BMC Gastroenterology

SYSTEMATIC REVIEW

Open Access

Prevalence and patterns of peptic ulcer disease in Africa: a systematic review and meta-analysis

Seid Mohammed Abdu[1*], Ebrahim Msaye Assefa[1] and Hussen Abdu[1]

Abstract

Background Peptic ulcer disease (PUD) remains a significant yet poorly understood public health issue in Africa, despite its declining prevalence in Western countries. Studies from Africa report a highly variable burden, with the highest prevalence observed in West Africa and the lowest in Southern Africa. However, the overall burden of PUD in Africa, its patterns (duodenal ulcers, gastric ulcers, and coexisting ulcers), and its association with H. pylori infection remain unclear.

Objective This review aims to systematically analyze the pooled prevalence and patterns of PUD in Africa through a systematic review and meta-analysis.

Design A systematic review and meta-analysis was conducted following the PRISMA checklist. We searched PubMed, Hinari, and Google Scholar, supplemented by Google and Yahoo search engines. Observational studies reporting the prevalence and patterns of PUD among the African population were included. Two independent reviewers extracted data and assessed study quality. Pooled prevalence estimates were calculated using a random-effects model, with heterogeneity assessed via the Cochrane Q test and I^2 statistic.

Results A comprehensive analysis of 58 studies revealed a pooled prevalence of PUD in Africa at 15.2%. The most common ulcer pattern was DU at 10.2%, followed by GU at 5.8%, while 0.6% of cases had both types. Regional variations were observed, with West Africa having the highest prevalence (19%), followed by East Africa (15%), North Africa (12%), and Southern Africa (8%). Among individual countries, Ghana reported the highest prevalence (27%), followed by Ethiopia (19%) and Tanzania (16%). Furthermore, the pooled prevalence of PUD was 14% before 2010 and 15% in 2011 and later. Additionally, 57.1% of patients tested positive for Helicobacter pylori infection, with its prevalence reaching 76.4% among those diagnosed with PUD. Substantial heterogeneity was observed across most analyses, with I^2 values exceeding 95% and p-values < 0.001.

Conclusion The analysis revealed a significant burden of PUD in Africa, with DU being more common than GU. Regional disparities were observed, with the highest prevalence in West and East Africa. Over the past two decades, the burden has remained relatively stable, reflecting a concerning trend. *H. pylori* infection was also frequently diagnosed in individuals undergoing endoscopic examination. However, substantial heterogeneity was noted across studies, highlighting variability in reported prevalence.

Keywords Peptic ulcer disease, Duodenal ulcer, Gastric ulcer, Prevalence, Pattern, Africa, Systematic review, Meta-analysis

*Correspondence:
Seid Mohammed Abdu
seidmd041@gmail.com

Introduction

Peptic ulcer disease (PUD) is an acid-peptic injury that causes mucosal breaks penetrating the submucosa, most commonly in the stomach and proximal duodenum. However, ulcers can also occur in the esophagus and other parts of the gastrointestinal tract, including Meckel's diverticulum [1–3].

Traditionally, PUD was linked to a hypersecretory acid environment, along with dietary factors and stress. However, the understanding of PUD shifted with the discovery of H. pylori infection and the widespread use of NSAIDs, both of which are now recognized as major contributors to PUD [3]. As a result of this evolving understanding, the lifetime prevalence of PUD in the general population has been estimated to range between 5 and 10%, with an incidence of 0.1–0.3% per year [4, 5]. In 2019, the global prevalence of PUD was approximately 8.09 million, reflecting a 25.82% increase since 1990 [6]. However, in many regions, especially in high-income countries, the prevalence and incidence of PUD have declined, primarily due to a significant decline in H. pylori infection rates [2, 7]. This downward trend has been demonstrated by several prospective studies conducted across Europe, including those from the Netherlands [8], Spain [9], Belgium [10], the United Kingdom [11], and the United States of America [12], all of which report notable reductions in incidence, hospital admissions, and mortality rates over the past 20–30 years [6]. Despite the overall decline, PUD remains a significant health risk due to complications like bleeding, perforation, and obstruction [13]. The economic burden is also substantial, with the U.S. spending nearly $2 billion on related conditions in 2016 [14]. In contrast to Western countries, studies from Africa reveal a wide variability in PUD prevalence, ranging from 7.9% in Nigeria [15] to 71.3% in Ghana [16], indicating significant disparities in disease burden across the continent.

These disparities highlight the need for a deeper understanding of PUD in Africa, where the epidemiology may differ from that observed in high-income countries. While Timothy et al. (2019) [17] provides a valuable literature review on PUD, its patterns, and gastric histopathology in Africa, it does not employ a systematic review and meta-analysis methodology. The fragmented nature of available data underlines the need for a comprehensive synthesis of findings. Therefore, this study aimed to fill that gap by conducting a systematic review and meta-analysis to estimate the pooled prevalence and patterns of PUD in Africa.

Methods

Protocol registration

This review was conducted to synthesize existing evidence on the prevalence and patterns of PUD in Africa. The protocol has been registered by the International Prospective Register of Systematic Reviews (PROSPERO) with registration number [CRD42024541571].

Search strategy

This systematic review and meta-analysis adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [18] (Research Checklist). An extensive literature search was conducted across electronic databases, including PubMed, Google Scholar, Hinari, and website searches (google and Yahoo) up to December 31, 2024, in three phases. Initially, relevant Medical Subject Headings (MeSH) and key terms were identified in the existing literature. In the second phase, full searches were conducted in the selected databases using proper terms. Finally, in the third phase, the reference lists of all relevant studies and university websites were reviewed to identify any additional eligible studies. The search was structured using Boolean operators (OR, AND) to combine different MeSH terms and keywords. The search query used was ((("Prevalence"[Title/Abstract] OR"Incidence"[Title/Abstract] OR"Magnitude"[Title/Abstract] OR"Epidemiology"[Title/Abstract]) OR (Proportion[Title/Abstract])) AND (((((Peptic Ulcer Disease [Title/Abstract]) OR (Gastroduodenal Ulcer [Title/Abstract])) OR (Gastroduodenal Ulcers[Title/Abstract])) OR (Ulcer, Gastroduodenal [Title/Abstract])) OR (Ulcers, Gastroduodenal)) AND [Countries name]. filters; English, free full text, and date from 2000- April 2024, (S1 Appendix).

Criteria for considering studies for the review

Inclusion criteria

This review included observational studies from Africa reporting the prevalence and/or pattern of PUD, including DU, GU, and cases where both DU and GU were present. The study included individuals of all age groups. Only articles published in English were considered, focusing on publication from the past 24 years (2000–2024) up to December 2024. All included studies employed endoscopy as the diagnostic method for PUD. To avoid duplication, if multiple studies from the same institution used the same population, study unit, and study period (even if published in different journals), only the most comprehensive one was included. In cases where multiple publications from the same institution had overlapping study periods (e.g., 1977–2015 and 1977–2020), the study

covering the largest time span was selected for inclusion. Importantly, studies were considered based on their publication date, regardless of whether their data collection period extended before 2000, as most of the included studies used retrospectively collected data.

Exclusion criteria

Case reports, case series, and any other studies lacking the necessary data to estimate PUD prevalence were excluded. Additionally, studies that exclusively collected data from specific population groups, such as only children, the elderly, or a single-sex group, were not included. Furthermore, studies reporting endoscopic findings based solely on specific indications, such as only patients presenting with upper gastrointestinal bleeding, were excluded to prevent selection bias and minimize the risk of over or underestimating the prevalence of PUD.

Selection process

The selection of studies for this systematic review and meta-analysis was conducted in a two-step process. First, studies were identified through a systematic search of relevant databases, and duplicate records were removed using EndNote. Next, articles were manually screened by title and abstract to assess their relevance based on the inclusion and exclusion criteria. Articles found relevant by title and abstract were screened for full eligibility. Two investigators (SMA and EMA) independently evaluated the eligibility of articles. In cases of disagreement, the issue was resolved through discussion and by referring to the predefined inclusion and exclusion criteria. If consensus could not be reached, a third investigator was consulted for the final decision. Finally, the full text of potentially eligible studies was reviewed for inclusion.

Data extraction and quality assessment

The same two investigators who performed study selection independently extracted the data using Microsoft Excel. The data extraction sheet recorded each study's author name, publication year, data collection years, country, overall PUD prevalence, PUD pattern (DU, GU, or both), sample size, and number of H. pylori-positive cases. The methodological quality of the included studies was assessed using the quality assessment tool of the JBI for prevalence studies [19]. Articles scoring 7 or above on the scale were considered good quality (S2 Appendix).

Outcome of interest

The primary outcome was the prevalence of PUD and its patterns (DU, GU, and combined ulcers), as reported in the original studies either as a percentage or as the number of PUD cases (n) out of the total patients examined (N). Pattern of PUD refers to the site-specific distribution of ulcers, including GU, DU, and coexisting forms.

Statistical analysis

The pooled prevalence and pattern of PUD were determined along with a corresponding 95% confidence interval using the random-effects method. Assessments of heterogeneity, publication bias, and sensitivity analysis were also conducted. Cochran's Q test and the I^2 statistic were used to assess the heterogeneity of the included studies. Egger's regression test was run whenever possible, and funnel plots were used to evaluate potential publication bias and small study effects. A predefined subgroup analysis based on region, study period, study design, and country was undertaken to investigate potential sources of heterogeneity. Furthermore, a leave-one-out sensitivity analysis was performed to examine the influence of individual studies and the robustness of the pooled results against outliers. A p-value less than 0.05 was considered the threshold for statistical significance. All statistical analyses were performed using STATA version 17 (STATA Corporation, College Station, TX, USA).

Results

In our initial search, 807 publications were identified. Of these, 190 articles were excluded due to duplication. A total of 617 articles were screened, and 532 were excluded at the title and abstract stage as they did not meet the eligibility criteria. The remaining 85 full texts were evaluated, but 2 could not be retrieved. Therefore, 83 full texts were assessed for eligibility, of which 54 were found to be eligible. The reasons for the exclusion of the other 29 full texts are detailed in Fig. 1. Additionally, four articles were identified through supplementary searches (via Yahoo and Google), bringing the total number of included studies to 58 (Fig. 1).

Characteristics of included studies

A total of 58 institution-based observational studies, with a population size of 91,061 were included in this meta-analysis. Of the 58 eligible studies, 23 (39.66%) were conducted in East Africa (Ethiopia, Kenya, Somalia, Rwanda, Uganda, Tanzania, Sudan) and 21 (36.21%) in West Africa (Nigeria, Ghana, Burkina Faso, Ivory Coast). The Central Africa region was represented by only 1 study (1.72%) from the Democratic Republic of Congo. North Africa (Egypt, Libya) contributed 5 studies (8.62%), and Southern Africa (South Africa, Zambia, Malawi) contributed 8 studies (13.79%). Regarding data collection methods, 35 studies (60.34%) were retrospective, and the remaining 23 studies (39.66%) were prospective. Among the included studies, the largest sample size was 25,849 (from a study in Zambia [20], while the smallest sample

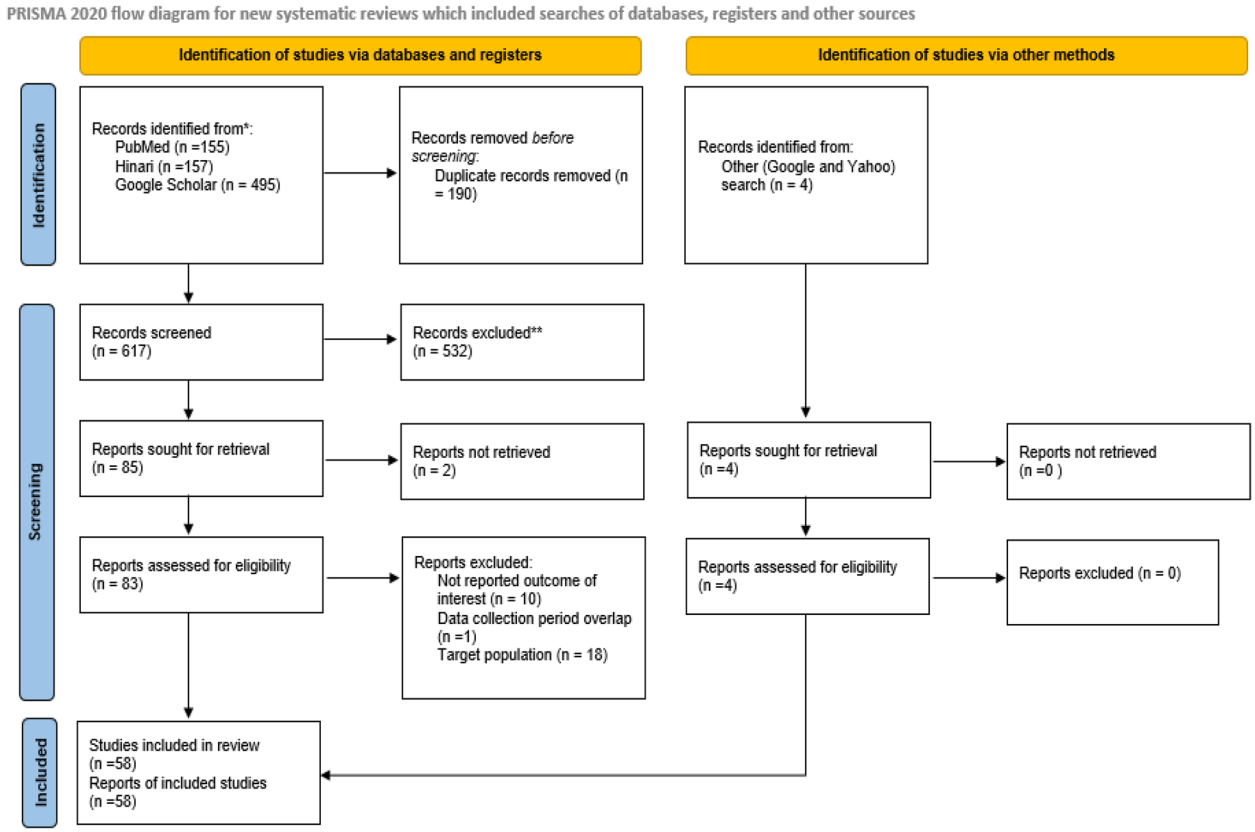

Fig. 1 Depicts the schematic flow of study selection steps for PUD in Africa

size was 95 (from Egypt [21]. All studies included in this review used endoscopy as the diagnostic instrument (Table 1).

Risk of bias for each included study

Of the 58 included studies, 48 (82.76%) were assessed as having low risk of bias. In contrast, 8 studies (13.79%) had a moderate risk of bias, and 2 studies (3.45%) had a high risk of bias (score ≤ 4), primarily due to issues such as inadequate sample size (see Table 1).

The Pooled Prevalence of PUD and its patterns

Of the 91,064 patients who underwent endoscopic examination, 15,239 were diagnosed with PUD in the included studies. This corresponds to the pooled prevalence of 15.2% (95% CI: 13.2, 17.2) across included studies. The inverse variance I^2 was 98.7% with $p < 0.001$, indicating significant heterogeneity among the included studies (S1 Figure). Regarding the specific patterns of PUD, the pooled prevalence of DU was 10.2% (95% CI: 8.8, 11.7) based on analysis of 44 studies (S2 Figure), while GU had a pooled prevalence of 5.8% (95% CI: 4.7, 6.8) from 46 studies (S3 Figure). In addition, eight studies reported simultaneous involvement of both DU and GU, with pooled prevalence of 0.6% (95% CI: 0.2, 0.9).

Among the 58 included studies across different regions of the continent, 16 reported on *H. pylori* testing. Of these, 11 used a rapid urease test, 2 employed microscopic tissue examination, 2 used a stool antigen test, and 1 utilized a serological test, resulting in a pooled H. pylori prevalence of 57.1% (95% CI: 48.1–66.1) (S4 Figure). Notably, among the 16 studies reporting on H. pylori, 8 provided the proportion of PUD patients who were H. pylori-positive, yielding a pooled prevalence of 76.4% (95% CI: 66.9–85.8).

Subgroup analysis for prevalence PUD in Africa

The primary studies included in this systematic review and meta-analysis exhibited a significant heterogeneity. To explore the potential sources of this variability a sub-group analysis based on the region, year, countries, and study design was conducted. Starting from regions, four major regions of Africa were included. Twenty-three studies from East Africa had a pooled prevalence of 15%, twenty-one studies from West Africa had a pooled prevalence of 19%, five studies from North Africa had a

Table 1 Characteristics of the included studies on the prevalence and pattern of PUD, include DU, GU, and both DU and GU in Africa

First Author name, Year of publication	Countries	Region	Years of data collection	Sample size	Male	Female	H. Pylori +	PUD*	PUD Patterns			Risk of bias
									GU**	DU***	GU&DU	
Argaw, A.M., et al. 2023 [22]	Ethiopia	East Africa	2012–2019	5753	3648	2105		849	609	240	///	Low
Assefa, B., et al. 2022 [23]	Ethiopia	East Africa	2020	218	118	100	107	76	56	21	///	Low
Melak W, et al. 2023 [24]	Ethiopia	East Africa	2018–2022	142	75	67	24	16	12	4	///	Moderate
Kiros YK et al.2017 [26]	Ethiopia	East Africa	2011–2015	1994	1170	824	///	176			///	Low
Getahun GM et al. (2015 [26]	Ethiopia	East Africa	2005–2015	1310	668	642	///	358	333	25	///	Low
Zena D et al. 2024 [26]	Ethiopia	East Africa	2023–2024	279	118	161	///	49	26	23	///	Low
Makanga W, et al. 2014 [26]	Kenya	East Africa	2011–2013	5948	1372	1564	///	906	594	312	///	Low
Mwangi CN. et al. 2020 [26]	Kenya	East Africa	2018–2019	487	266	221	199	40	14	18	8	Low
Ayuo PO, et al. 2014 [26]	Kenya	East Africa	1993–2003	1690	864	826	///	238	186	52	///	Low
Lodenyo H. et al. 2005 [26]	Kenya	East Africa	1998–2001	768	484	284	///	73	62	11	///	Low
Adani AA et al. 2023 [26]	Somalia	East Africa	2021–2022	634	363	271	299	234	145	89	///	Low
Bulur O et al. 2018 [26]	Somalia	East Africa	2015–2017	306	209	97	///	15	13	2	///	Low
Obayo S. et al. 2015 [26]	Uganda	East Africa	2014–2015	184	110	74	114	21	7	14	///	Moderate
Namugerwa J. et al. 2017 [26]	Uganda	East Africa	2017	385	151	234	///	57	///	///	///	Moderate
Okello TR, et al. (2016) [38]	Uganda	East Africa	2015	605	243	362	///	14	///	///	///	Low
Doe MJ et al.(2021) [26]	Uganda	East Africa	2009–2019	833	474	359	///	48	37	11		Low
Walker TD et al. 2014 [38]	Rwanda	East Africa	2011–2014	961	438	523	622	233	194	39	///	Low
Ayana SM et al. 2014 [42]	Tanzania	East Africa	2009–2010	208	99	109	130	50	38	12	///	Low
Qu LS, et al. 2023 [26]	Tanzania	East Africa	2013–2021	3146	1455	1691	///	365	244	121	15	Low
Khamisi R H. 2013 [38]	Tanzania	East Africa	2013	159	94	65	///	20	7	13	///	Low
El Shallaly et al.2021 [42]	Sudan	East Africa	2007–2019	1859	1058	794	///	197	149	47	1	Low
Elhadi AA et al. 2014 [26]	Sudan	East Africa	2013	390	170	220	///	82	///	///	///	Low
Adam HY et al. 2008 [38]	Sudan	East Africa	2003–2007	1150	656	494	///	63	47	16	///	Low
Yahya H. 2023 [42]	Nigeria	West Africa	2014–2022	1958	1339	619	///	171	54	102	15	Low
Ray-Offor E. et al. 2020 [26]	Nigeria	West Africa	2014–2019	434	–––	–––	///	31	12	17	2	Low
Okoye OG. et al.2021 [38]	Nigeria	West Africa	2016–2017	132	66	66	59	37	25	15	///	Moderate
Odeghe E A. et al. 2023 [42]	Nigeria	West Africa	2020–2021	227	96	131	133	42	///	///	///	Low
Ismaila BO. et al. 2013 [53]	Nigeria	West Africa	2010–2012	122	–––	–––	///	9	///	///	///	Moderate
Misauno M. et al. 2011 [26]	Nigeria	West Africa	1999–2010	989	593	396	///	133	93	40	///	Low
Ngim O et al. 2017 [38]	Nigeria	West Africa	2012–2014	171	86	85	///	9	1	8	///	Low
Jeje EA et al. 2013 [42]	Nigeria	West Africa	1994–1997	184	101	83	///	44	35	9	///	Low
Nwokediuko SC et al. 2012 [53]	Nigeria	West Africa	1995–99, 2006–10	1365	727	638	///	130	71	59	///	Low
Oluwagbenga OO et al. [26]	Nigeria	West Africa	2003–2007	181	95	86	///	21	16	5	///	Moderate
Archampong TN. et al.2016 [38]	Ghana	West Africa	2010–2012	242	127	115	198	170	83	87	///	Low

Table 1 (continued)

First Author name, Year of publication	Countries	Region	Years of data collection	Sample size	Male	Female	H. Pylori +	PUD*	PUD Patterns			Risk of bias
									GU**	DU***	GU&DU	
Darko R et al. 2015 [42]	Ghana	West Africa	1999–2012	2401	1120	1281	1361	339	333	6	///	Low
Agyei-NkansahA et al. 2019 [64]	Ghana	West Africa	2012	371	159	212	160	65	25	40	///	Low
Duah A et al.2022 [65]	Ghana	West Africa	2019–2020	571	244	327	225	82	52	30	///	Low
Aduful HK. et al. 2007 [53]	Ghana	West Africa	1995- 2002	6977	3777	3200	///	1608	1383	225	///	Low
Gyedu A, Yorke J 2014 [67]	Ghana	West Africa	2006–2011	3110	1327	1783	///	850	94	147	///	Low
Dakubo JC et al. 2011 [26]	Ghana	West Africa	2008	1643	792	851	///	279	184	95	///	Low
Tabiri S et al.2015 [38]	Ghana	West Africa	2010–2014	2414	1199	1215	///	858	249	609	///	Low
Koura M. et al.2017 [42]	Burkina Faso	West Africa	2015–2016	1022	470	552	///	271	99	172	5	Low
Meda ZC et al. 2023 [64]	Burkina Faso	West Africa	2019–2020	180	96	84	///	19		19	///	Low
Okon JB et al. 2021 [65]	Cote d'Ivoire	West Africa	2019–2020	**1010**	475	535	///	190	///	///	///	Low
El-Ghannam R et al. 2019 [21]	Egypt	North Africa	2019	95	37	58	92	5	///	///	///	High
Moustafa HM, et al. 2023 [53]	Egypt	North Africa	2019–2020	2500	1226	1274	///	228	127	101	///	Low
Fouad M et al. 2018 [67]	Egypt	North Africa	2013–2015	218	128	90	///	10			///	Low
Ali MH et al. 2024 [26]	Egypt	North Africa	2018–2019	928	536	392	///	131	78	53	///	Low
Tumi A. et al.2007 [38]	Libya	North Africa	2000	99	53	46	69	37	43	1	///	High
Cheddie S.et al.2020 [42]	South Africa	Southern Africa	2014–2016	1000	306	694	///	101	///	///	///	Low
Mnyombolo Y et al. 2022 [64]	South Africa	Southern Africa	2017–2018	300	–––	–––	///	11	///	11	///	Low
Ntola VC et al. 2019 [65]	South Africa	Southern Africa	2015	194	73	121	///	5	///	///	///	Moderate
Fernando N et al. 2001 [53]	Zambia	Southern Africa	1999–2002	191	–––	–––	155	7	6	1	///	Moderate
Kayamba V, et al.2024 [20]	Zambia	Southern Africa	1977–2021	25,849	–––	–––	///	4610	2276	2095	239	Low
Kelly P et al.2008 [67]	Zambia	Southern Africa	1999–2005	2132	1100	941	///	395	231	158	6	Low
Wolf LL. et al. 2012 [26]	Malawi	Southern Africa	2008–2010	1004	562	441	///	36	18	18	///	Low
Mothes H. et al. 2009 [38]	Malawi	Southern Africa	2004–2006	441	–––	–––	///	6	///	///	///	Low
Adonis NM et al.2021 [42]	Congo(DRC)	Central Africa	2014–2016	1000	450	550	///	119	72	47	///	Low

* Peptic ulcer disease, **Duodenal ulcer, *** Gastric ulcer

pooled prevalence of 12%, and eight studies from Southern Africa had a pooled prevalence of 8%.

Further subgroup analysis by country revealed the highest pooled PUD prevalence in Ghana (27%) and the lowest in South Africa (5%). When stratified by study period, the pooled prevalence remained relatively stable over two decades: approximately 14% before 2010 and 15% in 2011 and later. Regarding study design, the pooled PUD prevalence was 15% for prospective cross-sectional studies and 14% for retrospective cross-sectional studies. Across all subgroup analyses, substantial heterogeneity was observed, with I^2 values exceeding 95% and *p*-values < 0.001, indicating high variability in the reported prevalence of PUD (Table 2).

Sensitivity analysis for prevalence of PUD in Africa

To determine whether a single study's findings had a substantial influence on the pooled prevalence of PUD in Africa, a leave-one-out sensitivity analysis was performed. All of the sensitivity analysis's findings fell between the pooled prevalence's 95% confidence intervals (95% CI: 13.2, 17.2), suggesting that no single study have had an influence on the observed pooled prevalence of PUD.

Publication bias for prevalence and pattern of PUD in Africa

Visual inspection of the funnel plot demonstrated symmetry, indicating that there was no publication bias among the included studies. Egger's test also revealed that there was no publication bias, ($p = 0.833$) (Fig. 2).

Discussion

This study addresses a major gap in the literature by providing the first comprehensive pooled analysis of PUD prevalence and patterns across Africa. From 58 studies, we found a pooled PUD prevalence of 15.2% (95% CI: 13.2–17.2%). Among ulcer types, the pooled prevalence of DU was 10.2% (95% CI: 8.8, 11.7), while that of GU was 5.8% (95% CI: 4.7, 6.8). The prevalence varied across regions, ranging from 8% in Southern Africa to 19% in West Africa. Over the past two decades, pooled estimates remained relatively stable, with rates of 14% before 2010 and 15% after 2011. Regarding *H. pylori* testing, the pooled prevalence was 57.1% (95% CI: 48.1, 66.1).

This study challenges the earlier belief that PUD is rare in Africa [17]. In fact, our analysis shows that PUD is widespread across Africa, with a high pooled prevalence of 15.2%. This figure is comparable to a report from China (17% [64]) but is significantly higher than the estimated

Table 2 Subgroup Analysis of the Pooled Prevalence of Peptic Ulcer Disease by Region, Study Countries, Year, and Study Design in Africa

Variables	Characteristics	Number of studies	Pooled (95% CI)	(I^2, *p*-value)
Based on Study Region				
Study Region	East Africa	23	15% (95% CI: 12, 17)	97.93%, $P < 0.001$
	West Africa	21	19% (95% CI: 15, 23)	98.64%, $P < 0.001$
	North Africa	5	12% (95% CI: 7, 17)	93.85%, $P < 0.001$
	Southern Africa	8	8% (95% CI: 1, 14)	99.49%, $P < 0.001$
Based on Study countries				
Study countries	Kenya	4	12% (95% CI: 9, 15)	93.50%, $P < 0.001$
	Uganda	4	8% (95% CI: 4, 13)	94.67%, $p < 0.001$
	Tanzania	3	16% (95% CI: 9, 22)	///
	Sudan	3	12% (95% CI: 6, 18)	///
	Nigeria	10	12% (95% CI: 10, 15)	88.86%, $P < 0.001$
	Ghana	8	27% (95% CI: 21, 33)	98.99%, $P < 0.001$
	Egypt	4	9% (95% CI: 5, 12)	90.63%, $P < 0.001$
	Ethiopia	6	19% (95% CI: 13, 25)	97.84%, $p < 0.001$
	South Africa	3	5% (95% CI:1, 10)	///
	Zambia	3	13% (95% CI: 7, 20)	///
Based on years of the data collected				
Years of the data collection	≤ 2010	15	14% (95% CI: 10, 19)	99.20%, $p < 0.001$
	≥ 2011	40	15% (95% CI: 13, 17)	98.94%, $p < 0.001$
Base on Study design				
Study design	Prospective cross-sectional	23	18% (95% CI: 14, 22)	99.04%, $p < 0.001$
	Retrospective cross-sectional	35	14% (95% CI: 11, 16)	97.82%, $p < 0.001$

Number of studies = 58 Root MSE = 8.976

Std_Eff	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
slope	.1315699	.0176728	7.44	0.000	.0961671	.1669727
bias	.4442622	2.101633	0.21	0.833	-3.765814	4.654339

Test of H0: no small-study effects P = 0.833

Fig. 2 Small-study effects test, slope, bias coefficients with confidence intervals, and *p*-value

global average of 8.4% [65]. The differences between our study and the global study may stem from several key factors. While the global study included data from 21 studies across various regions worldwide, our analysis was based on 58 studies specifically from Africa. This regional focus is significant, as Africa has distinct epidemiological characteristics compared to other parts of the world. Another crucial factor is the markedly higher prevalence of H. pylori infection in Africa. This well-established cause of PUD might contribute to the higher PUD prevalence observed in our analysis compared to the global study [1, 53, 67].

Globally, including the Western world, PUD has shown a consistent decline between 1990 and 2019, with an annual decline rate of 1.42% [26]. In contrast, our data show a different trend: the African population continues to face a persistently high burden, with prevalence rates of ~14% before 2010 and ~15% after 2011 (essentially stable over two decades). This significant burden is likely driven by a complex interplay of factors specific to the region, including a high prevalence of H. pylori (the primary cause of PUD [1, 38, 42, 53, 64, 65, 67] in many African countries [26, 38, 38, 42, 64]. Beyond H. pylori infection, several additional factors may contribute to the high burden of PUD in Africa including poverty, poor sanitation, and limited healthcare access which can delay diagnosis and treatment and thereby increase the risk of complications [65]. Additionally, dietary habits such as high consumption of spicy foods, alcohol, and caffeine, along with chronic stress exacerbated by political instability and economic hardships, may stimulate gastric acid secretion and increase the risk of ulcer formation [53].

Furthermore, the pooled prevalence of H. pylori infection was 57.1% (95% CI: 48.1–66.1). This is similar to reports from regions with comparable socioeconomic challenges, such as Latin America and the Caribbean (59.3% [67]), and parts of South America and Western Asia (69.4% and 66.6%, respectively [26]). These findings show that H. pylori infection remains a persistent public health challenge in areas with limited access to clean water, overcrowding, and inadequate healthcare resources [26, 38]. Notably, when H. pylori infection was assessed exclusively in patients with PUD, its prevalence was 76.4% (95% CI: 66.9–85.8). Given these findings, further research is needed to evaluate the long-term benefits of population-based screening and H. pylori eradication, particularly in reducing the risk of PUD and its severe complications.

Given the high prevalence of PUD and H. pylori, the findings of this systematic review and meta-analysis have significant clinical, epidemiological, and pathophysiological implications. The pooled prevalence of PUD at 15.2% shows a substantial burden of the disease in Africa, where healthcare resources are already limited. Clinically, the high prevalence of PUD and its strong association with H. pylori underscore the importance of targeted diagnostic and therapeutic interventions, particularly H. pylori eradication strategies. From a pathophysiological perspective, the role of H. pylori in PUD development is well documented. The bacterium induces chronic inflammation in the gastric mucosa, leading to ulcer formation, particularly in the duodenum. This inflammation disrupts the protective mucosal layer, making it more susceptible to damage from gastric acid [38].

Strengths and limitations of the study

Multiple factors may explain the variation in PUD prevalence estimates observed across countries, and regions in this study. While all included studies relied on endoscopic examination for PUD, they did not consistently involve gastroenterologists or trained endoscopists. Some studies exclusively utilized gastroenterologists, whereas others relied on general surgeons or physicians with varying levels of expertise. Consequently, despite efforts to ensure consistent diagnostic criteria, inconsistent or interobserver variability of data may have influenced the reported prevalence rates. Variability in study design and data collection methods may also have contributed to these differences. Given these variations, readers should

interpret PUD prevalence within the context of specific study settings, as diagnostic approaches are not uniform across or even within regions. For instance, many studies were based in tertiary hospitals, potentially omitting cases from lower-level healthcare facilities or individuals unable to access endoscopy services. This exclusion has significant implications, as undiagnosed cases may result in missed opportunities for early intervention. Furthermore, our study focused on individuals primarily referred for endoscopy due to persistent and severe symptoms, including elderly patients, aligning with the criteria outlined by ASGE [42]. Given that many patients in our study exhibited concerning symptoms and underwent endoscopy based on clinical indications, it is important to interpret the high prevalence reported with caution, as this patient selection could significantly influence pooled prevalence rates.

The heterogeneity observed among the included studies suggests that effect sizes varied due to either methodological differences or genuine variations in PUD prevalence. In such cases, it is crucial to identify potential sources of heterogeneity and determine whether the differences between studies justify combining continental prevalence estimates. In our study, variability may stem from differences in diagnostic practices, data collection methods, reporting rates, and overall study population size. For example, interobserver variability and the completeness of medical records likely varied across settings, influencing case identification and prevalence estimations. To account for these differences, we employed a random-effects model to aggregate effect sizes across studies, ensuring a more accurate reflection of variations in study populations. Despite the substantial heterogeneity indicated by the I^2 values, we remain confident in the robustness of our findings. This confidence is supported by a rigorous study selection process based on predefined inclusion criteria, consistent direction of effect, robust statistical methodologies, the high quality of individual studies, and the comprehensive data set we identified. By emphasizing research from the past 20 years and including 58 studies, our review provides an up-to-date perspective on the state of PUD in Africa, reinforcing the validity of our findings. These factors allow for a detailed interpretation of the results, despite the observed heterogeneity.

Limitations of the study

Because we restricted inclusion to English-language studies, it is possible that relevant research in other languages was missed. This limitation may affect the comprehensiveness and generalizability of our findings.

Conclusion

This systematic review and meta-analysis reveals a significant burden of PUD and H. pylori infection in Africa, along with notable regional variations and a persistently high prevalence over the past two decades among patients undergoing endoscopic examination. These findings emphasize the importance of implementing effective screening and treatment strategies for PUD. Given this substantial burden, future research should focus on understanding the prevalence of both symptomatic and asymptomatic PUD in the general population, identifying risk factors (including H. pylori and other contributors), and gathering sex-specific data to explore potential differences in PUD prevalence, patterns, and treatment outcomes between males and females. Such efforts will be crucial to inform public health strategies and clinical practices aimed at reducing the PUD burden and improving patient management in African healthcare settings.

Abbreviations

PUD	Peptic Ulcer Disease
GU	Gastric Ulcers
DU	Duodenal Ulcer
MeSH	Medical Subject Heading

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12876-025-03906-y.

Supplementary Material 1.

Supplementary Material 2.

Supplementary Material 3.

Acknowledgements

Not Applicable.

Authors' contributions

S.M.A. conceptualized the study. Data curation was carried out by S.M.A. and H.A. Formal analysis was conducted by S.M.A., E.M.A., and H.A., while the investigation and methodology were handled by S.M.A. and H.A. Software development was completed by S.M.A., and the study was supervised by both S.M.A. and H.A. The original draft was written by S.M.A., E.M.A., and H.A., and all authors contributed to reviewing and editing the manuscript. All authors reviewed and approved the final version of the manuscript.

Funding

Funding was not obtained from any individual or institution for the study.

Data availability

Data is provided within the manuscript or supplementary information files.

Declarations

Ethical approval and consent to participate

Not applicable because the datasets used in this study's analysis are freely accessible on the database and website.

Consent for publication

Not applicable.

Competing interests
The authors declare no competing interests.

Author details
[1]Department of Biomedical Sciences, College of Medicine and Health Sciences, Wollo University, Dessie, Ethiopia.

Received: 10 February 2025 Accepted: 17 April 2025
Published online: 25 April 2025

References

1. Malik T, Gnanapandithan K, Singh K. Peptic Ulcer Disease. [Updated 2021 Jul 29]. StatPearls. Treasure Island: StatPearls Publishing; 2022.
2. Lanas A, Chan FK. Peptic ulcer disease. The Lancet. 2017;390(10094):613–24.
3. Tarasconi A, et al. Perforated and bleeding peptic ulcer: WSES guidelines. World journal of emergency surgery. 2020;15:1–24.
4. Kasper DL, et al. Harrison's principles of internal medicine (2 vols). McGraw-Hill Education; 2015.
5. Rosenstock S, Jørgensen T. Prevalence and incidence of peptic ulcer disease in a Danish County–a prospective cohort study. Gut. 1995;36(6):819–24.
6. Xie X, et al. The global, regional and national burden of peptic ulcer disease from 1990 to 2019: a population-based study. BMC Gastroenterol. 2022;22(1):58.
7. Sung J, Kuipers E, El-Serag H. Systematic review: the global incidence and prevalence of peptic ulcer disease. Aliment Pharmacol Ther. 2009;29(9):938–46.
8. Post P, Kuipers E, Meijer G. Declining incidence of peptic ulcer but not of its complications: a nation-wide study in The Netherlands. Aliment Pharmacol Ther. 2006;23(11):1587–93.
9. Perez-Aisa M, Del Pino D, Siles M. Clinical trends in ulcer diagnosis in a populationwith high prevalence of. Helicobacter pylori: p. 65–72.
10. Bartholomeeusen S, et al. Time trends in the incidence of peptic ulcers and oesophagitis between 1994 and 2003. Br J Gen Pract. 2007;57(539):497–9.
11. Cai S, et al. Uncomplicated peptic ulcer in the UK: trends from 1997 to 2005. Aliment Pharmacol Ther. 2009;30(10):1039–48.
12. Lewis, J.D., et al., Hospitalization and mortality rates from peptic ulcer disease and GI bleeding in the 1990s: relationship to sales of non-steroidal anti-inflammatory drugs and acid suppression medications. Official journal of the American College of Gastroenterology| ACG, 2002. 97(10):2540–2549.
13. Lau JY, et al. Systematic review of the epidemiology of complicated peptic ulcer disease: incidence, recurrence, risk factors and mortality. Digestion. 2011;84(2):102–13.
14. Peery AF, et al. Burden and cost of gastrointestinal, liver, and pancreatic diseases in the United States: update 2021. Gastroenterology. 2022;162(2):621–44.
15. Eniojukan J, Okonkwo O, and U. Adje, Risk Factors, management and other correlates of peptic ulcer disease in a university community in south-south Nigeria. Pharmaceut Biosci J. 2017:07–15.
16. Tabiri S, Akanbong P, Abubakari BB. Assessment of the environmental risk factors for a gastric ulcer in northern Ghana. Pan Afr Med J. 2016;25:160. https://doi.org/10.11604/pamj.2016.25.160.8531.
17. Archampong TN, et al. Gastro-duodenal disease in Africa: Literature review and clinical data from Accra, Ghana. World J Gastroenterol. 2019;25(26):3344.
18. Page MJ, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. Int J Surg. 2021;88: 105906.
19. JBI. CRITICAL APPRAISAL TOOLS. 2020; Available from: https://jbi.global/critical-appraisal-tools.
20. Kayamba V, Mubbunu M, Kelly P. Endoscopic diagnosis of gastric and oesophageal cancer in Lusaka, Zambia: a retrospective analysis. BMC Gastroenterol. 2024;24(1):122.
21. El-Ghannam R, et al. Endoscopic and Microbiological Findings of Helicobacter pylori Infection among Dyspeptic Patients in Suez Canal University Hospital. Egyptian Journal of Medical Microbiology. 2019;28(4):103–9.
22. Argaw AM, et al. Indications and Findings of Upper Gastrointestinal Endoscopy at a Tertiary Hospital in Ethiopia: A Cross-Sectional Study. Clin Experimental Gastroenterology, 2023:187–196.
23. Assefa B, et al. Peptic ulcer disease among dyspeptic patients at endoscopy unit, University of Gondar hospital, Northwest Ethiopia. BMC Gastroenterol. 2022;22(1):164.
24. Melak W, et al. Predictive value of alarm features in diagnosing upper gastrointestinal malignancies among dyspeptic patients: A cross-sectional study in Ethiopia. Gastroenterol Hepatol Res. 2023;5(3):13.
25. Kiros YK, et al. Endoscopic and histopathological correlation of gastrointestinal diseases in ayder referral hospital, Mekelle University, Northern Ethiopia. Ethiopian Med J. 2017;55(4).
26. Getahun GM, Abubeker ZA, Upper gastrointestinal endoscopy findings at gondar university hospital, north-western ethiopia: an eight year analysis. Int J Pharmaceut Health Care Res. ;03(2): 60–65.
27. Zena D, et al. Patterns of upper gastrointestinal diseases among patients undergoing esophagogastroduodenoscopy at three hospitals in Asella town, Southeast Ethiopia. Sci Rep. 2024;14(1):24067.
28. Makanga W, Nyaoncha A. Upper gastrointestinal disease in Nairobi and Nakuru counties, Kenya; a two year comparative endoscopy study. Annals Afr Surg. 2014;11(2).
29. Mwangi CN, et al. Prevalence and endoscopic findings of Helicobacter pylori infection among dyspeptic patients in Kenya. Open Journal of Medical Microbiology. 2020;10(04):233.
30. Ayuo P, Some F, Kiplagat J. Upper gastrointestinal endoscopy findings in patients referred with upper gastrointestinal symptoms in Eldoret, Kenya: a retrospective review. East Afr Med J. 2014;91(8):267–73.
31. Lodenyo H, et al. Patterns of upper gastrointestinal diseases based on endoscopy in the period 1998–2001. Afr J Health Sci. 2005;12(1):49–54.
32. Adani AA, et al. Helicobacter pylori status and associated upper gastrointestinal endoscopic diagnosis in a tertiary hospital: A retrospective study. Journal of Clinical Sciences. 2023;20(4):118–22.
33. Bulur O, et al. The only and first analysis of upper gastrointestinal endoscopy results from Mogadishu-Somalia. Turkiye Klinikleri Cardiovascular Sciences. 2018;30(1):1–5.
34. Obayo S, et al. Upper gastrointestinal diseases in patients for endoscopy in South-Western Uganda. Afr Health Sci. 2015;15(3):959–66.
35. Namugerwa J. Peptic ulcer prevalence among patient attending Kampala International University Teaching Hospital in Ishaka Bushenyi Municipality. 2017.
36. Okello TR, et al. An Evaluation of 605 Endoscopic Examination in a Rural Setting, Lacor Hospital in Northern Uganda. J Adv Med Med Res. 2016:15(10):1–7. https://doi.org/10.9734/BJMMR/2016/24412.
37. Doe MJ, et al. Upper gastrointestinal endoscopy findings in Mbale Regional Referral Hospital, Eastern Uganda: a 10-year retrospective analysis. Afr Health Sci. 2021;21(2):919–26.
38. Walker TD, et al. Helicobacter pylori status and associated gastroscopic diagnoses in a tertiary hospital endoscopy population in Rwanda. Trans R Soc Trop Med Hyg. 2014;108(5):305–7.
39. Ayana SM, Swai B, Maro VP, Kibiki GS. Upper gastrointestinal endoscopic findings and prevalence of Helicobacter pylori infection among adult patients with dyspepsia in northern Tanzania. Tanzan J Health Res. 2014;16(1):16–22. https://doi.org/10.4314/thrb.v16i1.3.
40. Qu L-S, Gubi MM. Clinical features of upper gastrointestinal endoscopy in 3146 patients: a 9-year retrospective cohort study in Zanzibar Archipelago. Tanzania African Health Sciences. 2023;23(2):393–401.
41. Khamisi R. Indications and findings of patients undergoing upper gastrointestinal endoscopy at Muhimbili National Hospital, Dar es salaam, Tanzania. 2013, Muhimbili University of Health and Allied Sciences.
42. El Shallaly GEHA, et al. The Change in Upper Gastrointestinal Disease Pattern in Sudan. Dysphagia. 2021;123:6.8.
43. Elhadi A, et al. Pattern of endoscopic findings of upper gastrointestinal tract in Omdurman teaching hospital. Sudan Sudan Journal of Medical Sciences. 2014;9(2):71–4.
44. Adam HY, Doumi E. Upper Gastrointestinal Endoscopy in El Obeid, Western Sudan: Analysis of the First 1150 Cases. Sudan Journal of Medical Sciences. 2008;3(2):91–4.
45. Yahya H. Change in prevalence and pattern of peptic ulcer disease in the Northern Savannah of Nigeria: An endoscopic study. Ann Afr Med. 2023;22(4):420–5.

46. Ray-Offor E, Opusunju KA. Current status of peptic ulcer disease in Port Harcourt metropolis. Nigeria African Health Sciences. 2020;20(3):1446–51.
47. Okoye OG, et al., Research Article Correlation of Clinical, Endoscopic, and Pathological Findings among Suspected Peptic Ulcer Disease Patients in Abuja, Nigeria. 2021.
48. Odeghe EA, et al. Appropriateness and diagnostic yield of open access gastroscopy in two tertiary centers in South-western Nigeria. Afr Health Sci. 2023;23(2):386–92.
49. Ismaila BO, Misauno MA. Gastrointestinal endoscopy in Nigeria--a prospective two year audit. Pan Afr Med J. 2013;14:22. https://doi.org/10.11604/pamj.2013.14.22.1865.
50. Misauno M, et al. SPECTRUM OF ENDOSCOPICALLY DIAGNOSED UPPER GASTROINTESTINAL DISEASES IN JOS. Sahel Medical Journal. 2011;14(2):63–6.
51. Ngim O, et al. A Two Year Review of Upper Gastrointestinal Endoscopy in Calabar. Nigeria IOSR J Med Dent Sci. 2017;16:31–4.
52. Jeje E, Olajide T, Akande B. Upper gastrointestinal endoscopy-our findings, our experience in Lagoon Hospital, Lagos, Nigeria. 2013.
53. Nwokediuko SC, et al. Time trends of upper gastrointestinal diseases in Nigeria. Ann Gastroenterol. 2012;25(1):52.
54. Oluwagbenga OO, et al. Upper gastrointestinal endoscopy in Ido-ekiti, Nigeria: a four-year review. Open Journal of Gastroenterology and Hepatology. 2020;3(2):35–35.
55. Archampong TN, et al. Factors associated with gastro-duodenal disease in patients undergoing upper GI endoscopy at the Korle-Bu Teaching Hospital, Accra. Ghana Afr Health Sci. 2016;16(2):611–9.
56. Darko R, et al. Changing patterns of the prevalence of Helicobacter pylori among patients at a corporate hospital in Ghana. Ghana Med J. 2015;49(3):147–53.
57. Agyei-Nkansah A, Duah A, Alfonso M. Indications and findings of upper gastrointestinal endoscopy in patients presenting to a District Hospital, Ghana. Pan Afr Med J. 2019;34:82. https://doi.org/10.11604/pamj.2019.34.82.18002.
58. Amoako Duah et al. Indications and findings of oesophagogastroduodenoscopy in patients with symptoms of upper gastrointestinal disease in Eastern Regional Hospital, Koforidua, Ghana. PAMJ Clinical Medicine. 2022;10:18. https://doi.org/10.11604/pamj-cm.2022.10.18.23969.
59. Aduful H, et al. Upper gastrointestinal endoscopy at the korle bu teaching hospital, accra, ghana. Ghana Med J. 2007;41(1):12–6.
60. Gyedu A, Yorke J. Upper gastrointestinal endoscopy in the patient population of Kumasi, Ghana: indications and findings. Pan Afr Med J. 2014;18:327. https://doi.org/10.11604/pamj.2014.18.327.4806.
61. Dakubo J, Clegg-Lamptey J, Sowah P. Appropriateness of referrals for upper gastrointestinal endoscopy. West Afr J Med. 2011;30(5):342–7.
62. Tabiri S, Prosper A, Adam A. Upper gastrointestinal endoscopic findings in patients presenting to Tamale Teaching Hospital, Ghana. Unified Journal of Medicine and Medical Sciences. 2015;1(2):006–11.
63. Koura M, et al. Upper gastrointestinal endoscopy at University Hospital Souro Sanou Bobo-Dioulasso (Burkina Faso), about 1022 cases: signs and lesions observed. Open Journal of Gastroenterology. 2017;7(11):287–96.
64. Ziemle Clement M, et al. Acceptability of Oesogastroduodenal Fibroscopy in Private Health Facilities from the City of Bobo-Dioulasso in Burkina Faso. Central Afr J Public Health. 2023.
65. Okon JB, et al. Factors Associated with the Applicability of EPAGE (European Panel on the Appropriateness of Gastrointestinal Endoscopy) and the Suitability of Indications for Eso-Gastroduodenal Endoscopy in a West African Country. Open Journal of Gastroenterology. 2021;11(10):173–83.
66. Moustafa HM, et al. Upper endoscopic findings in patients attending the endoscopy unit of al-azhar assiut university hospital: 2019–2020. Al-Azhar Assiut Medical Journal. 2023;21(2):110–7.
67. Fouad M, et al. Prevalence of eosinophilic esophagitis in adult patients with upper gastrointestinal symptoms in a locality in upper Egypt. Clinical Endoscopy. 2018;51(4):357–61.
68. Hussein Mohammed A, Zaghloul AM, Malak M. Study of upper gastrointestinal endoscopic patterns among patients who underwent Esophagogastroduodenoscopy in Sohag University Hospital. Sohag Med J. 2024;28(3):42–50.
69. Tumi A, et al. Prevalence of Helicobacter pylori infection in patients with dyspepsia in Tripoli central hospital, Tripoli. Libya Libyan J Inf Dis. 2007;1:124–7.
70. Cheddie S, Manneh C, Moodley Y. Alarm features as predictors of major findings in a rural South African upper endoscopic service. S Afr J Surg. 2020;58(4):216a–216e.
71. Mnyombolo Y, Pillay S. Indications, outcomes and complications of endoscopies performed at a regional hospital in Kwazulu-Natal. South Africa South African Gastroenterology Review. 2022;20(1):32–40.
72. Ntola V, et al. An audit of upper gastrointestinal endoscopy performed on patients at Prince Mshiyeni Memorial Hospital in Durban. KwaZulu-Natal South African Journal of Surgery. 2019;57(3):55–8.
73. Fernando N, et al. Helicobacter pylori infection in an urban African population. J Clin Microbiol. 2001;39(4):1323–7.
74. Kelly P, et al. Gastrointestinal pathology in the University Teaching Hospital, Lusaka, Zambia: review of endoscopic and pathology records. Trans R Soc Trop Med Hyg. 2008;102(2):194–9.
75. Wolf LL, et al. Esophagogastroduodenoscopy in a public referral hospital in Lilongwe, Malawi: spectrum of disease and associated risk factors. World J Surg. 2012;36(5):1074–82.
76. Mothes H, et al. Do patients in rural Malawi benefit from upper gastrointestinal endoscopy? Trop Doct. 2009;39(2):73–6.
77. Adonis NM, et al. Profile of endoscopic lesions and prevalence of h. pylori infection at the digestive endoscopy unit of panzi general reference hospital in Bukavu. Open J Gastroenterol. 2021;11(11):230–243.
78. Li Z, et al. Epidemiology of peptic ulcer disease: endoscopic results of the systematic investigation of gastrointestinal disease in China. Off J Amer College Gastroenterol. 2010;105(12):2570–7 ACG.
79. Salari N, et al. The global prevalence of peptic ulcer in the world: A systematic review and meta-analysis. Indian Journal of Surgery. 2022;84(5):913–21.
80. Smith S, Fowora M, Pellicano R. Infections with Helicobacter pylori and challenges encountered in Africa. World J Gastroenterol. 2019;25(25):3183–95.
81. Henriksen T-H. Peptic ulcer disease is strongly associated with Helicobacter pylori in east, west, central and South Africa. Scand J Gastroenterol. 2001;36(6):561–4.
82. Zhang Z, et al. Peptic ulcer disease burden, trends, and inequalities in 204 countries and territories, 1990–2019: a population-based study. Therap Adv Gastroenterol. 2023;16:17562848231210376.
83. Van Zanten SV, Sherman P. Helicobacter pylori infection as a cause of gastritis, duodenal ulcer, gastric cancer and nonulcer dyspepsia: a systematic overview. Canadian Med Assoc J. 1994;150(2):177.
84. Nguyen TL, et al. Helicobacter pylori infection and gastroduodenal diseases in Vietnam: a cross-sectional, hospital-based study. BMC Gastroenterol. 2010;10:1–7.
85. Schulz C, Kupčinskas J. Review-Helicobacter pylori and non-malignant upper gastro-intestinal diseases. Helicobacter. 2020;25: e12738.
86. Narayanan M, Reddy KM, Marsicano E. Peptic Ulcer Disease and Helicobacter pylori infection. Mo Med. 2018;115(3):219–24.
87. Huang JQ, Sridhar S, Hunt RH. Role of Helicobacter pylori infection and non-steroidal anti-inflammatory drugs in peptic-ulcer disease: a meta-analysis. Lancet. 2002;359(9300):14–22.
88. Peek RM Jr, Crabtree JE. Helicobacter infection and gastric neoplasia. J Pathol: J Patholog Soc Great Brit Ireland. 2006;208(2):233–48.
89. Hooi JK, et al. Global prevalence of Helicobacter pylori infection: systematic review and meta-analysis. Gastroenterology. 2017;153(2):420–9.
90. Tanih N, et al. An African perspective on Helicobacter pylori: prevalence of human infection, drug resistance, and alternative approaches to treatment. Ann Trop Med Parasitol. 2009;103(3):189–204.
91. Mungazi SG, Chihaka OB, Muguti GI. Prevalence ofHelicobacter pyloriin asymptomatic patients at surgical outpatient department: Harare hospitals. Annals of medicine and surgery. 2018;35:153–7.
92. Bounder G, et al. Epidemiology of Helicobacter pylori infection and related gastric pathologies in Moroccan population. J Life Sci. 2017;11:211–8.
93. Smith SI, et al. Helicobacter pylori Diagnosis and Treatment in Africa: The First Lagos Consensus Statement of the African Helicobacter and Microbiota Study Group. Dig Dis. 2024;42(3):240–56.
94. Dong SXM, Chang CCY, Rowe KJ. A collection of the etiological theories, characteristics, and observations/phenomena of peptic ulcers in existing data. Data Brief. 2018;19:1058–67.

95. Zamani M, et al. Systematic review with meta-analysis: the worldwide prevalence of Helicobacter pylori infection. Aliment Pharmacol Ther. 2018;47(7):868–76.
96. Smith S, et al. Clinical and socio-demographic risk factors for acquisition of Helicobacter pylori infection in Nigeria. Asian Pacific Journal of Cancer Prevention: APJCP. 2018;19(7):1851.
97. Bauer B, Meyer TF. The human gastric pathogen Helicobacter pylori and its association with gastric cancer and ulcer disease. Ulcers. 2011;2011(1): 340157.
98. Early DS, et al. Appropriate use of GI endoscopy. Gastrointest Endosc. 2012;75(6):1127–31.

Publisher's Note