Effectiveness of eradication therapy for Helicobacter pylori infection in Africa: A systematic review and meta-analysis

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Abstract

Background

The effectiveness of *Helicobacter pylori* (*H. pylori*) eradication depends on the treatment protocol. This study aimed to investigate the *H. pylori* eradication effectiveness in Africa using the best available evidence from databases.

Methods

PubMed, Google Scholar, Hinari, Scopus, and the directory of Open Access Journals (DOAJ) were searched. The quality of each included study was assessed using Cochrane risk-of-bias tool for randomized trials (RoB2) and Risk of Bias in Non-Randomized Studies of Intervention (ROBINS-I) for observational studies. Heterogeneity between studies was assessed using I^2 test statistics based on the random effect model. Stata version 13 (College Station, Texas 77845 USA) software was employed to compute the pooled eradication rate. Forest plots and tables were used to present the data.

Results

Twenty-two studies from 9 African countries with a total population of 2,163 met the inclusion criteria and were included in the analysis. The pooled eradication rate of *H. pylori* by standard therapy was 79% (95% CI: 75%, 82%), with heterogeneity (I^2 = 93.02%). In the subgroup analysis by study design, a higher eradication rate was reported from observational studies (85%, 95% CI: 79%-90%), compared to randomized control trials (77%, 95% CI: 73%-82%); by the duration of therapy, higher eradication rate was reported in 10-days regimen (88%, 95% CI: 84–92), compared to 7-days regimen (66%, 95% CI: 55–77); by country, the highest eradication rate was found in Ethiopia (90%; 95% CI: 87%-93%) and the lowest eradication rate was reported in Ivory Coast (22.3%; 95% CI:15%-29%); by type of *H. pylori* test, the highest eradication rate was reported when rapid urease test coupled with histology (88%, 95% CI: 77–96), and the lowest eradication rate was reported using histology alone (22.3%; 95% CI:15%-29%).

Conclusions

Eradication therapy for *H. pylori* in Africa had eradication rates that could be considered effective even in the lowest reported cases. This study demonstrates the necessity to optimize current *H. pylori* treatment regimens in each country, taking into account the antibiotic susceptibility of the bacteria.

Background

Helicobacter pylori (H. pylori) is a microaerophilic, Gram-negative, spiral-shaped motile bacterial pathogen that colonizes the gastric mucosa of approximately half of the world's population. *H. pylori* infection is associated with gastritis, peptic ulcer, atrophic gastritis, gastric adenocarcinoma, and mucosa-associated lymphoid tissue lymphoma (MALT). The presentation of a range of clinical conditions is primarily determined by bacterial virulence, host genetics, and the individual's lifestyle [1–4]. The prevalence of *H. pylori* infection varies globally, with Africa being the highest infection rate [5]. The bacterium is primarily acquired during early childhood under low socioeconomic conditions and close family contact [6].

According to the Maastricht VI/Florence consensus report 2022, individuals with or without clinical evidence of *H. pylori* infection are recommended to receive first-line eradication therapy to prevent the development of infection-associated complications, such as gastritis and cancer [7]. Moreover, large-scale eradication of *H. pylori* in a population reduced the incidence and mortality of gastric cancer [8]. In light of this, guidelines have been developed as a national or regional first-line eradication protocol that consists of different antibiotic combinations, including triple therapies, bismuth-free therapies

(sequential, concomitant, or hybrid regimens), and bismuth-based quadruple therapy [9]. The effectiveness of eradication therapy has been assessed based on the pre-protocol analysis and categorized as excellent (≥ 95% success), good (≥ 90% success), borderline acceptable (85–89% success), or unacceptable (< 85% success) [10]. The presence of *H. pylori* resistance to one or more antimicrobial agents or poor medication adherence increases the likelihood of treatment failure, even with excellent regimens.

H. pylori eradication rate differs in different settings based on the type of regimen employed, duration of therapy, and local antibacterial susceptibility pattern. According to a recent systematic review and meta-analysis, first-line treatment had a 98% global *H. pylori* eradication rate, with a subcontinental success rate of 98% in Asia, 94% in Africa, 94% in Europe, 93% in South America, and 84% in North America. In this report, five African countries with a total of 7 studies comprising 1021 patients were included, Morocco (n = 3), Egypt (n = 1), Kenya (n = 1), Nigeria (n = 1), and Tunisia (n = 1) [11]

However, there is no pooled eradication rate consisting of observational and randomized controlled trials for *H. pylori* infection in Africa. However, small-scale studies were reported in different countries in Africa. Therefore, African studies differ in study settings, methodology, and other characteristics. In addition, no systematic review or meta-analysis has been conducted on the eradication rate of *H. pylori* infection in Africa. Therefore, we have undertaken a systematic review to determine the eradication rate of *H. pylori* in Africa using previously published articles.

Methods

Databases and search strategy

PubMed, Google Scholar, Hinari, Scopus, and the directory of Open Access Journals (DOAJ) were searched to identify potential articles on *H. pylori* eradication in Africa. The search was conducted following the PRISMA guideline and checklists ([12], Fig. 1). To search PubMed, the following terms were combined using MeSH (Medical Subject Headings) and Boolean operators; "*Helicobacter pylori*" "OR" "*H. pylori*" AND "eradication therapy" OR "treatment failure" OR "triple therapy" OR "quadruple therapy" OR "antimicrobial resistance" OR "antibacterial resistance" OR "antibiotic resistance" OR "efficacy" OR "effectiveness" OR "treatment" AND "Africa" OR "Algeria" OR "Angola" OR "Benin" OR "Botswana" OR "Burkina Faso" OR "Burundi" OR "Cameroon" OR "Canary Islands" OR "Cape Verde" OR "Central African Republic" OR "Chad" OR "Comoros" OR "Congo" OR "Democratic Republic of Congo" OR "Djibouti" OR "Egypt" OR "Equatorial Guinea" OR "Eritrea" OR "Ethiopia" OR "Gabon" OR "Gambia" OR "Ghana" OR "Guinea" OR "Guinea Bissau" OR "Ivory Coast" OR "Cote d'Ivoire" OR "Jamahiriya" OR "Kenya" OR "Lesotho" OR "Liberia" OR "Libya" OR "Madagascar" OR "Malawi" OR "Mali" OR "Mauritania" OR "Mauritius" OR "Mayotte" OR "Morocco" OR "Mozambique" OR "Namibia" OR "Niger" OR "Nigeria" OR "Rwanda" OR "Sao Tome" OR "Senegal" OR "Seychelles" OR "Sierra Leone" OR "Somalia" OR "South Africa" OR "South Sudan" OR "St Helena" OR "Sudan" OR "Swaziland" OR "Tanzania" OR "Togo" OR "Tunisia" OR "Uganda" OR "Western Sahara" OR "Zaire" OR "Zambia" OR "Zimbabwe" OR "Central Africa" OR "Central African" OR "West Africa" OR "West African" OR "Western Africa" OR "Western African" OR "East Africa" OR "East African" OR "Eastern Africa" OR "Eastern African" OR "North Africa" OR "North African" OR "Northern Africa" OR "Northern African" OR "South African" OR "Southern Africa" OR "Southern African" OR "sub Saharan Africa" OR "sub Saharan African" OR "subSaharan Africa" OR "subSaharan African". The search included articles published in both English and non-English language. Google Translate was used to determine a publication's eligibility for data extraction if it was written in a language other than English. To minimize bias and reduce the chance of missing studies, each author participated in extracting relevant articles from the different databases. The search results were combined into EndNote 20 (Clarivate Analytics USA). Articles were selected based on predefined inclusion criteria. This study included articles with the following characteristics: Observational or Randomized Clinical Trials (RCT), original journal articles, articles that reported *H. pylori* eradication therapy on human subjects, and articles that reported *H. pylori* eradication therapy in Africa. Duplicate studies, studies that reported *in vitro* anti-*H. pylori* susceptibility testing, studies that primary objective was not eradication therapy, and studies with inconsistent methodology or results were excluded. All articles that met the eligibility requirements and were published up through March 2022 were included. Two-stage selection of the articles was conducted. During stage

one, the titles, abstracts, tables and figures of all retrieved articles were reviewed, and those articles that addressed the study question were deemed eligible for further review. However, those articles that did not satisfy our selection criteria were dropped. During stage two, the eligible articles were reviewed in full detail, and data mining was performed.

Quality Assessment

The quality of included studies was assessed by using a revised Cochrane risk-of-bias tool for randomized trials (RoB2) and Risk Of Bias in Non-Randomized Studies-of Interventions (ROBINS-I) (Supplementary files 1 and 2). The authors independently assessed the quality of each study, and a consensus was reached on twenty-two studies conducted in nine African countries.

Data Extraction

Data were extracted into a customized Microsoft excel spreadsheet. The characteristics of extracted data in each study include: first author name, year of publication, country of study, study design, number of study participants, characteristics of study participants (naïve or nan-naïve), laboratory methods for *H. pylori* positivity test, number of *H. pylori*-positive participants, *H. pylori* eradication regimen, duration of follow up, laboratory methods for *H. pylori* eradication confirmation, and number of *H. pylori* eradicated individuals. In addition, graphs of the summary of the risk of bias were developed using RevMan 5.3 (Cochrane Informatics and Knowledge Management Department, London, UK).

Data analysis

Statistical analyses were conducted using Stata version 13.0 (StataCorp, LP, college station, TX). The eradication rate values were pooled using the *metaprop* command in Stata. The heterogeneity of the studies was assessed using the I^2 statistic, and significance was declared at $I^2 > 50\%$ and Q-test ($p < 0.10$). Because of high heterogeneity among the studies, the random-effects model (REM) was used to estimate the pooled proportion and 95% CIs using the DerSimonian and Laird methods. The Freeman-Turkey double arcsine transformation was used to avoid missing proportions near or at 0 and 1 from the meta-analysis. Subgroup analysis was done by study design, country, laboratory tests for *H. pylori* infection, eradication regimen, type of regimen analysis, characteristics of the study population, follow-up duration, and tests employed to confirm eradication. The presence of publication bias was tested using Egger's test. Forest plots and tables were constructed to display the individual studies and pooled results.

Publication Bias And Sensitivity Analysis

A funnel plot was drawn to evaluate the potential for publication bias. The funnel plots' gap suggests potential publication bias. In addition, Egger's regression asymmetry tests were used to assess publication bias, with $p < 0.05$ considered to indicate potential publication bias. Finally, sensitivity and leave-one-out analysis were done to evaluate the prime determinant of the pooled eradication rate and to detect the possible causes of heterogeneity between studies.

Results

Characteristics of included studies

Twenty-two studies from nine African countries with a total population of 2,163 met the inclusion criteria of the meta-analysis. These studies were published articles from 1992 to 2020, and the number of articles by country is indicated in Table 1. The detailed characteristics of included studies are presented in Table 2. Among the included studies, 8 were observational, and 14 were randomized control trials (RCT). Except for Abd-Elsalam *et al.*, 2016, all study participants were

newly diagnosed cases with gastrointestinal disorder. Twelve studies used multiple tests to detect *H. pylori*, while 10 employed a single test to declare *H. pylori* infection. Eighteen studies employed a single test, and 4 studies used multiple tests to prove *H. pylori* eradication. The *H. pylori* eradication rates in the qualified studies ranged from 22.3–90%.

Table 1
Number of articles included in the study by country

Country	Number of articles	Reference
Egypt	7	[13–19]
Morocco	4	[20–23]
South Africa	4	[24–27]
Algeria	2	[28, 29]
Ethiopia	1	[30]
Nigeria	1	[31]
Tanzania	1	[32]
Kenya	1	[33]
Ivory Coast	1	[34]

Table 2
Lists and characteristics of included 22 studies

Authors	Study Type	Country	*H. pylori* Positive	Eradicated	Test method	Regimen	Duration (days)	Outcome measure (weeks)	Confirmed test
Abd-Elsalam *et al.*,2016 *	RCT	Egypt	94	83	FAT	OLDN	14	6	FAT
Abou Saif_1 *et al.*,2015	RCT	Egypt	18	17	FAT	5OA, 5OLM	10	4	FAT
Benajah_1 *et al.*, 2013	PS	Morocco	204	156	RUT + H + C	OAM/C	7	12	UBT
Doffou *et al.*, 2015	RCT	Ivory Coast	64	18	H	OAM	7	4	H
Elkhodary *et al.*, 2020	RCT	Egypt	33	21	FAT	DLA	7	4	FAT
Farhoud_1 *et al.*,2020	RCT	Egypt	30	19	RUT	LAC	14	6	UBT
Gebeyehu et al., 2019	PS	Ethiopia	421	379	FAT	OAC	14	4	FAT
Hanafy *et al.*,2016	PS	Egypt	248	169	FAT	LAC	14	4	FAT
Hassan *et al.*, 2019	RCT	Egypt	50	31	FAT	OAC	14	4	FAT
Jaka *et al.*,2019	PS	Tanzania	210	145	FAT	PPICM/A	10	5	FAT
Lahbabi *et al.*, 2012	RCT	Morocco	103	73	H or PCR	PPIAM	14	12	FAT
Laving_1 *et al.*,2013	RCT	Kenya	45	22	H	OAC	10	6	FAT
Louw_1 *et al.*,1992	RCT	South Africa	17	10	RUT + C + GS + H	S + B + OA	14	4	RUT + H + C
Louw_1 *et al.*,1998_a	PS	South Africa	24	22	RUT + H	LAC	7	4	RUT + H
Louw_1 *et al.*,1998_b	PS	South Africa	30	26	RUT + H + C	PAC	7	4	RUT + H + C
Moubri *et al.*,2018	PS	Algeria	101	79	C or H + RUT	PPIAC	14	8	UBT
Moubri_1 *et al.*,2019	RCT	Algeria	55	39	C + H + UBT	OAC	7	8	UBT

*Study participants were non-naïve. FAT = Fecal antigen test, RCT = Randomized controlled trial, PS-Prospective study, PP-Per protocol, ITT-Intention to treat, UBT-Urea breath test, H-Histology, RUT-Rapid urease test, C-Culture, OAC = Omeprazole + Amoxicillin + Clarithromycin, OCM = Omeprazole + Clarithromycin + Metronidazole, OAM = Omeprazole + Amoxicillin + Metronidazole, LAC = Lansoprazole + Amoxicillin + Clarithromycin, PAC = Pantoprazole + Amoxicillin + Clarithromycin, RAC = Rabeprazole + Amoxicillin + Clarithromycin, OCN = Omeprazole + Clarithromycin + Nitazoxanide, OACS = Omeprazole + Amoxicillin + Clarithromycin + Simvastatin, OLDN = Omeprazole + Levofloxacin + Doxycycline + Nitazoxanide, DLA = Dexolansoprazol + Levofloxacin + Amoxicillin OCT = Omeprazole + Clarithromycin + Tinidazole

Authors	Study Type	Country	*H. pylori* Positive	Eradicated	Test method	Regimen	Duration (days)	Outcome measure (weeks)	Confirmed test
Onyekwere, *et al.*,2014	RCT	Nigeria	29	25	UBT	RAC	10	4	UBT
Seddik_1 et al., 2013	RCT	Morocco	129	116	H	5OA, OCT	10	10	UBT
Shehata_1 *et al.*,2017	RCT	Egypt	112	106	FAT + H	OCN	14	6	FAT
Wong *et al.*, 2000	PS	South Africa	22	19	H + RUT + UBT	OAC	7	4	H + UBT
Zeriouh_1 *et al.*, 2020	RCT	Morocco	124	84	UBT or H	PPI + A	14	6	UBT

*Study participants were non-naïve. FAT = Fecal antigen test, RCT = Randomized controlled trial, PS-Prospective study, PP-Per protocol, ITT-Intention to treat, UBT-Urea breath test, H-Histology, RUT-Rapid urease test, C-Culture, OAC = Omeprazole + Amoxicillin + Clarithromycin, OCM = Omeprazole + Clarithromycin + Metronidazole, OAM = Omeprazole + Amoxicillin + Metronidazole, LAC = Lansoprazole + Amoxicillin + Clarithromycin, PAC = Pantoprazole + Amoxicillin + Clarithromycin, RAC = Rabeprazole + Amoxicillin + Clarithromycin, OCN = Omeprazole + Clarithromycin + Nitazoxanide, OACS = Omeprazole + Amoxicillin + Clarithromycin + Simvastatin, OLDN = Omeprazole + Levofloxacin + Doxycycline + Nitazoxanide, DLA = Dexolansoprazol + Levofloxacin + Amoxicillin OCT = Omeprazole + Clarithromycin + Tinidazole

Pooled eradication rate of H. pylori

A total of 2,163 people tested positive for *H. pylori* in Africa. Of which 1,659 confirmed eradication following first-line eradication therapy in the period under review. Our meta-analysis revealed pooled eradication rate of 79% (95% CI: 75%-82%), I^2 = 93.02% (Fig. 2). Moreover, the funnel plot for publication bias supported Egger's regression (p = 0.672) test, which showed no significant publication bias (Fig. 3).

Subgroup eradication rate of H. pylori

Subgroup analyses were conducted by country, study design, type of analysis, study population, duration of therapy, outcome measures and regimen. The pooled data were from nine countries. In addition, more studies were conducted in Egypt, which showed an eradication rate of 82%, and almost all countries showed a similar eradication rate except Ivory Coast (22.3%) (Table 3).

Table 3
The subgroup analysis of included studies by country, study design, type of analysis, study population, duration of therapy, outcome measures and regimen from 22 studies in Africa

Subgroup		*Eradication rate (%)*	*95% CI (%)*	*I^2 (%)*
Country	Egypt (n = 7)	82	(77–88)	89.85
	Morocco (n = 4)	82	(77–87)	92.2
	South Africa (n = 4)	86	(80–92)	60.17
	Algeria (n = 2)	78	(71–85)	53.33
	Ethiopia (n = 1)	90	(87–93	-
	Nigeria (n = 1)	87	(78–97)	-
	Tanzania (n = 1)	69	(62–75)	-
	Kenya (n = 1)	68	(58–78)	-
	Ivory Coast (n = 1)	22.3	(15–29)	-
Study design	PS	85	(79–90)	88.76
	RCT	77	(73–82)	93.84
Types of analysis	PP	78	(73–82)	94.18
	ITT	81	(76–86)	88.67
Study population	Naïve	79	(75–82)	93.24
	Non-naïve	86	(81–91)	-
Duration of therapy (days)	14	80	(74–85)	88.73
	10	88	(84–92)	83.49
	7	66	(55–77)	91.52
Outcome measures (weeks)	4	78	(71–84)	91.2
	6	81	(73–88)	92.7
	8	81	(72–88)	69.4
	12	84	(76–91)	90.7
H. pylori confirmed test	FAT	82	(76–87)	90.23
	UBT	83	(78–88)	88.5
	H	22.3	(16–30)	-
	UBT + H	86	(67–95)	-
	RUT + H	88	(77–96)	54.44

PS-Prospective study, RCT-Randomized control trial, PP-Per protocol, ITT-Intention to treat, FAT-Fecal antigen test, UBT-Urea breath test, H-Histology, RUT-Rapid urease test, C-Culture, OAC = Omeprazole + Amoxicillin + Clarithromycin, OCM = Omeprazole + Clarithromycin + Metronidazole, OAM = Omeprazole + Amoxicillin + Metronidazole, LAC = Lansoprazole + Amoxicillin + Clarithromycin, PAC = Pantoprazole + Amoxicillin + Clarithromycin, RAC = Rabeprazole + Amoxicillin + Clarithromycin, OCN = Omeprazole + Clarithromycin + Nitazoxanide, OACS = Omeprazole + Amoxicillin + Clarithromycin + Simvastatin, OLDN = Omeprazole + Levofloxacin + Doxycycline + Nitazoxanide, DLA = Dexlansoprazole + Levofloxacin + Amoxicillin OCT = Omeprazole + Clarithromycin + Tinidazole

Subgroup		*Eradication rate (%)*	*95% CI (%)*	*I^2 (%)*
	RUT + H + C	82	(69–92)	69.54
	FAT + RUT + H + C	77	(68–85)	59.28
Regimen	OLDN	86	(80–90)	
	5OA, 5OLM	95	(84–100)	
	5OA, 5OCM	95	(91–99)	
	14OCM	84	(71–95)	
	OAM/C	76	(70–82)	
	OAM	67	(27–96)	
	OAC	66	(50–80)	
	OCM	44	(23–67)	
	DLA	79	(68–88)	
	LAC	81	(69–91)	
	5LA, LCT	90	(74–97)	
	7LA, LCT	97	(83–99)	
	OACS	82	(69–90)	
	PPIAM	71	(64–77)	
	PPIAC	79	(74–83)	
	5PPIA, PPIMC	95	(92–98)	
	5OA, OCT	85	(66–94)	
	S + B + OA	59	(36–78)	
	S + OA	61	(39–80)	
	PAC	89	(81–95)	
	RAC	87	(76–96)	
	5OA, OCT	86	(82–90)	
	OCN	95	(91–97)	
	PPI + A	66	(60–72)	
	5PPI + A, PPI + ACM	88	(84–92)	
	OACM	94	(91–97)	

PS-Prospective study, RCT-Randomized control trial, PP-Per protocol, ITT-Intention to treat, FAT-Fecal antigen test, UBT-Urea breath test, H-Histology, RUT-Rapid urease test, C-Culture, OAC = Omeprazole + Amoxicillin + Clarithromycin, OCM = Omeprazole + Clarithromycin + Metronidazole, OAM = Omeprazole + Amoxicillin + Metronidazole, LAC = Lansoprazole + Amoxicillin + Clarithromycin, PAC = Pantoprazole + Amoxicillin + Clarithromycin, RAC = Rabeprazole + Amoxicillin + Clarithromycin, OCN = Omeprazole + Clarithromycin + Nitazoxanide, OACS = Omeprazole + Amoxicillin + Clarithromycin + Simvastatin, OLDN = Omeprazole + Levofloxacin + Doxycycline + Nitazoxanide, DLA = Dexlansoprazole + Levofloxacin + Amoxicillin OCT = Omeprazole + Clarithromycin + Tinidazole

Discussions

The 22 studies included in our analysis showed the pooled eradication rate in Africa was estimated to be 79% (95% CI: 75–82). This overall eradication rate is lower than reports from Ethiopia (90%), Nigeria (87%), South Africa (86%), Egypt (82%), Morocco (82%), and higher than reports from Tanzania (69%), Kenya (68%) and Ivory Coast (22.3%). These differences might be attributed to methods employed to diagnose *H. pylori*, type of eradication regimen and duration of therapy, local *H. pylori* pretreatment resistance and drug adherence, as stated by previous reports [45–49].

The eradication rate for *H. pylori* varies in different regions of the world. The overall success of eradication depends on the choice of eradication regimen, duration of the treatment, and local and regional antibiotic resistance pattern of *H. pylori*. The World Gastroenterology Organization (WGO), in its 2021 guideline, recommended the minimum acceptable eradication rate greater than 80% on an intention-to-treat basis using PPI-clarithromycin plus amoxicillin in areas where clarithromycin resistance is low or moderate [35]. Determining the national and regional eradication rate is fundamental to establish an appropriate eradication protocol for *H. pylori* infection. Estimating the effectiveness of *H. pylori* eradication is difficult since factors like pretreatment antibiotic resistance have a profound effect [36–39]. Some studies consider distinct *H. pylori* diagnosis or eradication confirmation tests and employ different eradication regimens and/or duration based on the local guideline on the *H. pylori* treatment [40–42]. In the regional context, *H. pylori* treatment in Africa largely depends on an empirical approach despite the highest infection rate in the world [43, 44].

In the subgroup analysis by country, the highest eradication rate of 90% was from Ethiopia, and the lowest was 22.3% from Ivory Coast, as shown in Table 3. The eradication rate depends on the sensitivity and specificity of tests that detect *H. pylori*. In the study from Ivory Coast, the *H. pylori* pre-and post-eradication detection was based on histological examination of gastric biopsy, which is less sensitive than conventional techniques such as urease test, anti-*H. pylori* antibody test, and PCR detection of bacterial genome. This finding is consistent with studies showing that treatment efficacy varies with *H. pylori* detection techniques [50–53].

This analysis presented the cumulative eradication rate for Africa and identified factors associated with eradication. In addition, the study included a sub-group analysis of differences in study design, country, treatment regimen, type of analysis, duration of eradication therapy, weeks of outcome measure and tests employed for *H. pylori* diagnosis and eradication confirmation. Africa contains 54 countries; however, this study has picked up reports only from 9 countries. Moreover, one-third of data are reported from Egypt. The fact might influence the generalization of our findings. Thus, eradication studies in Africa are so rare that more research must be promoted.

Conclusion

In Africa, the first-line therapy showed an acceptable minimum eradication rate for *H. pylori*. This study demonstrates the need to reassess antibiotic susceptibility in each country and optimize current *H. pylori* treatment regimens. Antibiotic susceptibility of *H. pylori* should be investigated in each nation of Africa. Although gastrointestinal disorders and associated *H. pylori* infections are common problems in Africa, less attention given to translate the efficiency of eradication and improve the eradication regimen.

Abbreviations

CI: confidence interval; *H. pylori*: *Helicobacter pylori*; OAC = Omeprazole + Amoxicillin + Clarithromycin; OCM = Omeprazole + Clarithromycin + Metronidazole; OAM = Omeprazole + Amoxicillin + Metronidazole; LAC = Lansoprazole + Amoxicillin + Clarithromycin; PAC = Pantoprazole + Amoxicillin + Clarithromycin; RAC = Rabeprazole + Amoxicillin + Clarithromycin; OCN = Omeprazole + Clarithromycin + Nitazoxacine; OACS = Omeprazole + Amoxicillin + Clarithromycin + Simvastatin; OLDN = Omeprazole + Levofloxacin + Doxycycline + *Nitazoxanide*; DLA = Dexlansoprazole + Levofloxacin + Amoxicillin; OCT= Omeprazole + Clarithromycin + Tinidazole; PS-Prospective study; RCT-Randomized control trial; PP-Per protocol; ITT-Intention to treat; FAT-Fecal antigen test; UBT-Urea breath test; H-Histology; RUT-Rapid urease test; C-Culture.

Declarations

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Competing interests

The authors declare that they have no competing interests.

Availability of data and materials

All data generated or analyzed are included in the result of the manuscript and its supplementary files.

Authors' contribution

SF: Conceived and designed the study, analyzed data, and drafted the manuscript. SD: interpret the results and review the manuscript. AG: assess methodological quality and review the manuscript. HI and HY: review the manuscript. SF, SD, AG, HE and SS select and evaluate the quality of studies and extract data. All authors revised, edited, and approved the manuscript.

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

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Figures

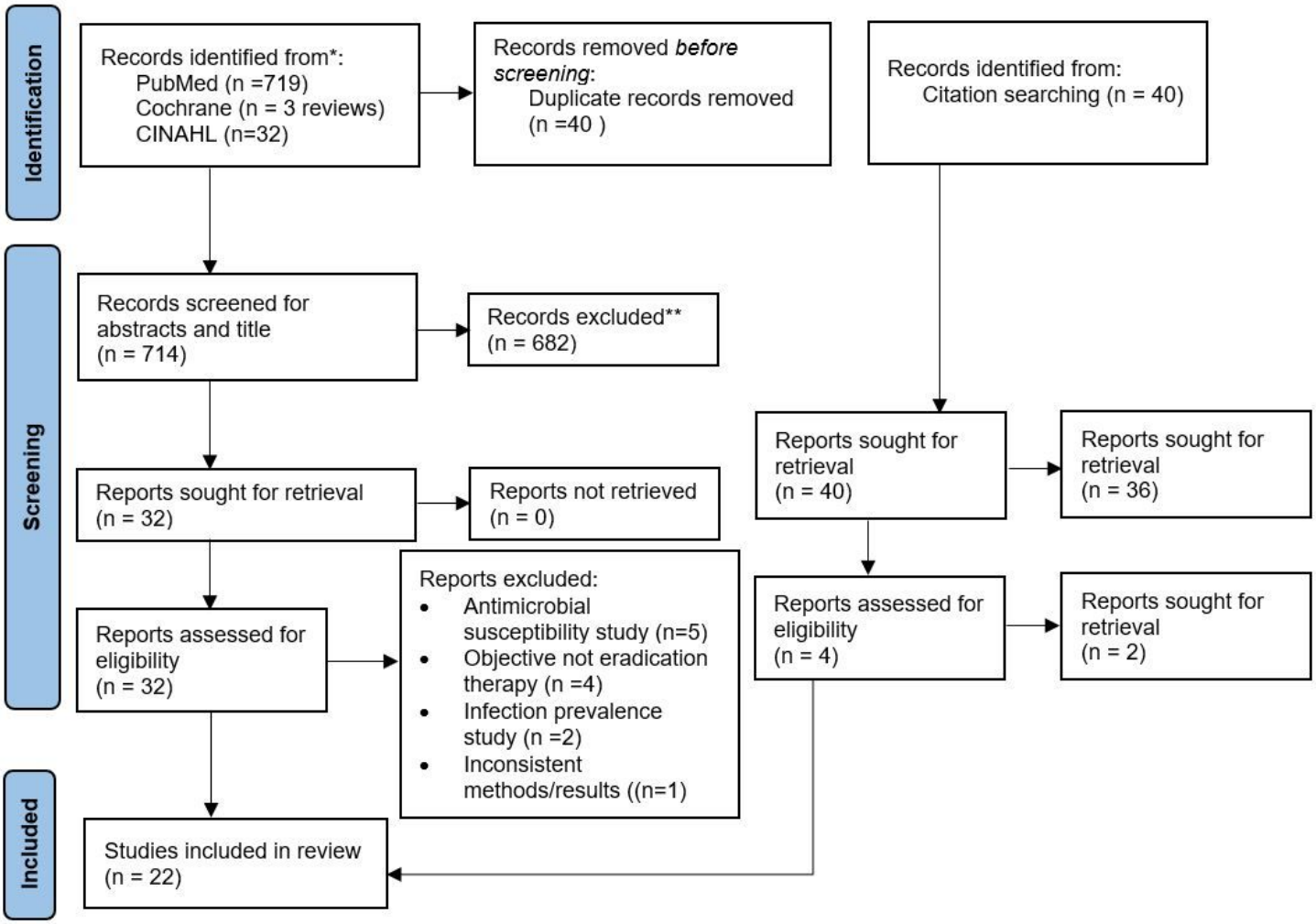

Figure 1

PRISMA flow chart of studies selection

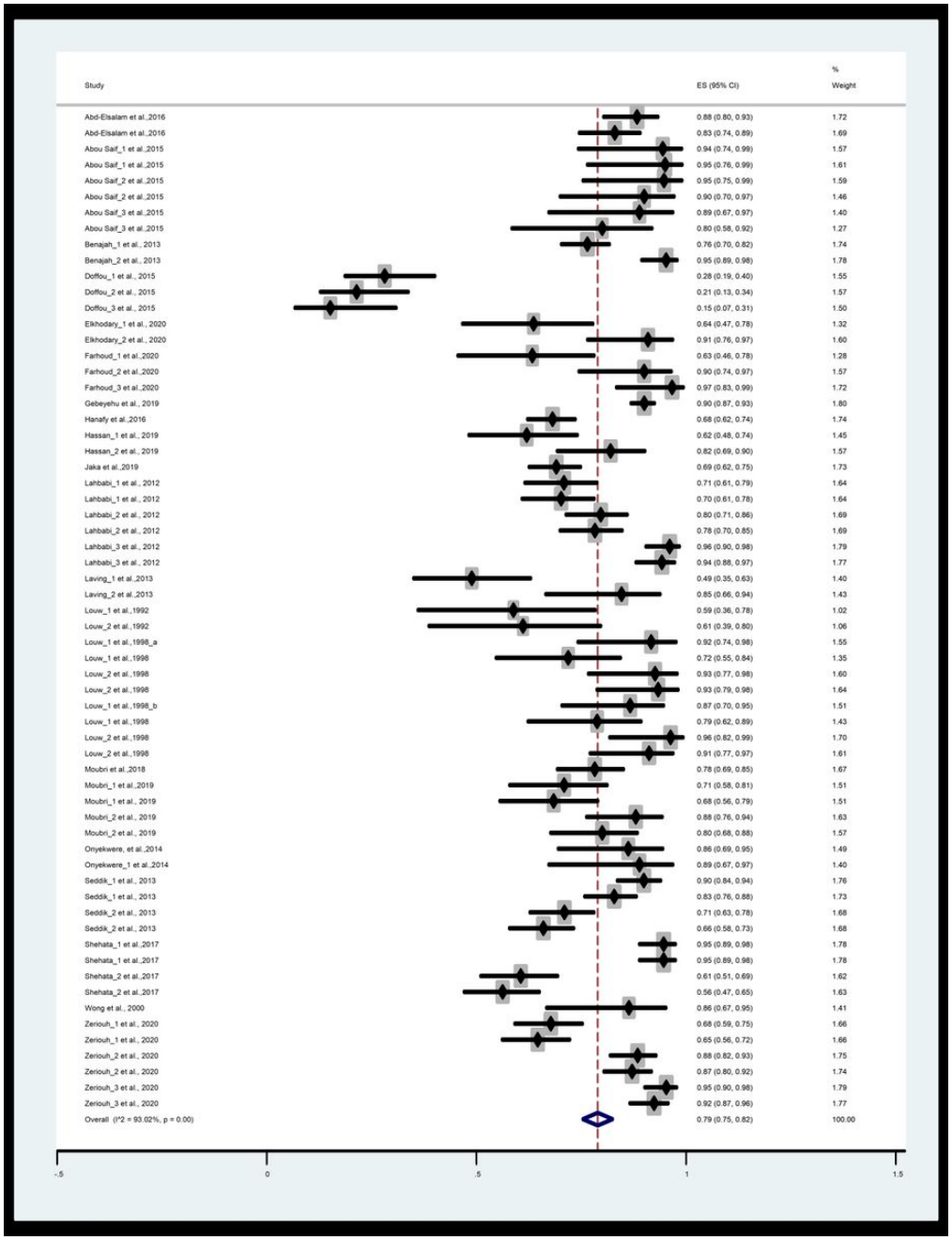

Figure 2

Forest plots of the pooled eradication rates of *Helicobacter pylori* infection by first-line standard therapy in Africa from 22 studies.

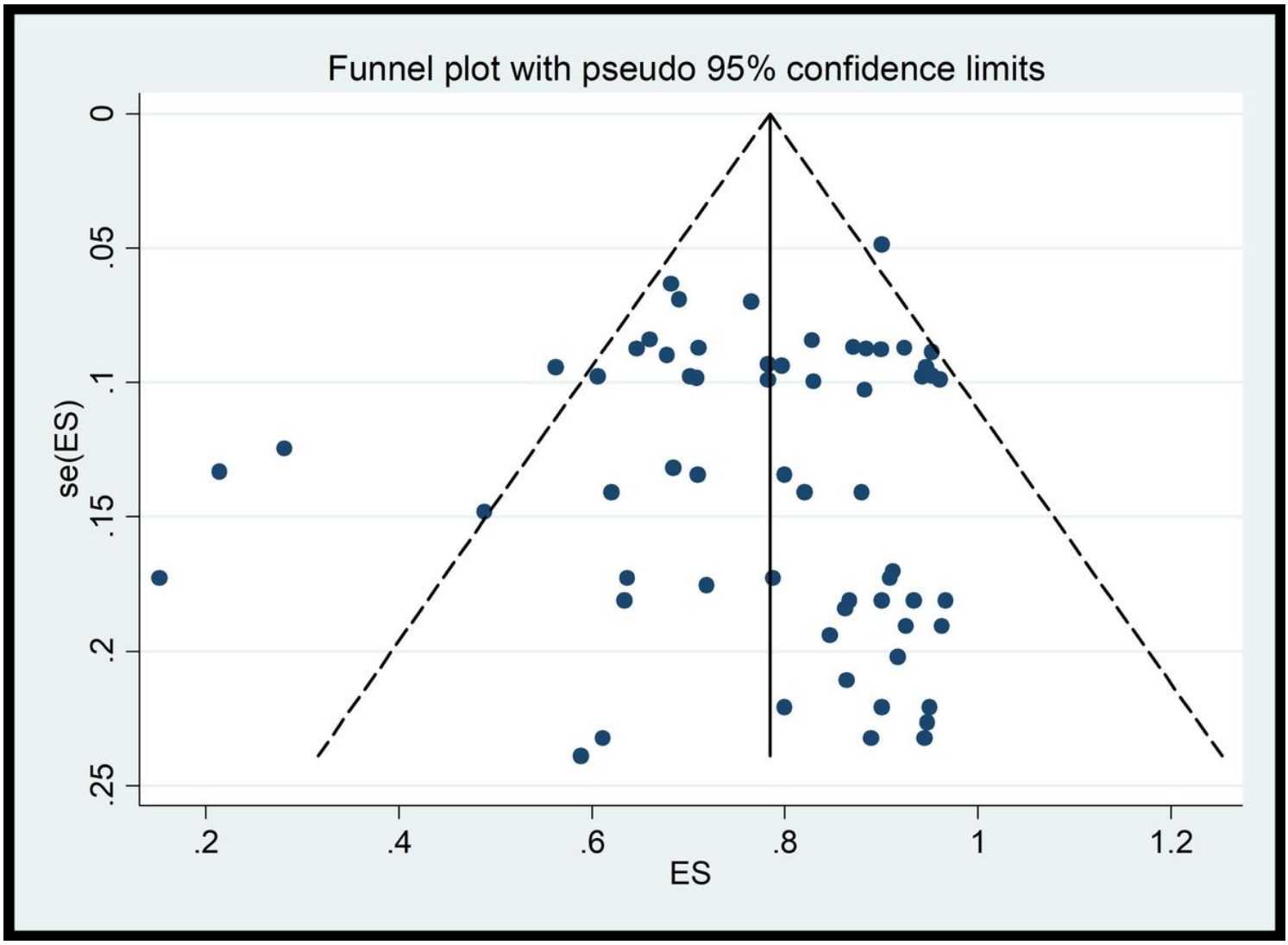

Figure 3

Funnel plot showing absence of publication bias with no small study effects, *p*=0.672. Publication bias assessment funnel plot; Egger's regression test (*p*=0.672).

Supplementary Files

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