

# Prevalence and antimicrobial susceptibility of group B streptococci among pregnant women in Ethiopia: A systemic review and meta-analysis study

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## Abstract

**Objective:** Maternal colonization or infection with drug-resistant Group B streptococcus is a serious disease that affects mother, fetus, and infant. The knowledge of maternal colonization and antimicrobial susceptibility test is substantially needed for a nation to formulate a policy or change the already existing one to reduce maternal, fetus, and infant mortality. As a result, the goal of this review was to determine the pooled prevalence Group B streptococcus colonization and antimicrobial susceptibility among Ethiopian pregnant women.

**Methods:** Literature searches were carried out in the electronic biomedical databases and indexing services such as PubMed/MEDLINE, Scopus, Science Direct, Web of Science, and Google Scholar. Original records of research articles, available online from 2014 to December 2020, addressing prevalence and antimicrobial-resistance pattern of Group B streptococcus in pregnant women were identified and screened. Endnote citation manager software version X9 for windows was utilized to collect and organize search outcomes and for removal of duplicate articles. The relevant data were extracted from included studies using a format prepared in Microsoft Excel and exported to STATA 14.0 software for the outcome measures analyses and subgrouping. The  $I^2$  index was used to measure heterogeneity between studies and median, and interquartile (25%, 75%) was used to assess antimicrobial susceptibility rate.

**Results and conclusion:** Sixteen original articles were found in both qualitative and quantitative analyses. Group B streptococcus colonization was recorded in 979 of the 5743 pregnant women, resulting in a 16% overall frequency (95% confidence interval: 13%–20%). The estimated prevalence varied significantly between studies with significant heterogeneity ( $\chi^2 = 154.31$ ,  $p = 0.001$ ,  $I^2 = 90.28$ ). Ampicillin (97.8%; interquartile range = 89.5%–100%), penicillin G (95.5%; interquartile range = 89.5%–100%), and vancomycin (100%; interquartile range = 89.5%–100%) susceptibility were all high in Group B streptococcus, whereas tetracycline (29%; interquartile range = 89.5%–100%) susceptibility was low. Group B streptococcus colonization rates in Ethiopian women during pregnancy were virtually similar to those in many underdeveloped countries, and Group B streptococcus isolates were highly sensitive to ampicillin, penicillin G, and vancomycin.

## Keywords

Prevalence, antimicrobial, pregnancy, meta-analysis, Ethiopia

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## Introduction

Within the genus *Streptococcus*, Group B streptococcus (GBS) or *Streptococcus agalactiae* is one of numerous serologically different species.<sup>1</sup> It is an encapsulated diplococcus exhibiting  $\beta$ -hemolysis on blood agar, facultative anaerobe, nutritionally fastidious, catalase, and mannitol salt negative.<sup>2</sup> Recognized by Lancefield classification as GBS in the 1930s and classified into 9 serotypes, a 10th serotype of it was recently identified.<sup>3</sup> GBS is a leading cause of serious infection and sepsis in both mothers and babies. Chorioamnionitis,

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endometritis, and urinary tract infections are among the maternal diseases linked to GBS.<sup>4</sup> GBS colonizes the vaginal and rectum of 10%–30% of pregnant women, and it is predicted that 50% of newborns will be colonized if exposed to GBS during delivery, with just 2% developing an invasive infection.<sup>5</sup> Every year, GBS causes between 114,000 and 204,000 invasive cases, as well as 147,000 stillbirths and infant deaths across the world.<sup>6</sup> Neonatal death rates in industrialized and poor nations, respectively, range from 10% to 15% and 40% to 58%, demonstrating that vertical transmission of *S. agalactiae* remains a global issue.<sup>3</sup> Infection with GBS causes sepsis and meningitis in newborns, which can lead to severe sickness, long-term disability, and death.<sup>1</sup>

The Center for Diseases Control (CDC) suggests two approaches for preventing GBS infection in newborns. Between 35 and 37 weeks of pregnancy, all pregnant women were tested for vaginal and rectal GBS colonization using a culture-based screening technique.<sup>7</sup> The alternative method is risk-based, which comprises identified candidates for intra-partum chemoprophylaxis based on the presence of any of the following intra-partum risk factors, and intra-partum antibiotics are suggested for those with positive culture results<sup>8</sup>: intra-partum fever of 38° centigrade, membrane rupture in 18h, and birth at less than 37 weeks. Risk-based screening is utilized in areas where culture-based screening is not accessible, and it is most commonly employed in low-resource settings. Chemoprophylaxis is still the most efficient way to prevent infections in mothers and babies.<sup>8</sup> The antibiotics of choice for GBS prophylaxis include penicillin, ampicillin, erythromycin, and clindamycin.<sup>8</sup> However, reports of medication resistance have made susceptibility testing a crucial part of the GBS management approach.<sup>8,9</sup> Ethiopia is a developing nation with a high newborn mortality rate of 33 per 1000 live births, accounting for 52% of under-5 mortality and 30% of neonatal death due to infection or sepsis.<sup>10</sup> Despite significant newborn mortality owing to infection, regular culture-based screening is not implemented as a national policy in Ethiopia.

Furthermore, several researches have been done in various parts of the country, albeit in a disjointed manner. As a result, the goal of this review is to aggregate and comprehensively report the prevalence of GBS colonization based on culture-based approach and antibiotic susceptibility testing, so that the data may aid future national protocol formulation for GBS screening.<sup>11,12</sup>

## Methods

The PRISMA 20 (Preferred Reporting Items for Systematic Reviews and Meta-analysis) standard was used to conduct these systematic reviews and meta-analyses.<sup>13</sup>

### Search strategy

A literature search of PubMed/Medline, Science Direct, Scopus, Web Science, and Google scholar databases was

identified for potentially relevant papers. GBS, *streptococcus agalactiae*, streptococci, group B streptococcus, vagina colonization, Ethiopia, prevalence, proportion, antibiotic, antimicrobial resistance, and antimicrobial sensitivity test were all searched using a mix of free text and thesaurus phrases. The following key phrases were combined using “AND” and “OR” Boolean operators to obtain research from an Internet database. Pregnancy AND Ethiopia AND GBS, GBS AND Ethiopia, Pregnancy AND Ethiopia AND group B streptococcus, pregnancy AND group B streptococcus AND Ethiopia, pregnancy AND streptococcus agalactiae AND Ethiopia, antibiotic susceptibility OR antibiotic resistance AND GBS OR *streptococcus agalactiae* AND Ethiopia. To find the relevant original papers in PubMed, we employed medical topic headings (MeSH words). Three authors (D.L., T.K., and L.C.H.) conducted the search and the most relevant papers were chosen based on established inclusion and exclusion criteria. The final author double-checked the consistency of the search method, research selection, and inclusion and exclusion criteria.

### Inclusion and exclusion criteria

We included published and unpublished (Addis Ababa Universities) studies that reported the prevalence of GBS colonization and their antimicrobial-resistance from inception to July 2021 in pregnant women. We also included studies published in English, human studies, and conducted only in Ethiopia. We excluded qualitative studies, review paper, commentaries, case series, case reports, conference proceeding, and abstracts.

### Data extraction

Data abstraction was conducted by two authors (D.L., T.K.) utilizing an Excel spreadsheet form. Using inclusion criteria, the two authors separately assessed titles, abstracts, full-text publications, and abstracted data. Discrepancies between the two authors who largely abstracted the data were arbitrated by the third author (L.C.H.). The following parameters were extracted from each study: the name of the first author, year of publication, study sites (regions), age, the specimen collection site, gestational age, the number of pregnant women who participated in the study, the number of moms positive for GBS, the prevalence/proportion, and the antibiotic susceptibility test.

### Methodology quality assessment

The assessment of methodological quality was carried out independently by two reviewers using the Newcastle-Ottawa scale (NOS). A quality scale was calculated based on three categories.

1. Selection (maximum 4 stars);
2. Comparability between groups (maximum 2 stars);

- Outcome assessment (maximum 3 stars). A maximum of 1 star could be awarded for each item in the group selection and outcome assessment categories. A maximum of 2 stars could be awarded for comparability. Therefore, the maximum possible score was 9 stars, which represented the highest methodological quality. Studies were labeled as having high quality if the score was above the average (8 stars). Disagreements between the reviewers were resolved through discussion.

### Statistical analysis

Endnote citation manager software version X9 for windows was utilized to collect and organize search outcomes and for removal of duplicate articles. The relevant data were extracted from included studies using a format prepared in Microsoft Excel and exported to STATA 14.0 software for the outcome measures analyses and subgrouping. To give a visual summary of the data, we utilized forest plots to estimate the pooled effect size and effect of each research along with their confidence interval (CI). Because of the expected heterogeneity, a random-effect model was utilized in this meta-analysis. The  $p$  value, Cochran test (Q-test), and  $I^2$  were used to represent statistical heterogeneity among studies, with  $p$  value of 0.05 and  $I^2$  values of 0%, 25%, 50%, and 75% indicating no, low, moderate, and high heterogeneity, respectively. For a quantitative examination of the likelihood of publication bias, we utilized Egger's regression test as well as visual inspection for symmetry of the plot. We also did subgroup analysis using publication years, sample size, and study location as covariate. If  $p < 0.05$ , all stated  $p$  values were two-sided and statistically significant.

## Result

### Literature identification and descriptions of studies

After evaluating the titles and abstracts of the 312 studies found, 156 duplicates were removed. We also omitted 110 publications since they did not mention the prevalence of GBS in Ethiopia. Finally, the entire text of the remaining 46 papers was downloaded and thoroughly examined to ensure that they met all of the inclusion requirements. We also removed 15 publications because they were not about GBS colonization during pregnancy in Ethiopia, and 15 more studies because they were not about GBS prevalence during pregnancy. Finally 16 articles full filling inclusion criteria were included in this review<sup>9,14-27</sup>(Figure 1).

All studies were facility-based cross-sectional. The age of included pregnant women ranged from 14<sup>21</sup> to 40 years.<sup>15,21,27-29</sup> Twelve of the studies reported antimicrobial susceptibility test,<sup>9,15-18,20-22,25,27,29,30</sup> nine of them used the Kirby-Bauer disk diffusion method for susceptibility test,<sup>9,20-22,25,27,29,30</sup> and one used Agar diffusion technique.<sup>17</sup> Only three of

the studies reported Serotype of GBS isolates and three of them reported type II most common followed by type V.<sup>23,26,27</sup> Sample size of included studies ranged from 126 to 1688.<sup>9,14-27</sup> and the prevalence of GBS during pregnancy ranged from 7.2% to 26.8%.<sup>14,17</sup> Five minimum antibiotics used for susceptibility test and 12 maximum antibiotics for susceptibility test were used.<sup>9,15-18,20-22,25,27,29,30</sup> Year of publication was from October 2014<sup>9,26</sup> to January 2020<sup>20,24,26,27,29,30</sup> and there were five studies from Oromia region,<sup>16,17,20,24,26</sup> four studies from Addis Ababa city administration,<sup>9,22,27,29</sup> three studies from SNNP region,<sup>15,23,28</sup> two from Tigray region,<sup>21,25</sup> and one each from Amhara<sup>18</sup> and Harari regions.<sup>14</sup> No study reported from Somalia, Afar, Gambella regions, Dire Dawa city administration and Benishangul-gumuz region. Twelve studies reported as sample were taken from Recto-vaginal,<sup>15-18,25,27,29,30</sup> three studies from lower vagina alone,<sup>17,22,25</sup> and one study from anal and vagina.<sup>21</sup> Five studies did not report the gestational age<sup>14,24,23,26,27</sup> while eight studies reported that the sample was taken at gestational age 35-37 weeks and one study reported a gestational age of 37-40 weeks.<sup>29</sup> Most of the studies were of high quality, but few were of low quality according to the authors' judgment (Table 1).

### Pooled prevalence estimate and heterogeneity

In Ethiopia, the prevalence of GBS during pregnancy was reported in 16 studies including 5734 pregnant women. As shown in Figure 2, among the 979 pregnant women colonized by GBS, the pooled prevalence was estimated to be 16% (95% CI: 13%-20%). The prevalence estimate differed significantly between studies ( $\chi^2=154.31$ ,  $p=0.001$ ,  $I^2=90.28$ ) (Figure 2).

### Subgroup analysis by region

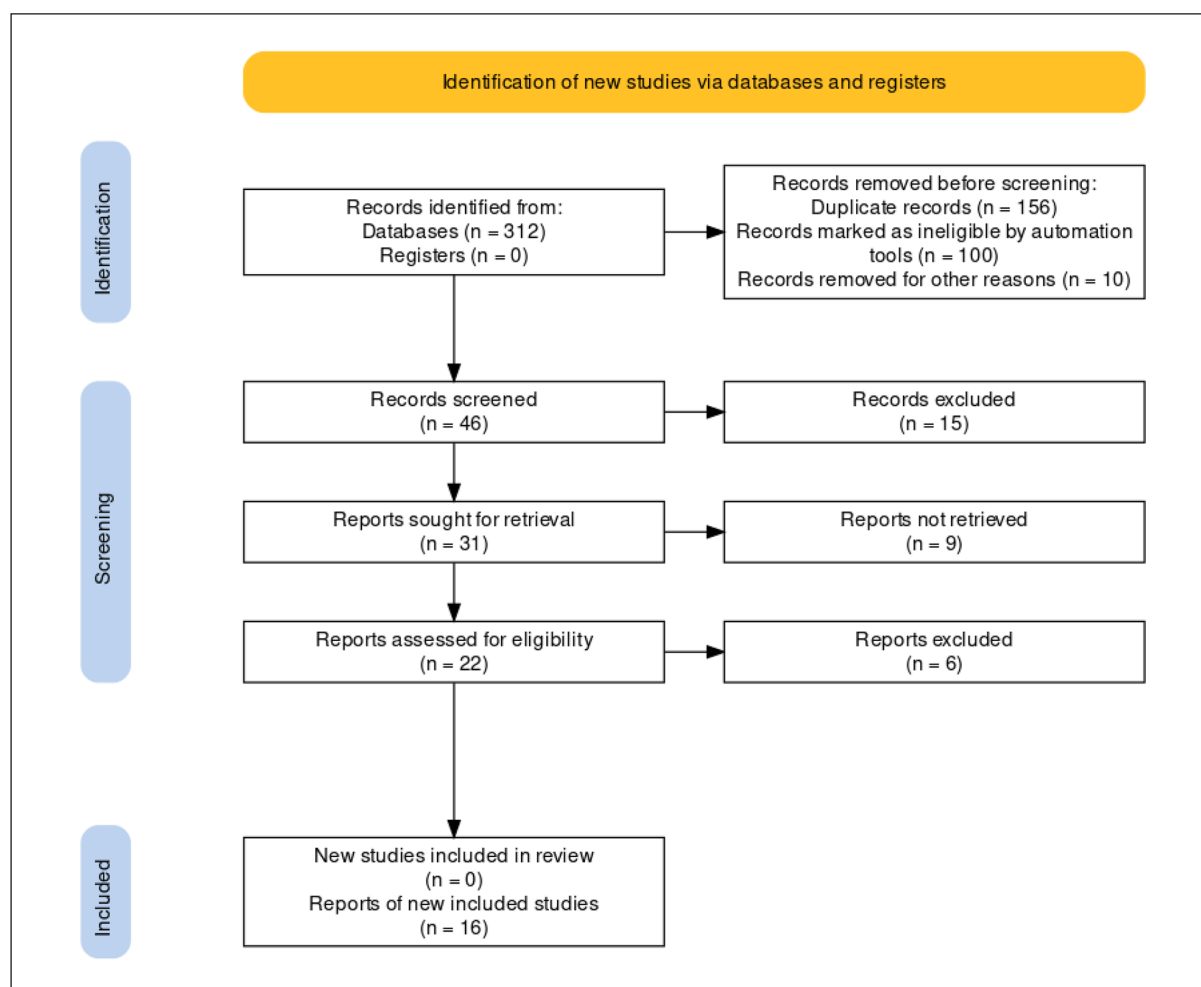
GBS colonization was found in 18% (95% CI: 11-24) of pregnant women in Oromia, 15% (95% CI: 8-21) of pregnant women in SNNP, and 17% (95% CI: 9-25) of pregnant women in Addis Ababa city administration (95% CI: 9-25) (Figure 3).

### Subgroup analysis by year of publication

Before 2016, the estimated pooled prevalence of GBS colonization was 14% (95% CI: 9-19), and between 2017 and 2020, the estimated pooled prevalence of GBS colonization was 18% (95% CI: 14-21), with no significant difference between groups ( $p=0.274$ ), (Figure 4).

### Subgroup analysis by site of sample taken

In our study, we discovered that those studies that took samples from the recto-vaginal had a higher prevalence of GBS of 18% (95% CI: 14-22) followed by samples taken from lower vagina at 14% (95% CI: 11-16) (Figure 5) (Table 2).

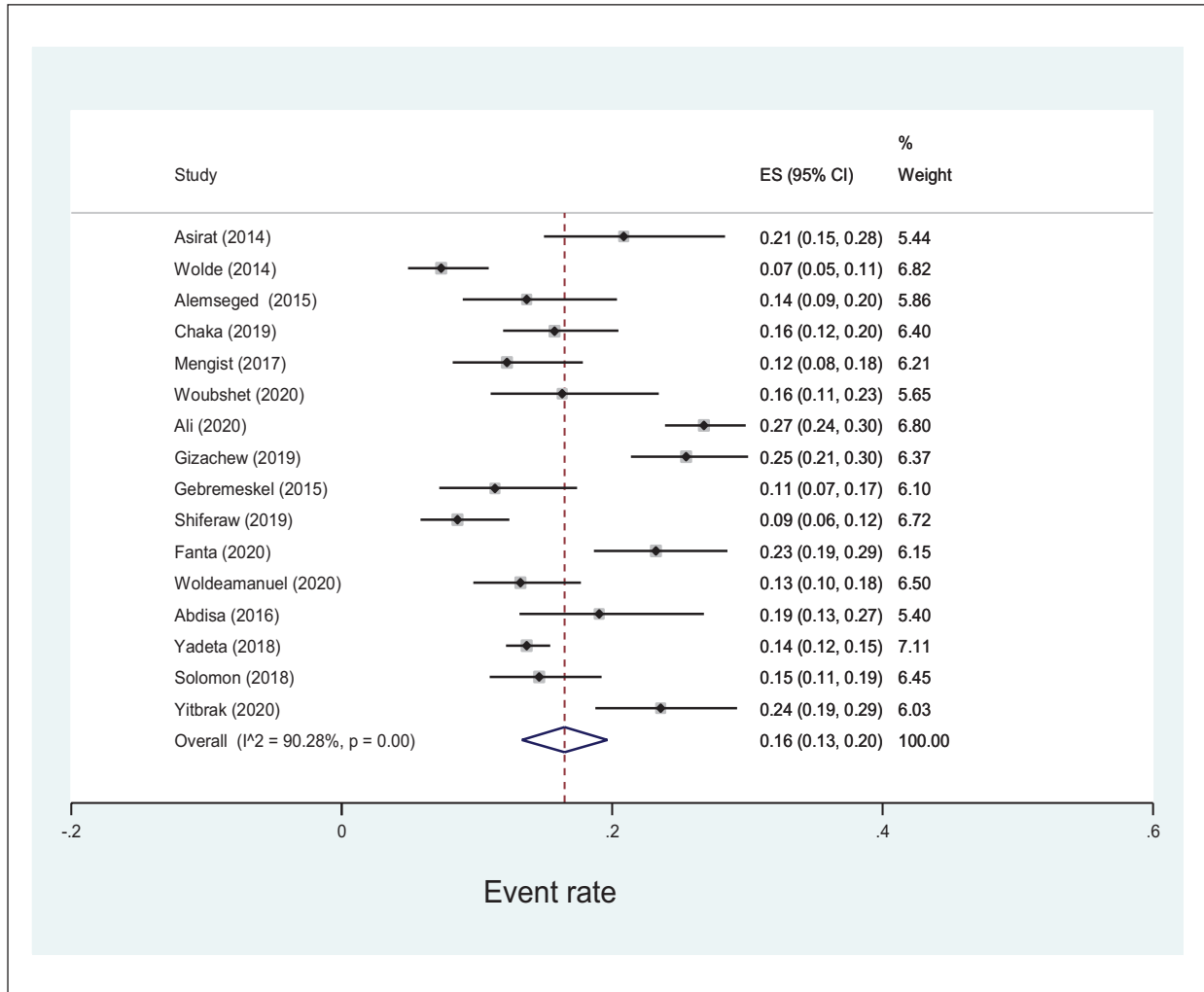


**Figure 1.** PRISMA flow diagram for study selection.

**Table 1.** Characteristics of studies included in systematic review and meta-analysis.

Author	Year	Study site	Age	Sampling site	GA (weeks)	Sample size	positive GBS culture	Prevalence (%)	Newcastle Ottawa
Asirat <sup>15</sup>	2014	Hawassa,	17–40	Recto-vagina	35–37	139	29	20.9	5
Wolde <sup>9</sup>	2014	Addis Ababa	CD	Recto-vagina	35–37	300	22	7.2	8
Alemseged <sup>25</sup>	2015	Mekelle, Tigray	26.1	lower vagina	35–37	139	19	13.7	8
Chaka <sup>23</sup>	2019	Hawassa, SNNP	CD	Recto-vagina	NA	280	44	15.7	5
Mengist <sup>16</sup>	2017	Nekemte, Oromia	16–38	lower vagina	≥35	180	22	12.2	7
Woubshet <sup>20</sup>	2020	Jimma, Oromia	16–38	Recto-vagina	35–37	135	22	16.3	5
Ali <sup>24</sup>	2020	Jimma, Adama, Addis Ababa, Oromia	CD	Recto-vagina	NA	840	225	26.8	8
Gizachew <sup>19</sup>	2019	Gonder, Amhara	CD	Recto-vagina	≥35	385	98	25.5	8
Gebremeskel <sup>21</sup>	2015	Adigrat, Tigray	14–40	anal and vagina	35–37	150	17	11.3	7
Shimelis <sup>28</sup>	2019	Arba Minch, SNNP	15–40	Recto-vagina	35–37	281	24	8.5	8
Fanta <sup>27</sup>	2020	Addis Ababa	16–40	Recto-vaginal	NA	280	65	23.2	6
Woldeamanuel <sup>26</sup>	2020	Adama, Oromia	15–27	Recto-vaginal	NA	280	37	13.2	6
Abdisa <sup>17</sup>	2016	Jimma, Oromia	26.5	Recto-vaginal	35–37	126	24	19	8
Yadeta <sup>14</sup>	2018	Harari	25.31	Recto-vaginal	NA	1688	231	13.68	5
Solomon <sup>22</sup>	2018	Addis Ababa	18–39	lower vagina	35–37	281	41	14.6	8
Yitbarek <sup>29</sup>	2020	Addis Ababa	18–40	Recto-vagina	37–40	250	59	23.6	4

CD: age mentioned in categorical description; NA: not available; SNNP: southern nation and nationalities peoples; GA: gestational age.



**Figure 2.** Forest plot showing pooled prevalence of GBS colonization during pregnancy in Ethiopia women, 2021.

**Subgroup analysis by sample size**

We also performed subgroup analysis by sample sizes (<200 vs. ≥200). Accordingly, the prevalence of GBS colonization in studies with sample size <200 was 15% (95% CI: 12–18) and it was 17% (95% CI: 13–21) in studies involving sample size of 200 and above (Figure 6).

**Publication bias assessment**

The visual assessment of the asymmetry of the funnel plot revealed no publication bias, which was statistically verified by Egger’s regression test ( $\beta=2.03$ , 95% CI: 2.2–6.3)  $p=0.322$ ) (Figure 7).

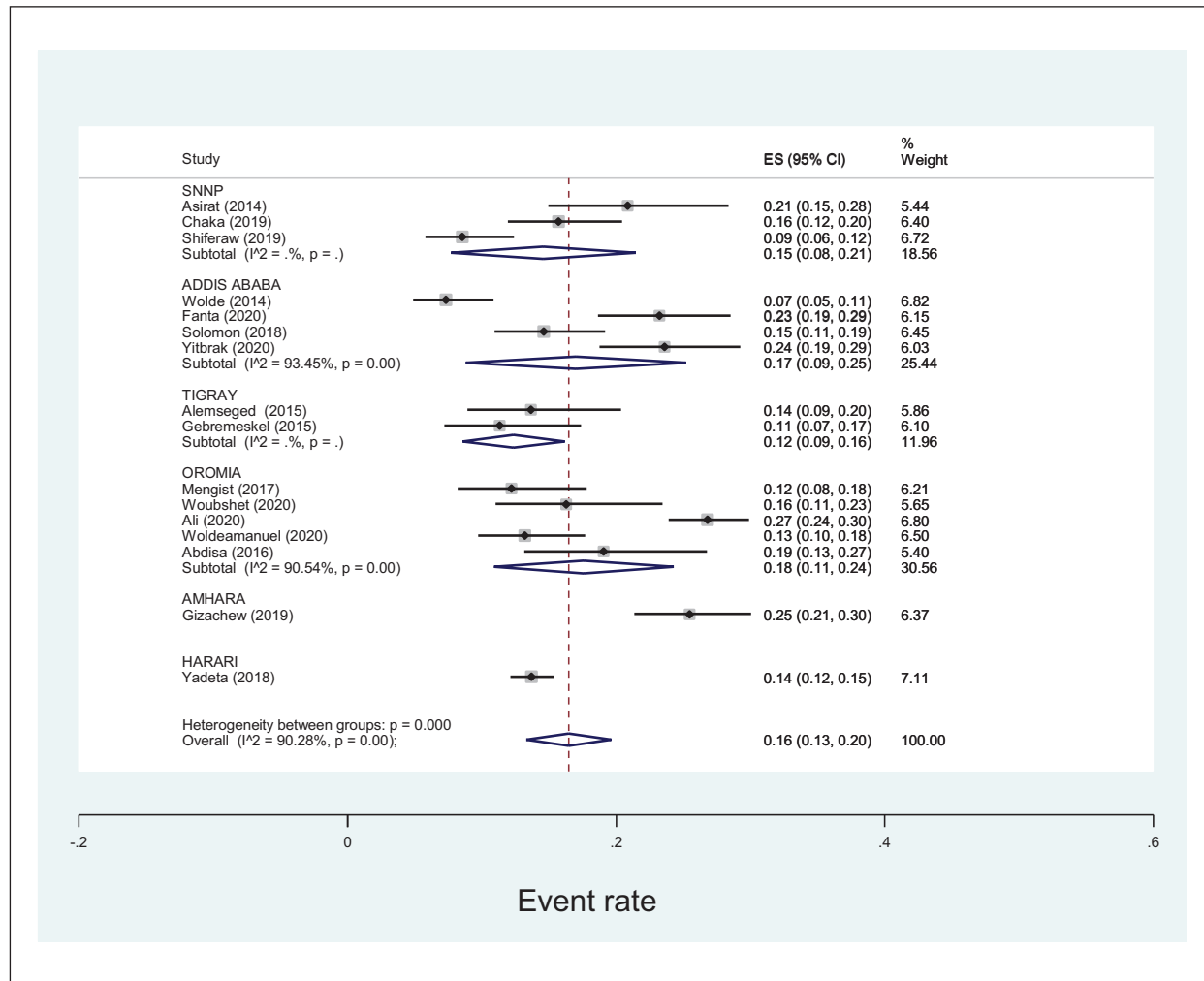
**Antimicrobial susceptibility test**

Antimicrobial susceptibility tests for identified GBS isolates were reported in 12 studies. Vancomycin had the highest prevalence of susceptibility (median 100%, interquartile

range (IQR)=89.18%–100%), followed by ampicillin (median 97.75%, IQR=89.45%–100%), while tetracycline had the lowest prevalence of susceptibility (median 29%, IQR=13.85%–43.73%) (Figure 8 and Table 3).

**Discussion**

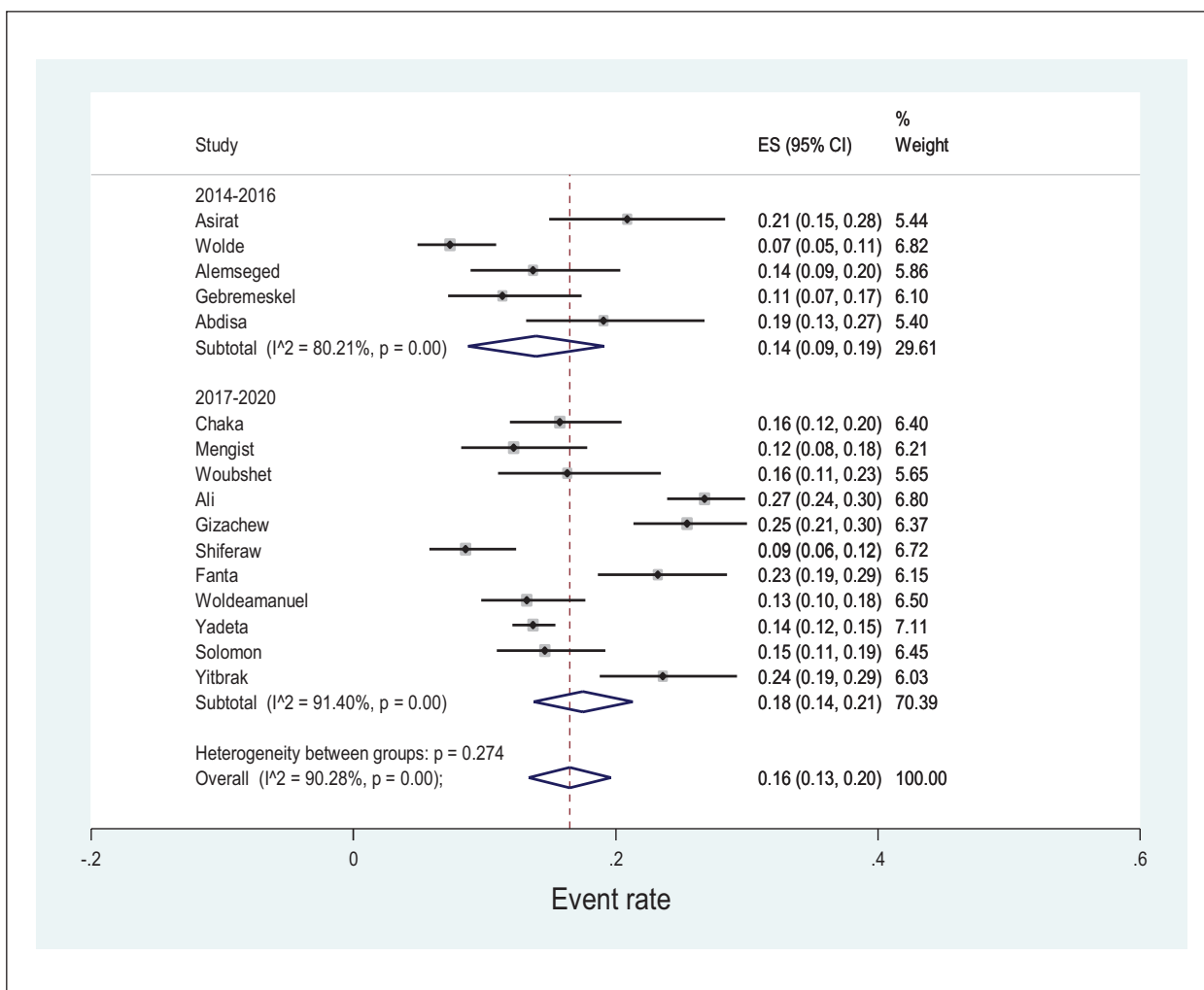
In Ethiopia, the prevalence of maternal colonization with GBS, as well as antibiotic susceptibility testing, has only been studied in modest and fragmented ways thus far. As a result, this is the first meta-analysis of its sort to describe the total proportion of GBS colonization in Ethiopia during pregnancy. We looked at 16 distinct researches from 5 different areas and 1 administrative city. As a result, in this review, the pooled estimate of GBS colonization among Ethiopian pregnant women was 16%, ranging from 15% to 18% in different areas. The present meta-analysis findings are lower than those of a meta-analysis of 73,791 pregnant women from 37 different African nations, which found a 17.9%



**Figure 3.** Forest plot depicting subgroup analysis by region on pooled prevalence of GBS colonization during pregnancy in Ethiopian women, 2021.

prevalence of GBS colonization.<sup>31</sup> Another meta-analysis of 22,206 pregnant women in Africa found a pooled prevalence of GBS colonization during pregnancy of 19.3%, which is greater than our present result.<sup>1</sup> Another comprehensive review and meta-analysis done in a Cameroonian tertiary hospital revealed a pooled prevalence of GBS colonization of 14%, which was lower than our data.<sup>32</sup> The pooled estimated prevalence of Group B Streptococcus in the vagina and rectum of pregnant women in Islamic and non-Islamic countries was 15% and 14%, respectively, according to a meta-analysis and systemic review.<sup>33</sup> Standards and laboratory diagnostic methods, differences in study location, differences in respondents' residence, differences in previous obstetric history, bacteriological method for organism detection, statistical differences in the study population, laboratory staff skill, and health and medical policies of countries and geographic regions could all contribute to the disparity.

Because of a lack of qualified workers and the availability of essential materials, culture-based detection of GBS during pregnancy is seldom done in Ethiopia. In most health facilities, GBS was assessed using a risk-based method and ampicillin was given to all patients empirically. In our study, all GBS were sensitive to vancomycin, whereas ampicillin susceptibility was 97.75% and penicillin G susceptibility was 95.45%. All isolates of GBS were shown to be sensitive to ampicillin, vancomycin, and penicillin in a meta-analysis done in Cameroon.<sup>34</sup> A meta-analysis done in the province of China found that the majority of GBS isolates were sensitive to ampicillin, penicillin, and vancomycin, with a pooled tetracycline resistance of 73%.<sup>5</sup> A study conducted in Iranian pregnant women on antibiotic resistance for GBS during pregnancy justified that the tetracycline resistance rate was 96.2%, while for ampicillin and penicillin, this was less than 4%.<sup>35</sup>



**Figure 4.** Forest plot depicting subgroup analysis by year of publication on pooled prevalence of GBS colonization during pregnancy in Ethiopian women, 2021.

**Table 2.** Summary of prevalence of GBS colonization among pregnant women in Ethiopia, 2021.

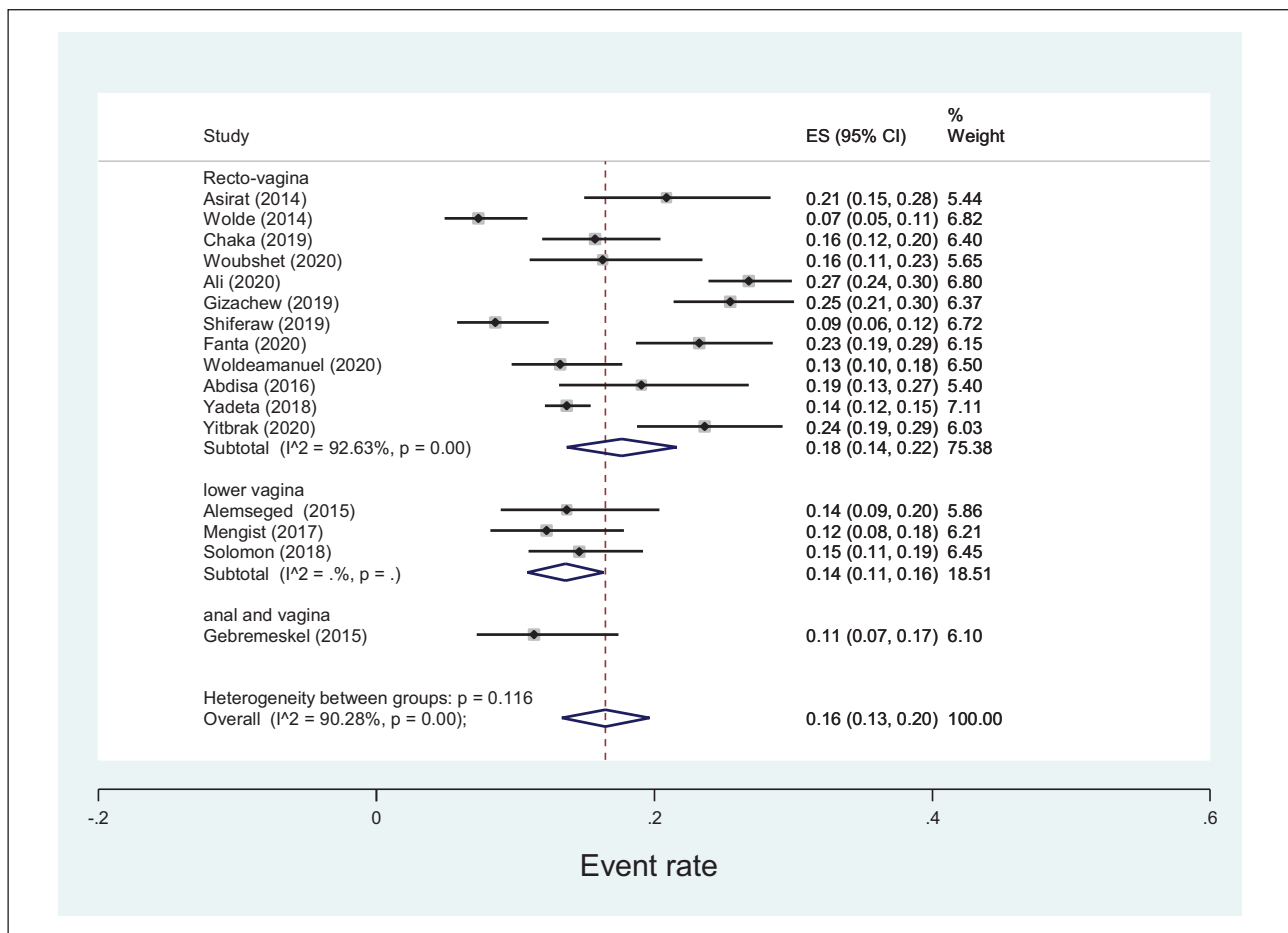
Subgroup	#studies	Sample size	Positive	Prevalence (95% CI)	Heterogeneity I <sup>2</sup> (%)	p value
Region	16	5734	979	16 (13–20)	90.28	0.001
Amhara	1	385	98	25 (21–30)		
Oromia	5	1435	330	18 (11–24)	90.54	0.001
SNNPR	3	700	97	15 (8–21)		
Tigray	2	289	36	12 (9–16)		
Addis Ababa	4	1111	187	17 (9–25)	93.45	0.001
Harari	1	1688	231	14 (12–15)		
Year of publication						
2014–2016	5	854	111	14 (9–19)	80.21	0.001
2017–2020	11	4880	868	18 (14–21)	91.4	0.001
Sampling site						
Recto-vaginal	12	4984	880	18 (14–22)	92.63	0.001
Lower vaginal	3	600	82	14 (11–16)		
Anal and vaginal	1	150	17	11(7–17)		
Sample size						
Sample <200	6	869	133	15 (12–18)	30.24	0.17
Sample size ≥200	12	4865	846	17 (13–21)	93.84	0.001

CI: confidence interval.

**Table 3.** Antibiotics susceptibility test for GBS during pregnancy among Ethiopian women, 2021.

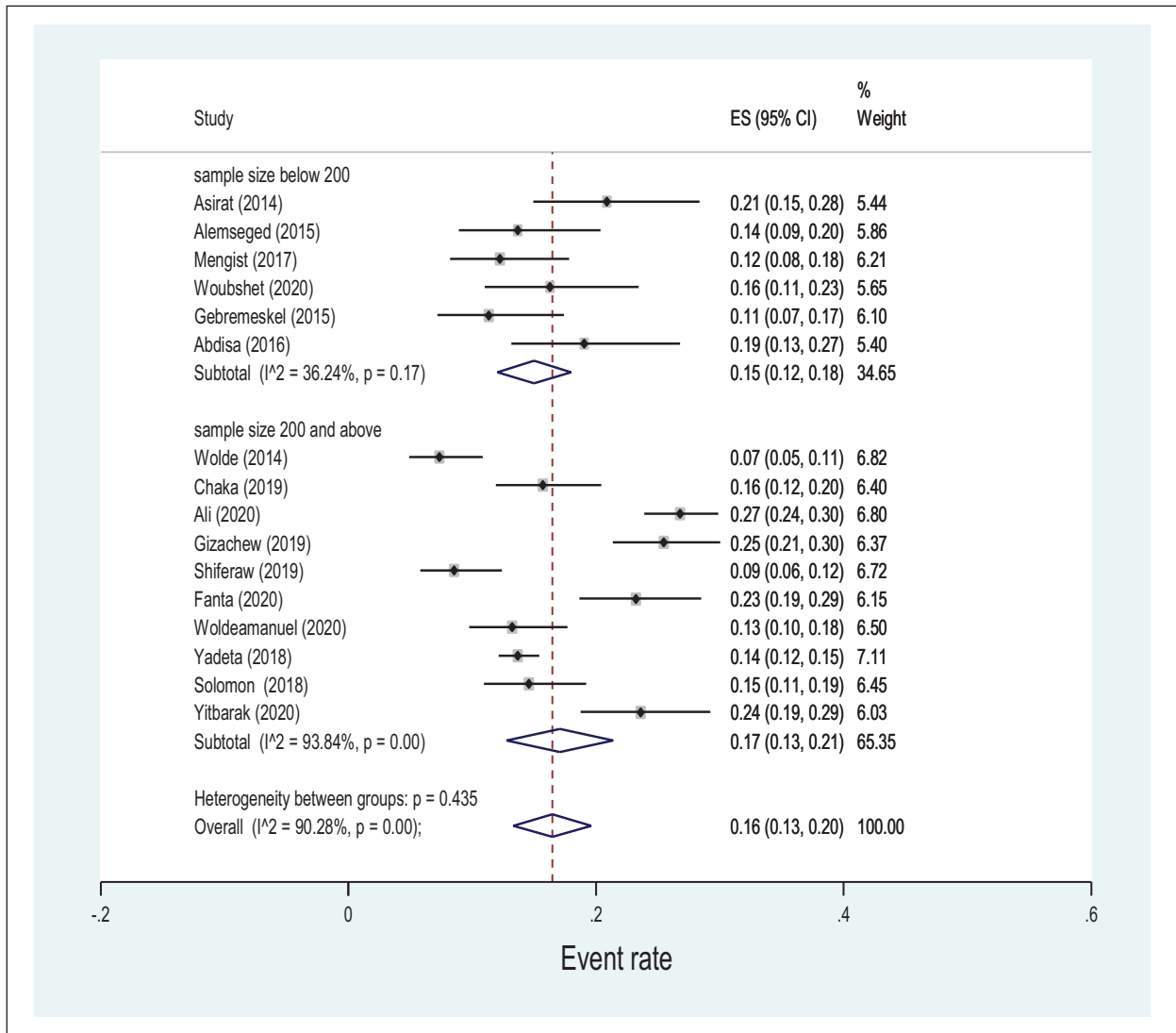
Author	Year of publication	PEN	AMP	VAN	CLM	GEN	ERY	CEF	TTC	CPR
Asirat	NA	100	100	100	NT	100	89.7	89.7	39.3	0
Wolde	2014	54.5	90.9	NT	86.4	NT	90.1	NT	NT	NT
Alemseged	2015	100	100	100	NT	NT	100	73.7	NT	21.3
Mengist	2017	13.6	NT	91	50	NT	41	27.2	NT	NT
Woubshet	2020	90.9	95.5	NT	45.5	0	45.5	NT	NT	NT
Ali	2020	100	NT	100	94	NT	94	NT	12	NT
Gizachew	2019	89.8	90.8	83.7	73.5	NT	67.3	68.4	19.4	0
Gebremeskel	2015	100	100	100	70.6	NT	76.5	NT	NT	NT
Shiferaw	2019	100	100	100	70.8	95.8	79.2	70.8	NT	0
Abdisa	2016	100	100	100	87.1	NT	90.3	90.3	45.2	0
Solomon	2018	80.5	85.4	83	73.2	NT	92.5	NT	NT	NT
Yitbarek	2018	42.3	45.7	93.3	86.4	NT	64.4	NT	NT	NT
Median	NA	95.45	97.75	100	73.35	84.45	89.7	72.25	29	85.95
IQR 25%	NA	61	89.45	89.18	65.45	0	65.13	58.1	13.85	70.9
IQR 75%	NA	100	100	100	86.58	100	91.95	89.85	43.73	90.23

NA: not available; NT: not tested; IQR: interquartile range; PEN: Penicillin; AMP: ampicillin; VAN: Vancomycin; CLM: Clindamycin; GEN: Gentamycin; ERY: Erythromycin; CEF: ceftriaxone; TTC: Tetracycline; CPR: Ciprofloxacin.



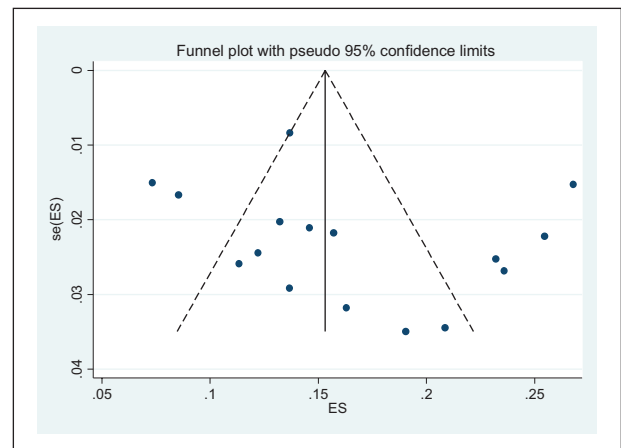
**Figure 5.** Forest plot depicting subgroup analysis by site of sample taken on pooled prevalence of GBS colonization during pregnancy in Ethiopian women, 2021.



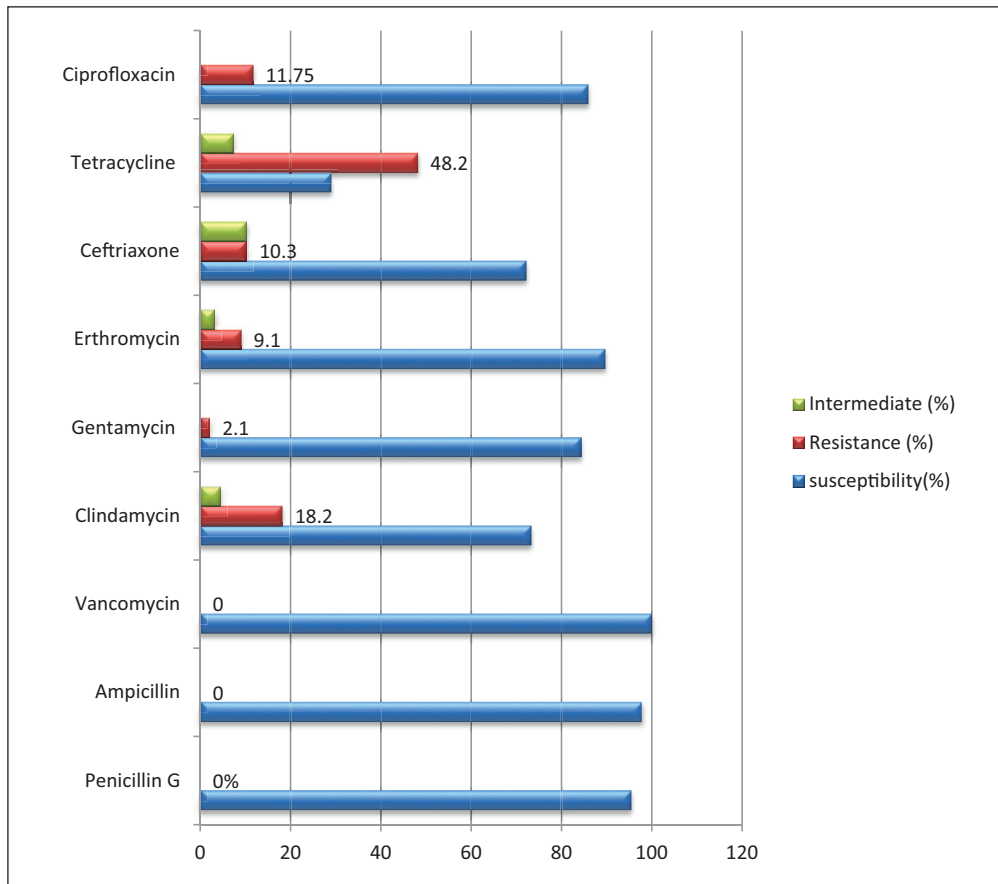


**Figure 6.** Forest plot depicting subgroup analysis by sample size on pooled prevalence of GBS colonization during pregnancy in Ethiopian women, 2021.

According to our review on antibiotic resistance and susceptibility to GBS, penicillin and ampicillin have been chosen for the prevention and treatment of GBS infections, and are typically given in early labor based on cultured discovered serotypes or those who meet the risk-based approach requirements. Instead of penicillin or ampicillin, erythromycin and clindamycin are given for pregnant women who are at risk of anaphylaxis. In most parts of Ethiopia, ceftriaxone is utilized as a second-line antibiotic in the absence of ampicillin or penicillin; however, in our investigation, ceftriaxone was found as intermediate to GBS resistance in about 20% of the cases.<sup>11,12</sup> Vancomycin can be used in the case of drug resistance to ampicillin and  $\beta$ -lactam antibiotics, despite the fact that it is costly and not commonly accessible in Ethiopia. In leading nations, CDC-recommended instructions were followed and antibiotic prophylaxis was



**Figure 7.** Assessment of publication bias.



**Figure 8.** Antimicrobial susceptibility testing pattern among pregnant women of Ethiopia for those colonized by GBS, 2021.

used, resulting in a 70% reduction in the frequency of infection in babies and newborns.<sup>8</sup>

### Strengths and limitations

To the best of our knowledge, this is the first study of its type to describe the countrywide prevalence of GBS colonization and antibiotic susceptibility testing for GBS among pregnant women in Ethiopia. It is critical to generate complete data for policymakers and other interested parties. This subject appears to be undervalued at the national level, with no real evidence-based strategy for detecting GBS colonization and prescribing sensitive antibiotics. The country's risk-based strategy has a number of flaws, including ignoring the problem and contributing to antibiotic resistance and our review will provide a vital concept for revising the present procedure. We also wanted to know what was driving the considerable heterogeneity we noticed in our review. This review had some limitations. First, a few of the reviews did not mention the gestational age at which the sample was taken, which is important because the gestational age at which the sample was taken affects the prevalence of GBS. Second, the method for antimicrobial susceptibility in some studies was not well mentioned in their methodology. Third, because most studies were conducted in the country's

major cities, with the majority of Ethiopians living in rural areas, the prevalence of GBS may be underestimated. Finally, only a few studies included a history of antibiotic use 2–3 weeks prior to sampling for GBS, which could have a significant effect on the growth of bacteria on culture media.

### Conclusion

Because the frequency of GBS identified in our study was high, screening all pregnant women for GBS at 35–37 weeks gestational age, as recommended by the CDC, is critical for reducing GBS-related maternal and newborn mortalities and morbidities. All serotypes of GBS identified in the reviews were highly sensitive to ampicillin, penicillin G, and vancomycin, according to our evaluation.

### Author contributions

All authors made a significant contribution to the work reported, be it in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; they took part in drafting, revising, or critically reviewing the article; gave final approval of the version to be published; agreed on the journal to which the article has been submitted; and agreed to be accountable for all aspects of the work.

## Data availability

All relevant data are available within the paper.

## Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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## Ethics Approval

Not applicable.

## Informed consent

Not applicable.

## Trial registration

Not registered.

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