

ORIGINAL ARTICLE

Evidence-based examination of the African enigma in relation to *Helicobacter pylori* infection

AAMER AGHA & DAVID Y. GRAHAM

Department of Medicine, VA Medical Center and Baylor College of Medicine, Houston, Texas, USA

Abstract

Objective. The African enigma describes the dissociation between the prevalence of *Helicobacter pylori* infection and *H. pylori*-related diseases. The aim of this study was to use an evidence-based review of endoscopic data from African countries to test whether there are data to support the concept of an African enigma. **Material and methods.** A Medline search was carried out to identify prospective endoscopic studies in African populations. Data collected included: the number of endoscopies, age range (or mean age if available), indications for endoscopy, country, years during which data were collected, male to female ratio, and specific outcome of duodenal ulcer, gastric ulcer, or gastric cancer. **Results.** Forty prospective endoscopic studies from 17 African countries were identified (20,531 patients) and evaluated between 1972 and 2001. Mean ages ranged from 31 to 53.1 years and male to female ratios from 0.67:1 to 4.64:1. *H. pylori*-related clinical outcomes were common; duodenal ulcers in 4326 patients (21.1%), gastric ulcers in 691 patients (3.4%), and gastric cancers in 503 patients (2.4%). **Conclusions.** Prospective upper endoscopic trials suggest that the clinical outcomes associated with *H. pylori* infection in Africa are similar to those seen in industrialized countries. No dissociation between the prevalence of *H. pylori* infection and *H. pylori*-related diseases existed; the African enigma as such does not exist and the continued study of the mechanism of a non-existent phenomenon is a misuse of resources. The myth resulted from reliance on anecdotal data and selection bias in populations with extremely limited access to health care and a relatively short life expectancy.

Key Words: Africa, endoscopy, gastric cancer, *Helicobacter pylori*, peptic ulcer

Introduction

Scientists, writers, and people in general are fascinated by enigmas. One such enigma is the so-called African enigma in relation to *Helicobacter pylori* infection [1] which focused on the fact that while *H. pylori* infection was almost universal among African populations, clinical outcome such as peptic ulcer or cancer were considered to be rare. The concept of an “African enigma” in relation to *H. pylori* was actually an extension of earlier enigmas noting that peptic ulcer disease, surgery for peptic ulcer, as well as necropsy data related to the prevalence of peptic ulcer or gastric cancer, all of which suggested that the prevalence of these diseases was significantly lower in Africa than in other areas of the world. The concept was challenged based on the potentially serious problems with the data upon

which the concept was based. For example, in Africa there were major difficulties in clinical assessment, limited radiological facilities, and infrequent medical attention, all of which could reduce the likelihood of a practicing physician finding an ulcer [2]. Nevertheless, the concept of an enigma flourished as additional largely anecdotal studies were published. One of the most frequently referenced studies regarding the enigma is that of Tovey & Tunstall who, in 1975, published a “progress report” on duodenal ulcer in black populations in Africa south of the Sahara [3]. They recognized and describe the difficulties with data collection and interpretation and confirmed that the available data were consistent with there being areas of high prevalence (West coast, Nile–Congo watershed, and Northern Tanzania and Ethiopia), and of low prevalence such as eastern Nigeria. They did not suggest the presence of

an enigma although this paper is one of the most commonly cited among the enigma enthusiasts in the *H. pylori* era.

When it was discovered that *H. pylori* infection was the underlying cause of peptic ulcer and gastric cancer, this led to a global evaluation of *H. pylori* and resulted in the enigma being revisited [1,4,5]. As in other parts of the developing world, the prevalence of *H. pylori* infection in Africa is high. A recent cohort analysis examined the association of *H. pylori* infection with the presence of peptic ulcer disease in the African continent and showed that the expected high correlation was present consistent with the notion that peptic ulcer is a reasonable surrogate for the presence of *H. pylori* infection [6]. These investigators did not examine whether peptic ulcer was actually common in Africa. The presence of a high rate of *H. pylori* infection in Africa and a paucity of *H. pylori*-related upper gastrointestinal pathology, if true, would be of great interest in relation to the pathogenesis of *H. pylori*-related disease and would lead to a careful examination of host, environmental, and *H. pylori* virulence. The paper examined the hypothesis that there is indeed such an African enigma in relation to clinical outcomes of *H. pylori* infection by focusing on data obtained in prospective endoscopic studies done in Africa.

Material and methods

We performed a Medline search using the terms "Africa" plus "endoscopy" or a combination of an African country plus "endoscopy" to generate an initial reference list. These papers were then scrutinized for additional references. Each paper was evaluated to the presence of prospective studies using upper gastrointestinal endoscopy. Exclusion criteria included studies whose purpose was to identify only specific types of upper gastrointestinal pathology for further study (e.g. non-ulcer dyspepsia, duodenal ulcers, etc.). The data collected included the number of endoscopies performed, age range (mean age if available), the indications for performing the study, country, years over which the data were collected, male to female ratio, and the specific pathology found (i.e. duodenal ulcer, gastric ulcer, or gastric cancer).

Results

A total of 40 prospective endoscopic studies from 17 countries were identified (Table I) [7–46]. These studies reported data on 20,531 patients who underwent upper endoscopy during the time period 1972 to 2001. The most common indications for endo-

scopy were the presence of dyspepsia or signs and symptoms consistent with upper gastrointestinal bleeding. Mean ages for the study groups ranged from 31 to 53.1 years. There were generally more men than women evaluated in most of the studies.

H. pylori-related diseases were common (Table II). Duodenal ulcers were identified in 4326 patients (21.1%), gastric ulcers in 691 patients (3.4%), and gastric cancers in 503 patients (2.4%).

Discussion

For many years the rarity of peptic ulcer surgery in Africa combined with necropsy data showing a low prevalence of ulcers and gastric cancer led to the belief that the prevalence of peptic ulcer disease in Africa was significantly lower than that in other areas of the world. It was also recognized that there were potentially serious problems with the data upon which the concept was based. Because of problems with hospital overcrowding in some areas, complaints about epigastric pain were often treated empirically without conducting a full investigation, leading to missed diagnoses [47].

In an early study, autopsy data were used to demonstrate the rarity of peptic ulcer disease in the Bantu African as compared to Europeans. However, even the researchers recognized the limitations of their findings, because the Bantu had less opportunity to receive medical attention and had "lack of confidence in European medical methods" [48]. The general distrust of Westernized medical practice is further echoed by a study of the prevalence of dyspepsia in rural northeastern Nigeria where over half the patients identified with dyspepsia went to traditional healers for treatment instead of allopathic physicians [49].

The relatively low life expectancy of the African was also recognized as a possible built-in selection bias that could explain the low incidence in the African population [47]. Eagle & Gillman mention that all but one of the Bantu patients with peptic ulcer disease were between 10 and 40 years of age, whereas all European patients in the study with documented peptic ulcer disease were over 40 years of age [48]. Nevertheless, continued studies based on poor techniques and skewed data were published and referenced, and continued to propagate the notion of decreased prevalence of ulcer disease in Africans throughout the contemporary literature.

In later studies a higher incidence of disease was recognized among Africans as the continent was becoming more urbanized [50–53]. This increase in incidence was attributed more to alterations in diet and added stressors of urban life than the possibility that a steadily increasing life expectancy in the

Table I. Summary of papers reviewed in these analyses.

Country	City	Date of study period (month/year)	Indication for endoscopy	Age range (years)	Mean Age (years)	N	Duodenal ulcer*	Gastric ulcer*	DU:GU	Gastric cancer*	Males	Females	M:F ratio
Cameroon [7]		2/86–9/88	Dyspepsia	12–81		1075	353 (32.8)	16 (1.5)	22.1	37 (3.4)	664	411	1.62
Cameroon [8]		3/87–5/89	Melena and/or hematemesis		39.64	172	58 (33.7)	23 (13.3)	2.5	6 (3.5)	124	48	2.58
Cameroon [9]	Banso	Before 1994	Epigastric pain	16–79	41	93	26 (28.0)	5 (5.4)	5.2	1 (1.1)	46	47	0.98
Cote d'Ivoire [10]	Abidjan	1988–1989	Abdominal pain, dyspepsia		36.8	277	26 (9.4)	23 (8.3)	1.1	6 (2.2)	159	118	1.35
Ethiopia [11]	Addis Ababa	3/89–4/90	Dyspepsia		35	444	64 (14.4)	18 (4.1)	3.6	3 (0.7)	309	135	2.29
Ethiopia [12]	Addis Ababa	9/75–1/79	Dyspepsia, upper GI bleeding, dysphagia, weight loss		32	1084	130 (12.0)	5 (0.5)	26.0	36 (3.3)	756	328	2.3
Ethiopia [13]		Before 1992	Dyspepsia			200	87 (43.5)	0 (0)		Not counted			
Ethiopia [14]	Yirga Alem	5/93–8/93	Upper GI symptoms		53.1	400	Not counted	Not counted	N/A	12 (3.0)			3
Ghana [15]	Kumasi	Before 1987	Not mentioned	12–71	41	39	23 (59.0)	Not counted		Not counted	28	11	2.55
Kenya [16]	Eldoret	4/93–4/93	Dyspepsia		42.3	45	9 (20.0)	4 (8.9)	2.3	Not counted			1.5
Kenya [17]	Nairobi	6/84–9/85	Dyspepsia, dysphagia, upper GI bleeding symptoms			1040	361 (34.7)	48 (4.6)	7.5	18 (1.7)			
Kenya [18]	Nairobi	12/88–3/89	Dyspepsia	14–78		66	14 (21.2)	6 (9.1)	2.3	Not counted			
Kenya [19]	Nairobi	6/93–9/94	Dyspepsia	12–70		120	35 (29.2)	11 (9.2)	3.2	8 (6.7)			1.55
Kenya [20]	Nairobi	11/94–11/95	Hb SS disease and dyspepsia	12–37		92	14 (15.2)	3 (3.3)	4.7	Not counted	37	55	0.67
Kenya [21]	Nairobi	6/98–1/99	Chronic renal failure and dyspepsia	18–70	38.7	154	30 (19.5)	8 (5.2)	3.8	2 (1.3)	90	64	1.41
Kenya [22]	Nairobi	6/00–3/01	Diabetes, dyspepsia			71	5 (7.0)	1 (1.4)	5.0	1 (1.4)			
Liberia [23]	Harbel	1/79–12/79	Recurrent epigastric pain	10–50		79	4 (5.1)	3 (3.8)	1.3	Not counted	65	14	4.64
Malawi [24]	Lilongwe	6/86–4/88	Upper GI bleeding		40	100	16 (16.0)	7 (7.0)	2.3	5 (5.0)			3.35
Malawi [25]		6/90–7/90	Dyspepsia		37	160	41 (25.6)	1 (0.6)	41.0	5 (3.1)			1.39
Nigeria [26]	Jos	10/91–9/92	Dyspepsia, UGIB, suspected GI cancer		37.7	243	42 (17.3)	12 (4.9)	3.5	3 (1.2)	121	122	1
Nigeria [27]	Jos	1/89–12/90	Dyspepsia, recurrent vomiting, dysphagia, hematemesis, melena	20–60		326	40 (12.3)	13 (4.0)	3.1	2 (0.6)	166	160	1.04
Nigeria [28]	Ibadan	1/82–12/86	Dyspepsia	14–75		374	39 (10.3)	14 (3.7)	2.8	Not counted			1.04
Nigeria [29]		2/88–2/89	Epigastric pain		34	57	6 (10.5)	1 (1.8)	6.0	1 (1.8)	39	18	2.17
Nigeria [30]	Zaria	6/78–8/82	Dyspepsia, UGIB, portal HTN		32	431	115 (26.6)	9 (2.1)	12.8	9 (2.1)			3
Nigeria [31]	Maiduguri	Before 1994	Dyspepsia		31	213	22 (10.3)	3 (1.4)	7.3	5 (2.3)	111	102	1.09
Rhodesia (Zimbabwe) [32]	Salisbury	6/72–7/74	Upper GI bleeding		38	138	36 (26.1)	24 (17.4)	1.5	7 (5.1)			3
Rwanda [33]	Kigali	5/86–6/86	Dyspepsia		34.6	173	49 (28.3)	2 (1.2)	24.5	7 (4.0)	79	94	0.84
Senegal [34]	Dakar	8/81–11/83	Epigastric pain	15–80		3000	499 (16.6)	87 (2.9)	5.7	43 (1.4)	2097	903	2.32
South Africa [35]	Ciskei and Transkei	Before 2000	Dyspepsia	14–90	51.5	97	9 (9.3)	7 (7.2)	1.3	1 (1.0)	46	51	0.9
South Africa [36]	Durban	1979	Not mentioned			218	59 (27.1)	Not counted		Not counted	121	97	1.25
South Africa [37]		6/87–10/88	Non-specific foregut symptoms		43.68	272	85 (31.3)	42 (15.4)	2.0	12 (4.4)	272	0	
South Africa [38]	Natal	Before 1988	Dyspepsia			224	67 (29.9)	21 (9.4)	3.2	Not counted			
South Africa [39]	Cape Town	Before 1987	Not mentioned			51	6 (11.8)	24 (47.1)	0.3	Not counted			
Sudan [40]	Khartoum	1/80–6/82	Not mentioned	10–80		2500	429 (17.2)	17 (0.7)	25.2	29 (1.2)			1.67

Table I (Continued)

Country	City	Date of study period (month/year)	Indication for endoscopy	Age range (years)	Mean Age (years)	N	Duodenal ulcer*	Gastric ulcer*	DU:GU	Gastric cancer*	Males	Females	M:F ratio
Sudan [41]	Khartoum	Before 1994	Dyspepsia	18–70	41	100	32 (32)	3 (3)	10.6	1 (1)	62	38	1.63
Tanzania [42]	Moshi	1985–1989	Dyspepsia, dysphagia, hematemesis, melena	8–94		3940	880 (22.3)	209 (5.3)	4.2	202 (5.1)			1.22
Uganda [43]	Kampala	1990–1993	Dyspepsia, GIB, dysphagia	13–85	42	330	51 (15.5)	10 (3.0)	5.1	18 (5.5)	192	138	1.39
Zaire [44]	Katana	12/88–6/89	Upper GI symptoms		39	324	38 (11.7)	5 (1.5)	7.6	23 (7.1)	180	144	1.25
Zimbabwe [45]	Harare	before 1995	Epigastric pain, bleeding, dyspepsia	11–74		95	10 (10.5)	6 (6.3)	1.7	Not counted	54	41	1.32
Zimbabwe [46]		before 1992	Upper GI symptoms		41	1714	516 (30.1)	Not counted		Not counted	1046	668	1.57
Totals						20531	4326 (21.1)	691 (3.4)	6.3	503 (2.4)			1.75

Abbreviations: DU:GU = duodenal to gastric ulcer ratio; GI = gastrointestinal; Hb SS = sickle cell hemoglobin; UGIB = upper gastrointestinal bleeding; HTN = hypertension; N/A = not applicable.

*Raw data are listed with percentages given in parentheses.

Table II. Range of study parameters among all studies examined.

Criteria	Range
Mean age (when listed)	31–53.1
Duodenal ulcer percentage	5.1–59.0
Gastric ulcer percentage	0.0–47.1
Gastric cancer percentage	0.6–7.1
Duodenal to gastric ulcer ratio (calculated)	0.3–41.0
Male to female ratio	0.67–4.64

continent allowed more people to survive long enough to acquire peptic ulcer disease. The urbanization theory was complicated by a study which showed the prevalence of dyspepsia in rural Africa to be similar to that of both rural and urban centers in Britain [54].

The advent of flexible endoscopy to evaluate upper gastrointestinal pathology has increased the sensitivity and specificity of diagnosing peptic ulcer disease and is currently the gold standard for diagnosis. Our review of the prospectively collected endoscopic data shows that among patients undergoing endoscopy for dyspepsia or upper gastrointestinal bleeding, duodenal ulcer was common. Gastric ulcers were also found and gastric cancer was not rare. The different clinical outcomes of *H. pylori* infections can be predicted largely from the pattern of gastritis present in the patient or in the population. Duodenal ulcer is associated with antral predominant gastritis and is typically a disease of younger individuals. In contrast, gastric ulcer and gastric cancer are typically associated with pangastritis and are diseases of older individuals, with gastric cancer being typically a disease of old age. The pattern of duodenal ulcer being most common and gastric ulcer and gastric cancer being less frequent is consistent with other populations where the rate of acquisition of atrophic gastritis and gastric atrophy is low and is consistent with a diet rich in fresh fruits and vegetables. Gastric cancer would be expected to be infrequent partly because of the relatively short average life expectancy in Africa.

The actual frequencies of the different diseases reported among the different studies varied widely, possibly reflecting variations in indications for endoscopy, the effect of the differences in the mean ages between the study groups, and the presence of local factors that favored one outcome over another (e.g. diet). Nonetheless, it is clear that a high prevalence of upper gastrointestinal pathology exists throughout the African continent, including South Africa, Malawi, Tanzania, and Kenya, which historically were included among the countries with a lower incidence of peptic ulcer disease [3]. In fact the overall prevalence of peptic ulcer diseases was 24.5%, which falls well within the prevalence of 12 to 25% among

symptomatic individuals in developed countries who undergo upper endoscopies. Moreover, the prevalence of gastric cancer identified was higher than the “less than 2%” among symptomatic individuals commonly quoted for endoscopy of individuals from developed countries.

We conclude that the concept of an African enigma in relation to *H. pylori* or to the *H. pylori*-related diseases of peptic ulcer and gastric cancer reflected inadequate data obtained from populations with extremely limited access to health care and with a relatively short life expectancy. As conditions and technology have improved, it has become apparent that the prevalence rate of peptic ulcer disease among those with *H. pylori* infection is similar to that of many developed countries.

Acknowledgements

This material is based upon work supported in part by the Office of Research and Development Medical Research Service Department of Veterans' Affairs and by Public Health Service grant DK56338 which funds the Texas Gulf Coast Digestive Diseases Center. We thank an anonymous reviewer who brought 10 studies to our attention that were not uncovered in our data search.

References

- [1] Holcombe C. *Helicobacter pylori*: the African enigma. Gut 1992;33:429–31.
- [2] Watkinson G. Geographic aspects of peptic ulcer. In: Card WI, editor. Modern trends in Gastroenterology, 3rd ed. Washington: Butterworths; 1961. pp 23–48.
- [3] Tovey FI, Tunstall M. Duodenal ulcer in black populations in Africa south of the Sahara. Gut 1975;16:564–76.
- [4] Holcombe C, Omotara BA, Eldridge J, Jones DM. *H. pylori*, the most common bacterial infection in Africa: a random serological study. Am J Gastroenterol 1992;87:28–30.
- [5] Kidd M, Louw JA, Marks IN. *Helicobacter pylori* in Africa: observations on an “enigma within an enigma”. J Gastroenterol Hepatol 1999;14:851–8.
- [6] Henriksen TH. Peptic ulcer disease is strongly associated with *Helicobacter pylori* in East, West, Central and South Africa. Scand J Gastroenterol 2001;36:561–4.
- [7] Dent AW. Gastroscopy in a West African rural mission hospital. Trop Doct 1990;20:118–21.
- [8] Ndjitoyap Ndam EC, Koki Ndombo PO, Fouda OA, Mougnotou RS, Nguemne TA, Behle A, et al. Upper digestive system hemorrhages in Cameroon (apropos of 172 cases examined via endoscopy). Med Trop (Mars) 1990; 50:181–4.
- [9] Palmer DD, Watson KR, Allen MJ. *Helicobacter pylori* infection and peptic ulcer disease in Cameroon, West Africa. J Clin Gastroenterol 1994;18:162–4.
- [10] Diomande MI, Flejou JF, Potet F, Dago-Akribi A, Ouattara D, Kadjo K, et al. Chronic gastritis and *Helicobacter pylori* infection on the Ivory Coast. A series of 277 symptomatic patients. Gastroenterol Clin Biol 1991;15:711–6.

- [11] Tedla Z. *Helicobacter pylori* infection in patients with upper gastrointestinal symptoms in Arba Minch Hospital: south-western Ethiopia [published erratum appears in Ethiop Med J 1992 Apr; 30:128]. Ethiop Med J 1992;30:43–9.
- [12] Tsega E. Analysis of fiberoptic gastroduodenoscopy in 1084 Ethiopians. Trop Geogr Med 1981;33:149–54.
- [13] Tsega E, Gebre W, Hathaway A, Kassa E. *Helicobacter pylori* infection in Ethiopian patients with dyspepsia. Ethiop Med J 1992;30:241–1.
- [14] Madebo T, Lindtjorn B, Henriksen TH. High incidence of oesophagus and stomach cancers in the Bale highlands of south Ethiopia. Trans R Soc Trop Med Hyg 1994;88:415.
- [15] Wyatt J, de Caestecker J, Rathbone B, Heatley R. *Campylobacter pyloridis* in tropical Africa. Br Med J 1987;295:1174.
- [16] Ayuo PO, Nugent CE. Dyspepsia: preliminary experience with upper gastrointestinal fiberoptic endoscopy in Eldoret. East Afr Med J 1994;71:261–3.
- [17] Lule GN, Wankya BM, Shah MV, Greenfield C. Peptic ulcer disease at Kenyatta National Hospital: an endoscopic experience. East Afr Med J 1987;64:638–42.
- [18] Lule GN, Sang F, Ogutu EO. *Helicobacter pylori* in peptic ulcer disease in Kenya. East Afr Med J 1991;68:324–7.
- [19] Ogutu EO, Kang'ethe SK, Nyabola L, Nyong'o A. Endoscopic findings and prevalence of *Helicobacter pylori* in Kenyan patients with dyspepsia. East Afr Med J 1998;75:85–9.
- [20] Maende JA, Ogutu EO, Nyong'o A, Aluoch JR. Upper gastrointestinal mucosal lesions in dyspeptic patients with homozygous sickle cell disease in Kenya. East Afr Med J 1998;75:148–50.
- [21] Karari EM, Lule GN, McLigeo SO, Amayo EO. Endoscopic findings and the prevalence of *Helicobacter pylori* in chronic renal failure patients with dyspepsia. East Afr Med J 2000;77:406–9.
- [22] Wafula JM, Lule GN, Otieno CF, Nyong'o A, Sayed SM. Upper gastrointestinal findings in diabetic outpatients at Kenyatta National Hospital, Nairobi. East Afr Med J 2002;79:232–6.
- [23] Stahel E, Gyr K, Jallah E, Heitz P. Gastroduodenitis and peptic ulcer in a rural Liberian community. An endoscopic prospective study. Trop Geogr Med 1981;33:155–60.
- [24] Harries AD, Wirima JJ. Upper gastrointestinal bleeding in Malawian adults and value of splenomegaly in predicting source of haemorrhage. East Afr Med J 1989;66:97–9.
- [25] Harries AD, Stewart M, Deegan KM, Mughogho GK, Wirima JJ, Hommel M, et al. *Helicobacter pylori* in Malawi, central Africa. J Infect Dis 1992;24:269–76.
- [26] Malu AO, Okeke EN, Daniyam C. Gastroduodenal diseases on the Jos plateau, Nigeria. Trans R Soc Trop Med Hyg 1994;88:413–4.
- [27] Andrew PJ, Dixon RA, Iya D, Park GT. Upper gastrointestinal endoscopy in an urban hospital in northern Nigeria: association of presenting features with endoscopic findings. Trop Doct 1995;25:9–11.
- [28] Olubuyide IO, Atoba MA, Ayoola EA. Dyspepsia in Ibadan. Trop Geogr Med 1989;41:337–40.
- [29] Holcombe C, Lucas SB, Umar H, Abba A. *Helicobacter* (= *Campylobacter*) *pylori* in Africa. Trans R Soc Trop Med Hyg 1990;84:294–6.
- [30] Malu AO, Wali SS, Kazmi R, Macauley D, Fakunle YM. Upper gastrointestinal endoscopy in Zaria, northern Nigeria. West Afr J Med 1990;9:279–84.
- [31] Holcombe C, Umar H, Lucas SB, Kaluba J. Low incidence of clinically significant gastroduodenal pathology despite a high incidence of *Helicobacter pylori* infection. Trans R Soc Trop Med Hyg 1994;88:569–71.
- [32] Wicks AC, Thomas GE, Clain DJ. Comparison of fiberoptic endoscopy in acute upper gastrointestinal haemorrhage in Africans and Europeans. Br Med J 1975;4:259–60.
- [33] Rouvroy D, Bogaerts J, Nsengiumwa O, Omar M, Versailles L, Haot J. *Campylobacter pylori*, gastritis, and peptic ulcer disease in central Africa. Br Med J 1987;295:1174.
- [34] Aubry P, Oddes B. Esophagogastroduodenal endoscopy in diagnosis in tropical areas. Apropos of 3000 studies performed in adults. Med Trop 1984;44:231–9.
- [35] O'Keefe SJ, Salvador B, Nainkin J, Majiki S, Stevens H, Atherstone A. Empiric treatment based on *Helicobacter pylori* serology cannot substitute for early endoscopy in the management of dyspeptic rural black Africans. S Afr Med J 2000;90:1129–35.
- [36] Moshal MG, Schlemmer L, Mason J, Naidoo NK. A study of occupational status, responsibility and authority in patients with duodenal ulcers, other gastrointestinal diseases and controls. Scand J Gastroenterol 1979;Suppl 54:31–40.
- [37] Louwrens HD, Jaskiewicz K, van Wyk MJ, Kotze TJ, Brits TA. Endoscopic investigation for gastric cancer in a high-risk group. S Afr Med J 1992;81:406–8.
- [38] Miller NM, Naran A, Simjee AE, Spitaels JM, Pettengell KE, van den Ende J, et al. Incidence of *Campylobacter pylori* in patients with upper gastrointestinal symptoms. S Afr Med J 1988;74:563–6.
- [39] Wright JP, Lastovica AJ, Emms M, Penfold SS. *Campylobacter pyloridis* and the gastric mucosa. S Afr Med J 1987;72:78–9.
- [40] Fedail SS, Araba BM, Homeida MM, Ghandour ZM. Upper gastrointestinal fiberoptic endoscopy experience in the Sudan. Analysis of 2500 endoscopies. Lancet 1983;2:897–9.
- [41] Azim Mirghani YA, Ahmed S, Ahmed M, Ismail MO, Fedail SS, Kamel M, et al. Detection of *Helicobacter pylori* in endoscopic biopsies in Sudan. Trop Doct 1994;24:161–3.
- [42] Missalek W, Jones F, Mmuni K, Cutinha P. Value of fiberoptic oesophago-gastro-duodenoscopy: experience with 4000 procedures at Kilimanjaro Christian Medical Centre, Moshi, Tanzania. Trop Doct 1991;21:165–8.
- [43] Kagimu M, Winkler C, Ddumba E. Who should be screened to reduce the endoscopy workload in Mulago Hospital? East Afr Med J 1996;73:832–4.
- [44] Glupczunski Y, Bourdeaux L, De Prez C, De Vos D, Devreker T, Balegamire B, Goossens H, et al. Prevalence of *Helicobacter pylori* in rural Kivu, eastern Zaire: a prospective endoscopic study. Eur J Gastroenterol Hepatol 1991;3:449–55.
- [45] Gangaidzo I, Mason PR, Kiire CF, Bak-Jensen E, Willen R, Lelwala-Guruge J, et al. *Helicobacter pylori* in endoscopy patients in Zimbabwe: value of enzyme-linked immunosorbent assay and a rapid urease test. Trans R Soc Trop Med Hyg 1995;89:502–5.
- [46] Gangaidzo I, Kiire C, Mason P, Sitima J, Gwanzura L. Prospective endoscopic study of duodenal ulcer in Zimbabwean Blacks. Cent Afr J Med 1992;38:397–402.
- [47] McKenzie MB. Peptic ulceration in the African of Durban. S Afr Med J 1957;31:1041–5.
- [48] Eagle PC, Gillman J. The incidence of peptic ulcer in the South African Bantu. S Afr J Med Sci 1938;3:1–6.
- [49] Holcombe C, Omotara BA, Padonu MK, Bassi AP. The prevalence of symptoms of dyspepsia in north eastern Nigeria. A random community-based survey. Trop Geogr Med 1991;43:209–14.
- [50] Khan AA. Duodenal ulcer amongst Africans in Nairobi. East Afr Med J 1958;35:679–84.

- [51] Charlewood GP, Frylinck R. Some discrepancies in disease incidence between the European and South African Negro. *S Afr J Med Sci* 1951;25:551-6.
- [52] Wapnick S, Gelfand M. Peptic ulcer in the Rhodesian African. *S Afr Med J* 1973;47:625-8.
- [53] Whittaker LR. On peptic ulceration in Kenya Africans. *East Afr Med J* 1961;38:449-51.
- [54] Gatumbi I, Roy AD. The prevalence of peptic ulcer dyspepsia in a rural community in Kenya. *East Afr Med J* 1970;47:627-33.