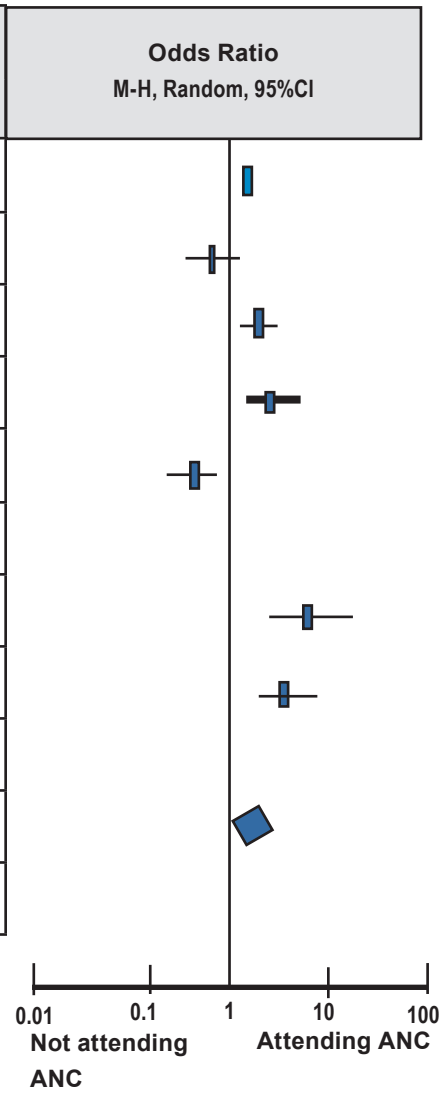
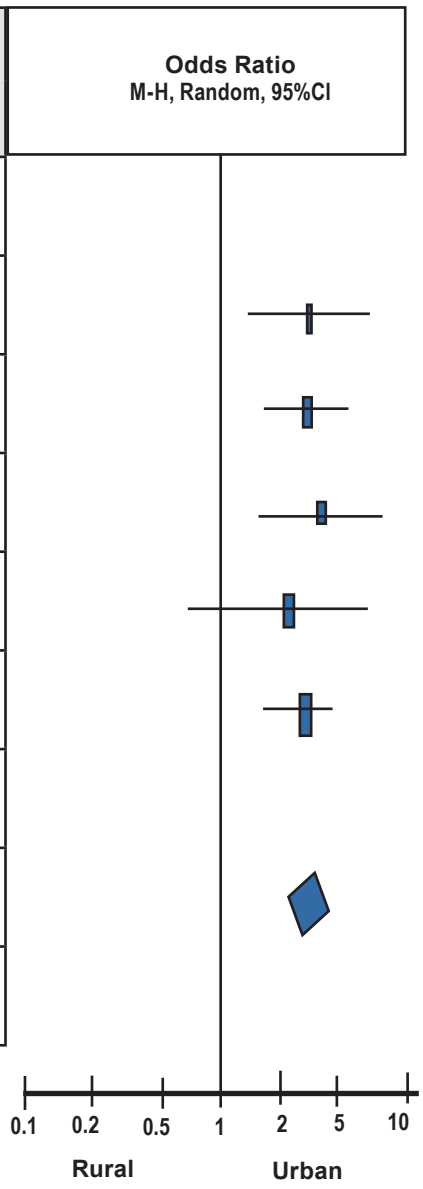


Figure 4: *Association Between Antenatal Care with Low Birth Weight in Ethiopia, 2018, (n=8).*

Residence

The results of the review presented statistically significant association between the residence of the mothers and low birth weight. Women who live in rural areas had a chance of more than twice giving birth to low birth weight babies when compared to urban residents (OR, 2.44; 95% CI: 1.94, 3.08, P<0.00001). Following a large *heterogeneity* between studies, sensitivity analysis was conducted and significant change was observed in the overall summary results of the odds ratio (OR) indicated an I^2 value of 0% ***(Figure 5).***

Study or Subgroup	Experimental		Control		Weight	Odds Ratio M-H, Random, 95%CI
	Events	Total	Events	Total		
Alemu and Umeta, 2016	3101	10308	367	1513	0.0%	1.34 [1.19, 1.52]
Assef et al., 2012	259	868	12	88	13.5%	2.69 [1.44, 5.04]
Demelash et al., 2015	62	126	67	261	26.6%	2.81 [1.80, 4.38]
Gebremedhin,et al 2015	29	129	16	179	12.2%	2.95 [1.53. 5.71]
Kastro et al., 2018	16	141	19	291	10.9%	1.83 [0.91, 3.19]
Mengesha et al., 2017	62	397	59	755	36.8%	2.18 [1.49, 3.19]
Total (95% CI)		**1661**		**1574**	**100%**	**2.44 [1.94, 3.08]**
Total events	428		173			



Heterogeneity: Tau² = 0.00; Chi² = 1.77, df = 4 (P< 0.78); 1² = 0%

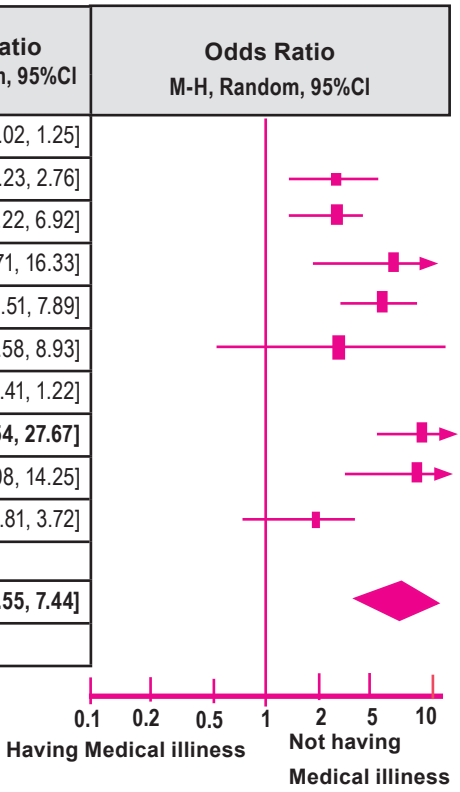
Test for overall effect: Z = 7.61 (P < 0.00001)

Figure 5: *Association Between Residences with Low Birth Weight in Ethiopia, 2018, (N=6).*

Any Maternal Medical Illness During Pregnancy

The odds ratio of the analysis indicated a significant association between having medical illness during pregnancy and low birth weight. Women who had medical illness during pregnancy nearly five times had higher odds of having low birth weight babies as compared with those who had no medical illness during pregnancy (OR = 4.36;95% CI: 2.55, 7.44; P < 0.00001). The investigators considered a random effect model for the analysis because the I^2 value was 95%. Besides, a Sensitivity analysis was done, and significant change was observed in the overall summary results of the odds ratio whereby the I^2 value was 83% after performing the sensitive analysis ***(Figure 6).***

Study or Subgroup	Having medical Illiness		Not Having medical Illiness		Weight	Odds Ratio M-H, Random, 95%CI
	Events	Total	Events	Total		
Alemu and Umeta, 2016	692	2185	2690	9250	0.0%	1.13 [1.02, 1.25]
Asmare et al., 2018	77	188	66	241	14.7	1.84 [1.23, 2.76]
Demelash et al., 2015	37	61	92	326	13.6%	3.92 [2.22, 6.92]
Gebregzabiherher et al., 2017	9	25	30	385	11.0%	6.66 [2.71, 16.33]
Gebremarian, 2005	78	156	69	432	14.7%	5.26 [3.51, 7.89]
Gebremedhin, et al., 2015	3	11	42	297	7.8%	2.28 [0.58, 8.93]
Hailu and Kebede, 2018	21	77	126	364	0.0%	0.71 [0.41, 1.22]
Kumlachew et al., 2018	35	68	21	307	13.0%	**14.44 [7.54, 27.67]**
Kumlachew et al., 2018	28	65	28	310	13.1%	7.62 [4.08, 14.25]
Zeleke et al., 2012	11	44	41	255	12.1%	1.74 [0.81, 3.72]
Total (95% CI)		**618**		**2553**	**100%**	**4.36 [2.55, 7.44]**
Total events	278		389			



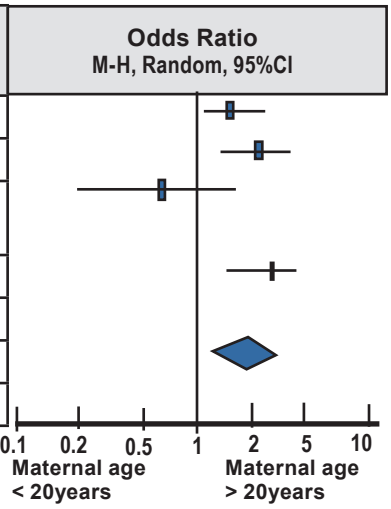
Heterogeneity: Tau² = 0.46; Chi² = 41.61, df = 7 (P< 0.0.00001); 1² = 83%
Test for overall effect: Z = 5.40 (P < 0.00001)

Figure 6: *Association Between any Medical Illnesses during Pregnancy With Low Birth Weight in Ethiopia, 2018, (N=10).*

Maternal Age

The odds ratio of the analysis indicated a significant association between maternal age and low birth weight. Women aged ≤ 20 years had nearly five times higher occurrence of low birth weight as compared with those who were aged less than 20 years (OR=1.80; 95% CI: 1.11, 2.90, P=0.02). ***(Figure 7)***

Study or Subgroup	Experimental		Control		Weight	Odds Ratio M-H, Random, 95%CI
	Events	Total	Events	Total		
Alemu and Umeta, 2016	182	492	3270	11310	33.2%	1.44 [1.20, 1.74]
Demelash et al., 2015	52	108	77	279	26.4%	2.44 [1.54, 3.86]
Gebregzabiherher et al 2017	4	59	39	365	12.8%	0.61 [0.21, 1.77]
Gebremarian, 2005	54	128	93	460	27.6%	2.88 [1.90,4.37]
Total (95% CI)		**787**		**12414**	**100%**	**1.80 [1.11, 2.90]**
Total events	292		3479			



Heterogeneity: Tau² = 0.00; Chi² = 1.77, df = 4 (P< 0.78); 1² = 0%
Test for overall effect: Z = 7.61 (P < 0.00001)

Figure 8: *Publication Bias of The Studies (N=7).*

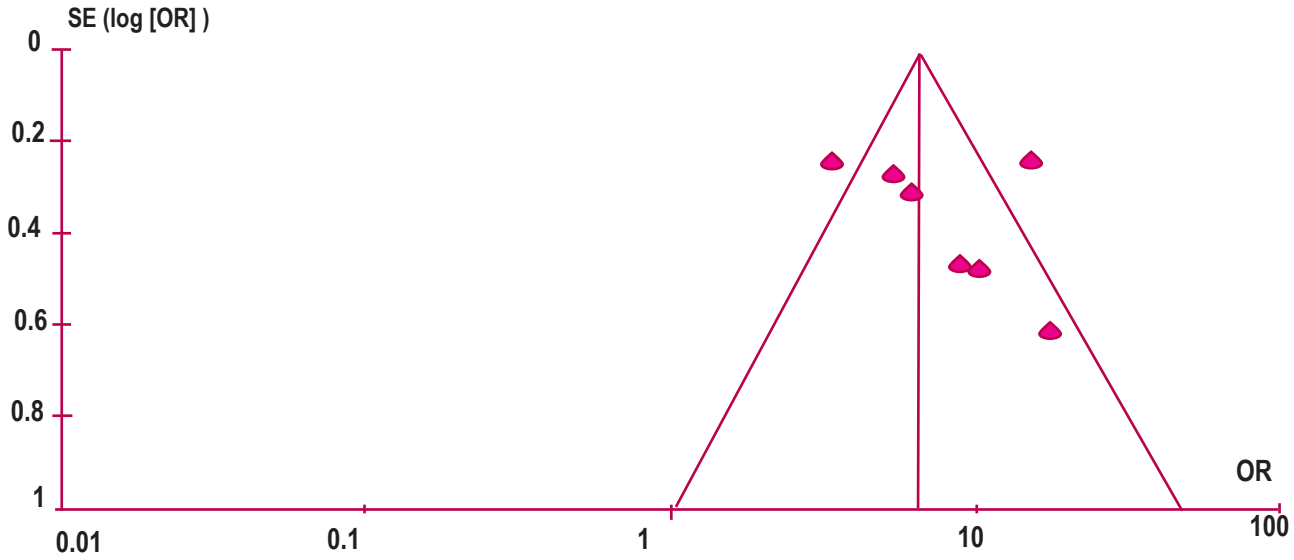


Figure 7: *Association Between Maternal Age with Low Birth Weight in Ethiopia, 2018, (n=4).*

Discussion

This systematic review was directed towards capturing the findings of primary studies that generated condensed evidence on the prevalence of low birth weight and its associated factors. A total of 16 studies that were conducted in the context of Ethiopia were identified and included [25-40]. The main findings of systematic review and meta-analysis have revealed the overall pooled prevalence and many factors associated with low birth weight. Significantly associated factors were the gestational age, antenatal care, the residence of the setting, medical illness and maternal age.

The authors used wide and all-inclusive search strategies from multiple databases and included published, unpublished studies and gray literature. Studies were evaluated for the methodological quality using a JBI critical appraisal tool checklists for every study design.

Although the literature search assessed all related studies within the desired scope, it was possible that, some relevant publications were missed out. For example, some studies which were not written in the English language, studies that could not be accessed in full text after unsuccessful e-mail communication with the author were disqualified.

In addition, it was hard to conclude that the studies were homogeneous. The popularity of the study might not be in full confidence, because the selected study was not from all regions of Ethiopia. Publication bias was also observed for some studies ***(Figure 8).***

According to the current systematic review and meta-analysis, the prevalence of low birth weight was high among common births in Ethiopia. The findings of this review showed that the overall pooled prevalence of low birth weight was 18% among births since millennium years. This finding is consistent to a study conducted in Ethiopia (17.3%) [41]. However, this review finding was lower than that of Ethiopia Demographic Health Survey 2016 (24%)[18]. The difference could be due to the Ethiopian government's efforts to accelerate the reduction of undernutrition through the national nutrition Strategy and the national nutrition programs.

The second phase of national nutrition programs which covers the period from 2016 to 2020, addresses the multi-sectoral and multi-dimensional nature of nutrition and guide policies, strategies, programs, and partnerships that deliver evidence-based, cost-effective nutrition interventions[42]. Several additional initiatives embody the government's commitment to improved nutrition and high numbers of studies included years after 2016.

The findings of this study reported that, there was a strong association between low birth weight with different factors. The major factors for low birth weight being prematurity (gestational age less than 37), mothers from rural residences, young age of mothers, no antenatal care and mothers having different medical

illnesses. These factors were presented in almost all studies included in the systematic review. These findings were supported by studies conducted in different areas [18, 41, 43-45].

A limitation to this study was the inclusion of studies which were not representative of all-regions in Ethiopia. Other factors affecting birth weight may have biased the study results, which we tried to compensate by taking appropriate inclusion and exclusion criteria. Due to limitation of time and resources, further exploration of determinants as associated with low birth weight could not be done. There is still need to conduct studies with large sample sizes at a local level and advanced analysis of the data to take necessary corrective action for the prevention of low birth weight.

Conclusions

The pooled prevalence of low birth weight was high in Ethiopia. Gestational age less than 37(preterm), mothers from the rural areas with lack of antenatal or postnatal knowledge, young age of mothers and lack of antenatal care follow up and mothers having different medical illnesses were the most significant contributing factors for low birth weight.

However, almost all these factors could be prevented by ante/prenatal consultation and education. Therefore, it is our recommendation that, pregnancy must be carefully planned with the help of community health workers and health providers. Full utilization of the maternal and child health care services from the country's health system must be achieved so that the nation gets healthy newborns who will lead healthy lives for building a better Ethiopia. Additional investigations on the risk factors of low birth weight are required to be conducted in different areas of Ethiopia.

Declarations

Ethics Approval and Consent to Participate

Not applicable.

Consent for Publication: Not applicable.

Availability of Data and Material

The data that support the review findings of this study are available upon submitting a reasonable request to the corresponding author.

Competing Interests

The authors declared that they have no competing interest.

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Authors' Contributions

TT*, TW, AA, and HU conceived and designed the review. TT* and TW carried out the draft of the manuscript and TT* is the guarantor of the review. TT* and TW developed the search strings. TT and TW screened and selected studies. TW and HU extract the data. AA and HU evaluated the quality of the studies. TT*, AA and TW carried out analysis and interpretation. TT*, TW, AA, and HU rigorously reviewed the manuscript. All authors read and approved the final version of the manuscript.

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