A SYSTEMATIC REVIEW AND META-ANALYSIS - OPEN ACCESS

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Magnitude of Variceal Bleeding Among Patients with Cirrhosis: A Systematic Review and Meta-Analysis 2026

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ABSTRACT

Introduction: Liver cirrhosis is a consequence of chronic liver damage and inflammation, characterized by diffuse hepatic fibrosis. Progressive hepatic fibrosis results in potentially life-threatening complications, such as gastroesophageal varices and variceal bleeding, which are associated with substantial morbidity, recurrent hospitalization, and high mortality rates. Therefore, this systematic review and meta-analysis aimed to estimate the pooled prevalence of variceal bleeding among patients with cirrhosis.

Methods and materials: - This systematic review and meta-analysis was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guideline. A literature search was conducted in PubMed, Scopus, Web of Science, Embase, Google Scholar, and the Cochrane Library from database inception until September 10. The methodological quality was assessed using the Joanna Briggs Institute critical appraisal tool. An inverse variance-weighted random-effects model meta-analysis was performed to estimate The I^2 test statistic and the Egger's regression statistical test was used to check between-study heterogeneity ad publication bias respectively. A p-value of less than 0.05 used to declare statistical significance.

Results: The twenty-one included studies were retrospective studies with 8998 participants and mostly conducted in the Asia region. The magnitude of variceal bleeding ranges from 11.7 - 91 %. The pooled global proportion of magnitude of variceal bleeding was found to be 56.0% (95% CI: 40.6-71.5). The highest magnitude of variceal bleeding is 66.1 % (95% CI: 46.9- 83.3) was seen in Africa region and the lowest is 26.7 % (95% CI: 9.6.-43.9) was seen in North America region.

Conclusion: According to this systematic review and meta-analysis variceal bleeding is a critical global health concern, which affects over half of the targeted population globally. The regional analysis showed significant geographic disparities ranging from 26.7% in North America to 66.1% in Africa. Therefore tailored public health strategies, enhanced access to prophylactic treatment and strengthened healthcare infrastructure is essential to decrease the burden of the disease.

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Introduction

Liver cirrhosis is a consequence of chronic liver damage and inflammation, and characterized by diffuse hepatic fibrosis [1]. Progressive hepatic fibrosis and architectural distortion lead to portal hypertension and impaired hepatic function, resulting in a range of potentially life-threatening complications; [2-4] such as gastroesophageal varices and variceal bleeding which are associated with substantial morbidity, recurrent hospitalization, and mortality [5-8].

Gastroesophageal varices develop in response to increased portal venous pressure and the formation of portosystemic collateral vessels. The risk of bleeding associated with gastroesophageal varices increases with the severity of portal hypertension, variceal size, age, drugs, and the presence of other endoscopic and clinical risk factors [9-12]. If once variceal bleeding occurs, pa-

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tients may develop severe hemodynamic instability, acute kidney injury, hepatic encephalopathy, infection, and other complications [13,14]. Evidence shows that despite advances in vasoactive therapy, endoscopic interventions, antibiotic prophylaxis, and management of portal hypertension, acute variceal hemorrhage remains a major cause of death among patients with decompensated cirrhosis [15,16].

Bleeding from esophageal varices can be devastating and can causing morbidity and mortality [17]. To mitigate these outcomes, primary prophylaxis using non-selective beta-blockers or endoscopic band ligation is essential for high-risk patients, while prompt administration of vasoactive drugs combined with early endoscopic therapy remains critical for controlling acute hemorrhage [18-21]. However, because early rebleeding rates remain high despite initial endoscopic control, modern clinical approaches increasingly emphasize early transjugular intrahepatic portosystemic shunt (TIPS) placement in high-risk individuals to minimize recurrent bleeding and improve overall survival [22,23]. Understanding the magnitude of variceal bleeding is therefore important for estimating the clinical burden, planning appropriate diagnostic and therapeutic services, and identifying populations that may benefit from strengthened preventive strategies.

Even though several studies have assessed variceal bleeding among patients with cirrhosis, their findings have been conducted in different populations and healthcare settings and have reported varying estimates. Also, the available evidence has not been sufficiently synthesized to provide a comprehensive pooled estimate of the magnitude of variceal bleeding. So this study can address this gap by systematically identifying relevant studies, quantitatively synthesizing their findings, and exploring potential sources of heterogeneity.

Objective of the study

- To estimate the pooled magnitude of variceal Bleeding among Patients with cirrhosis

Methods and Materials

Study Design and Reporting

This systematic review and meta-analysis was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guideline [24].

Eligibility criteria

Population, Outcome, condition, and Context (POCC) framework was used to set eligibility of studies.

- **Population**: The studies conducted among adult patients diagnosed with liver cirrhosis, regardless of the underlying etiology, sex, disease severity, or clinical status.
- **Outcome**: The outcome was the prevalence of variceal bleeding among patients with cirrhosis.
- **Condition**: the condition is variceal bleeding which is bleeding attributed to esophageal, gastric, or other clinically relevant gastroesophageal varices, as defined by the individual study.
- **Context**: studies conducted globally.

Inclusion criteria

Studies were included if they: were conducted among patients with clinically or radiologically diagnosed liver cirrhosis; reported magnitude of variceal bleeding, used an observational study design; whereas studies did not involve patients with cirrhosis, did not assess variceal bleeding, case reports, case series, editorials, letters, commentaries, conference abstracts without adequate data, narrative reviews, systematic reviews, meta-analyses, and clinical guidelines were excluded.

Information sources and search strategy

A literature search was conducted in PubMed, Scopus, Web of Science, Embase, Google Scholar, and the Cochrane Library from database inception until September 10. Additional eligible studies were identified through manual screening of the reference lists of included studies and relevant systematic reviews. The main search terms were “liver cirrhosis,” “hepatic cirrhosis,” “cirrhosis,” “variceal bleeding,” “variceal hemorrhage,” “gastroesophageal varices,” “esophageal varices,” “oesophageal varices,” “gastric varices,” “upper gastrointestinal bleeding,” and “portal hypertension.” The search strategy was adapted to the indexing system and syntax of each database.

Study selection

Retrieved articles were exported into endnote reference management software and duplicate were removed. All reviewers independently screened the titles and abstracts; then potentially related studies were retrieved in full text and assessed for eligibility. Any disagreement between the reviewers was resolved through discussion. When consensus could not be reached, a third reviewer was consulted.

Data extraction

A standardized data extraction form was developed containing: first author and year of publication, country and study setting, study design, sample size, type of varices, and prevalence of variceal bleeding. Discrepancies between the reviewers were resolved by comparing the extracted information with the original article and through discussion with other reviewers.

Outcome of the study

The primary outcome was the pooled magnitude of variceal bleeding among patients with cirrhosis. For each study, the prevalence was calculated as the number of cirrhotic patients who experienced variceal bleeding divided by the total number of cirrhotic patients assessed.

Quality assessment of the studies

The methodological quality of the included studies was independently assessed by all reviewers using a standardized Joanna Briggs Institute (JBI) critical appraisal tool for observational studies [25]. Studies were categorized according to their overall methodological quality. Disagreements were resolved through consultation each other.

Data synthesis and analysis

The extracted data were entered into Stata statistical software package version 14 for analysis. The magnitude of variceal bleeding reported by each study was transformed as appropriate and pooled to obtain an overall estimate with a 95% confidence interval (CI). Heterogeneity was assessed using Cochran's Q statistic and the I^2 statistic. I^2 values were interpreted as representing low, moderate, and high heterogeneity at approximately 25%, 50%, and 75%, respectively [26]. When substantial heterogeneity was observed, potential sources were explored using subgroup analyses and meta-regression. Sensitivity analyses, publication bias and small-study effects were assessed. Funnel plot asymmetry was assessed visually, and Egger's regression test was used objectively.

Results

Study selection and characteristics

Initially, 7981 studies were identified through database and manual searches. Of these, 2106 records were excluded due to duplication. The remaining records undertook title and abstract screening, resulting in the removal of 3563 articles. 2150 records were sought for retrieval, 159 not retrieved because of they are irrelevant. One thousand and nine hundred ninety-one publications were then assessed for eligibility, then 1970 Excluded due to eligibility criteria. Finally, 21 studies met the inclusion criteria and included in the analysis (Fig. 1).

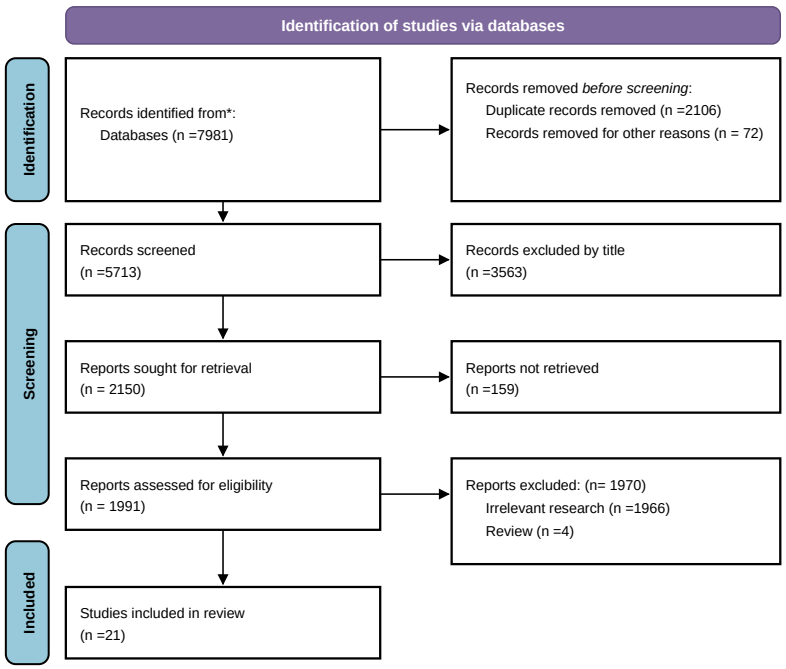

Figure 1. PRISMA flow diagram of study selection for Pooled magnitude of variceal bleeding among Patients with cirrhosis

The included studies were retrospective studies [27-47] with 8998 participants and mostly conducted in the Asia region. The sample size ranges from 34 [47] to 5775 [42] participants. Among included studies the magnitude of variceal bleeding ranges from 11.7 [42] - 91% [36]. All studies had good methodological quality (Table 1).

Table 1. Characteristics of the study included in systematic review and meta-analysis

Authors Name	Publication Year	Study area	Type	Study design	Sample size	Prevalence with 95%CI
Gunda DW	2019	Tanzania	Esophagus	Cross-section	223	39.5(33.0-45.9)
Duah A,	2018	Ghana	Esophagus	Cross-section	149	90.6(85.9-95.2)
Prihartini J	2005	Indonesia	Esophagus	Cross-section	47	76.6(64.4-88.7)
Gebregziabiher HT	2023	Ethiopia	Esophagus	Cross-section	206	85.4(80.5-90.2)
Chalasani N	1999	USA	Esophagus	Retrospective	346	20(15.7-24.2)
Thomopoulos KC	2003	Greece	Esophagus	Cross-section	184	50(42.7-57.2)
Umar A,	2015	Kenya	Esophagus	Cross-section	150	48(40.0-55.9)
Sharma SK	2007	India	Both	Cross-section	101	88.1(81.7-94.4)
Mujahid N	2024	India	Esophagus	Prospective	50	70(57.2-82.7)
Hossain E,	2018	Bangladesh	Esophagus	Cross-section	100	91(85.3-96.6)
Cherian JV	2011	India	Esophagus	Prospective	229	77.7(72.3-83.0)
Levy C,	2007	USA	Esophagus	Cross-section	210	49.6(42.8-56.3)
Merli M	2003	Italy	Esophagus	Cross-section	206	45.1(38.3-51.8)
Baye ML	2023	Ethiopia	Esophagus	Cross-section	262	52(45.9-58.0)
Achinge IG	2011	Nigeria	Esophagus	Cross-section	80	75(65.5-84.4)
Shukla R	2016	USA	Esophagus	Cohort	5775	11.7(10.8-12.5)
Varghese J	2008	India	Esophagus	Prospective	205	46.3(39.4-53.1)
Zakir MF	2024	Pakistan	Esophagus	Prospective	135	13.3(7.5-19.0)
Azad T	2025	Pakistan	Esophagus	Cross-section	186	18.3(12.7-23.8)
Bhattarai S,	2017	Nepal	Esophagus	Cross-section	120	66.6(58.1-75.0)
Ebrahimi M	2014	Iran	Both	Cross-section	34	64.7(48.6-80.7)

Magnitude of variceal bleeding

The pooled global proportion of magnitude of variceal bleeding was found to be 56.0% (95% CI: 40.6-71.5) with a heterogeneity index of 99.5%, with a P-value of less than 0.001 (Fig 2). The Eggers test yielded significant result (P ≤ 0.001). Therefore, Duval and Tweedie's trim-and-fill method was applied to assess the potential impact of publication bias. Because of there is no imputed study the adjusted pooled prevalence is similar, suggesting that publication bias.

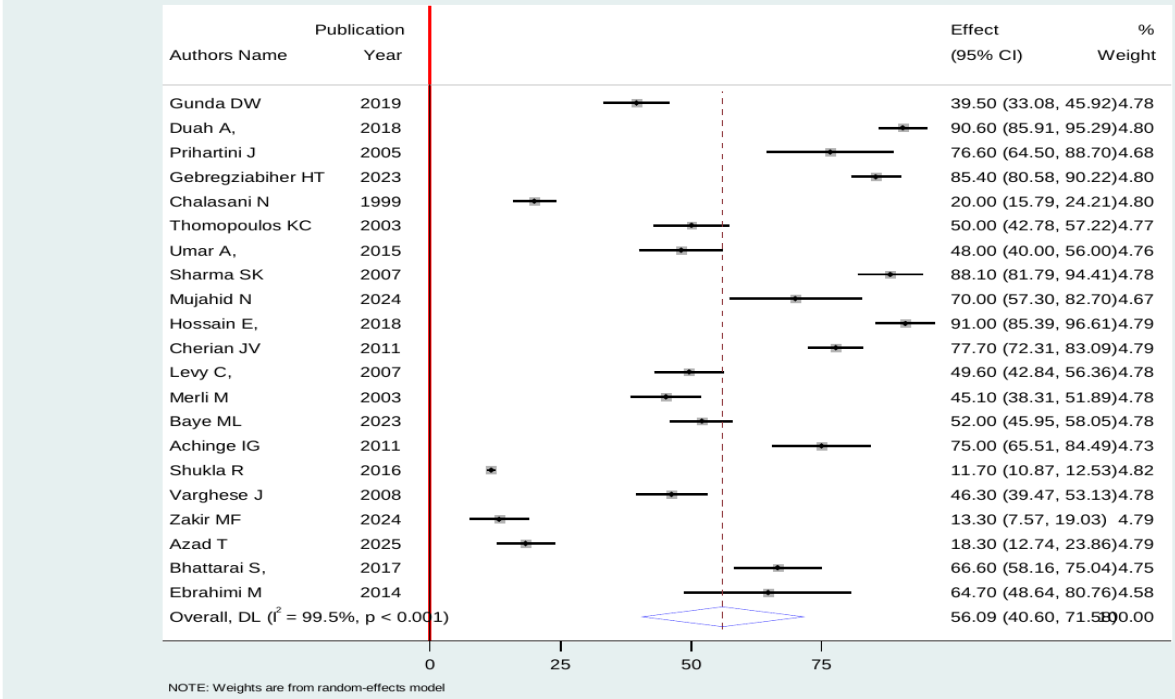

Figure 2. Forest plot showing the pooled magnitude of variceal bleeding among Patients with cirrhosis

Sub-group analysis

The subgroup analysis was conducted based on region of the studies conducted. The highest magnitude of variceal bleeding is 66.1 % (95% CI: 46.9-83.3, I^2 = 98.1%) was seen in Africa region and the lowest is 26.7 % (95% CI: 9.6.-43.9, I^2 = 98.5%) was seen in North America region (Fig. 3).

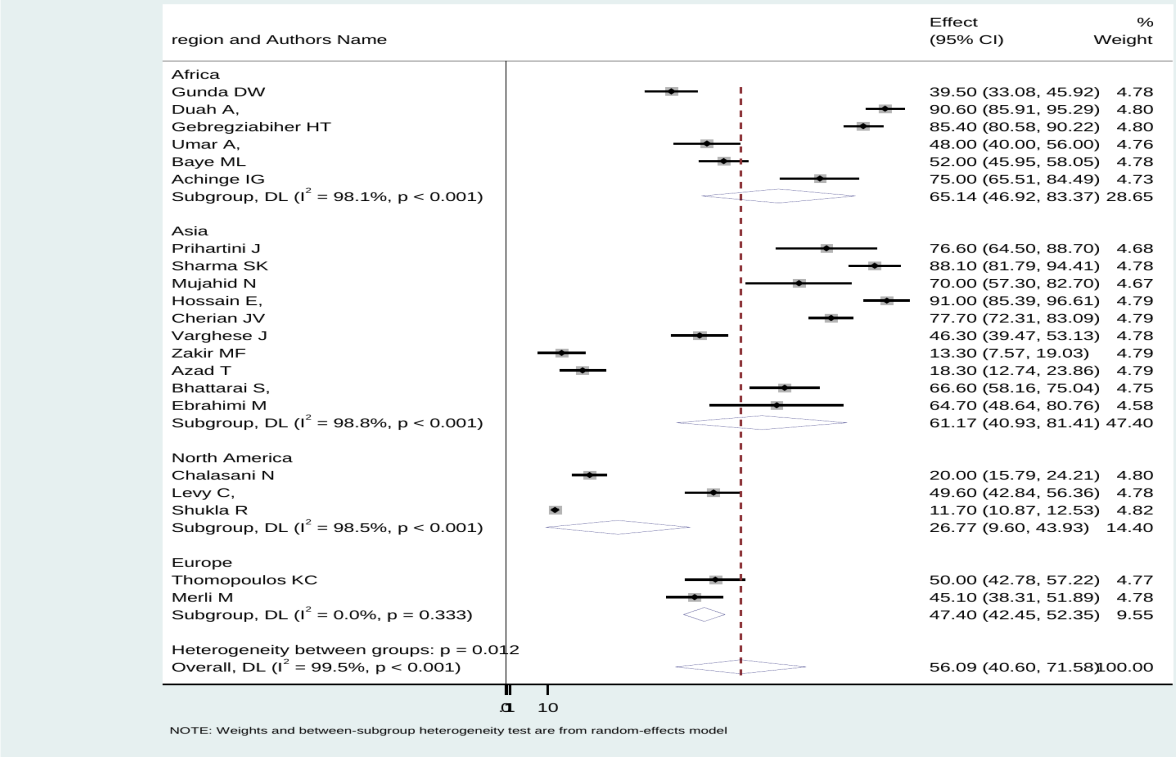

Figure 3. Subgroup analysis of pooled magnitude of variceal bleeding among Patients with cirrhosis

Meta-regression and publication bias

Meta-regression was conducted using year of publication and sample size as a covariates to identify source of heterogeneity. The analysis showed that publication year and sample size didn't have a significant effect on heterogeneity between studies, with a P- value of 0.435 and 0.227 respectively (Table 2). Publication bias was assessed using visual inspection of the funnel plot and Egger's regression test. Evidence of publication bias was identified,

as the funnel plot showed asymmetry and Egger's regression test was statistically significant (P < 0.001) (Fig. 4). Therefore, the trim-and-fill analysis was conducted and the adjusted funnel plot appeared symmetrical.

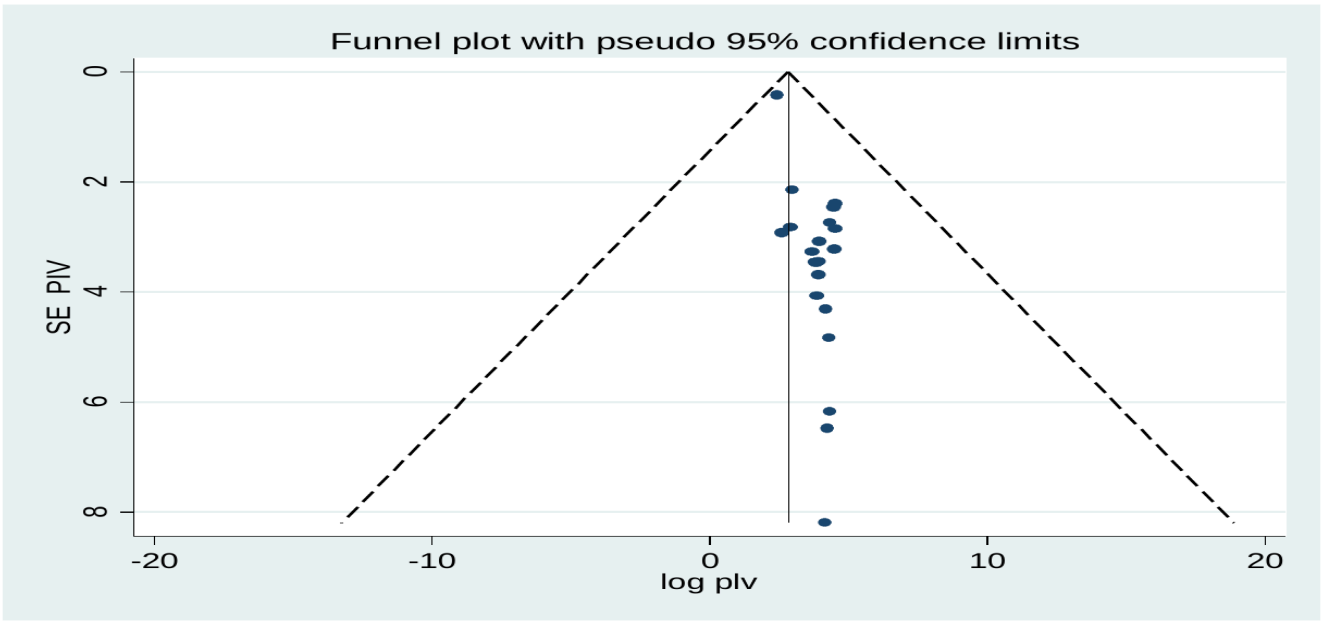

Figure 4. Funnel plot to test publication bias in 21 studies with 95% confidence limits

Table 2. Meta-regression analysis of factors affecting between-study heterogeneity

Prevalence	Coefficient	Std error	T	P>|t|	[95% Conf. Interval]
Sample size	-.0031687	.0025306	-1.25	0.227	-.0084853 - .002148
Publication year	-.6290461	.7875379	-0.80	0.435	-2.283602 - 1.02551
Constant	1297.928	1588.432	0.82	0.425	-2039.243-4635.1

Sensitivity analysis

Sensitivity analysis was performed to determine how various sources of uncertainty contribute to the overall uncertainty among the studies, but the results indicated that uncertainty has an insignificant influence on pooled prevalence (Fig. 5).

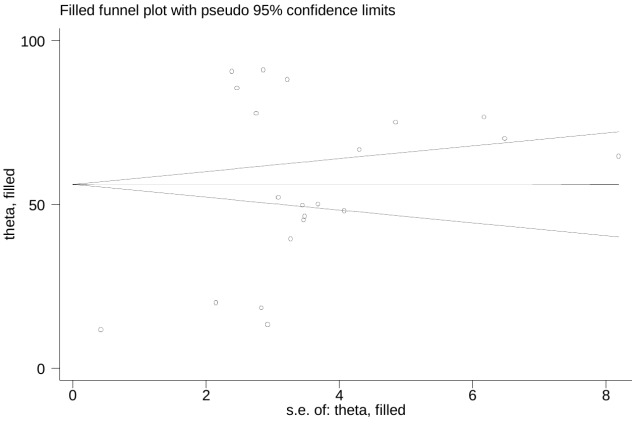

Figure 5. Funnel plot to test publication bias in 21 studies with 95% confidence limits trim and fill-analysis

Discussion

Variceal bleeding represents one of the most severe and life-threatening decompensating events in patients with liver cirrhosis, reducing directly from the progressive elevation of portal venous pressure and the subsequent formation of fragile portosystemic collateral vessels [48, 49]. The clinical trajectory following a variceal bleed is frequently complicated by hemodynamic instability, recurrent hemorrhage, hepatic encephalopathy, and secondary systemic infections, all of which contribute significantly to the global burden of liver-related morbidity and mortality [50, 51].

On this systematic review and meta-analysis the pooled global proportion of magnitude of variceal bleeding was found to be 56.0% (95% CI: 40.6-71.5). This finding is higher than a similar study conducted in Sub-Saharan Africa 46.1% [52]. This discrepancy is might be associated with of healthcare infrastructure limitations, clinical variations, study methodologies; differences in the underlying etiology and baseline care of portal hypertension.

The subgroup analysis based on geographic region revealed substantial variability in the pooled prevalence of variceal bleeding among target populations, ranging from 26.7% in North America to 66.1% in Africa. This marked disparity highlights the critical role that regional healthcare infrastructure, underlying disease etiology, and access to prophylactic interventions play in influencing gastrointestinal complications.

The high magnitude of variceal bleeding observed in the African region (66.1%; 95% CI: 46.9%–83.3%) aligns with broader epidemiological trends regarding chronic liver disease across the continent. In many sub-Saharan African nations, endemic infectious etiologies specifically chronic hepatitis B and C virus infections, alongside schistosomiasis drive a disproportionately high burden of liver cirrhosis and non-cirrhotic portal hypertension [53-55]. Furthermore, limited access to timely diagnostic endoscopy, delayed presentation of liver disease, and restricted availability of primary prophylactic measures [56]. In contrast, the lower prevalence observed in North America (26.7%; 95% CI: 9.6%–43.9%) might be due to advanced clinical screening pathways, widespread access to early interventions and adherence to clinical guidelines [57-59].

Limitation of the study

This systematic review and meta-analysis has several limitations. High statistical heterogeneity across the included primary studies restricts the generalizability of the overall pooled estimate. Additionally, the geographic distribution of eligible studies was uneven, leading to underrepresentation of certain regions and potential geographic bias. Lastly, potential publication must be acknowledged.

Conclusion

According to this systematic review and meta-analysis variceal bleeding is a critical global health concern, which affects over half of the targeted popu-

lation globally. The region based analysis showed significant geographic disparities ranging from 26.7% in North America to 66.1% in Africa. Therefore tailored public health strategies, enhanced access to prophylactic treatment and strengthened healthcare infrastructure is essential to decrease the burden of the disease.

Disclosure:

Ethical Considerations. Ethical approval was not required because this study did not involve direct interaction with human participants.

Consent for publication. Not applicable

Availability of data and materials. The data analyzed during the current systematic review and meta-analysis is available with reasonable request from corresponding author.

Competing interests. All the authors declare that they have no competing interests

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