

Progress report

Duodenal ulcer in black populations in Africa south of the Sahara

The Geographical Distribution of Duodenal Ulcer

The geographical distribution of a disease may provide valuable clues with regard to its aetiology. Likewise any historical changes in prevalence, associated with changes in the mode of living, may give additional information. In this report the prevalence of duodenal ulcer in Africa, south of the Sahara, is reviewed and areas of high and low prevalence are identified.

The information has been collected in several ways: by reviewing all the available literature; by extensive correspondence, personal interviews, and visits; and by replies to questionnaires sent out by Mr D. P. Burkitt of the Medical Research Council to a large number of mission hospitals, many of which have sent monthly returns over a period of three years.

There are many difficult problems to overcome in trying to establish the prevalence of a disease with a low mortality such as duodenal ulcer. These problems are considerable in a developed country and much greater in developing countries. The authors have endeavoured only to establish whether duodenal ulcer is a common or a rare problem in a given area. It has not been possible for the most part to use any exact parameters. In making an assessment it was noted whether the diagnosis had been made on clinical findings, *x*-ray evidence, surgical experience, or necropsy examinations. Many hospitals are without *x*-ray facilities. Surgical statistics can be selective and misleading, depending often on the facilities available and the reputation of the hospital, but nonetheless can be a valuable guide. One of the most useful indicators has been the incidence of complications—pyloric stenosis, haemorrhage and perforation, none of which can be easily overlooked. Great value has been attached to reports from mission hospitals where there has been long-continued service by individual doctors and where records have been well kept. Wherever possible the number of proven duodenal ulcer cases has been related to the number of annual admissions (excluding maternity). Figure 1 presents the overall results of the survey. Areas in which duodenal ulcer is common, occurs occasionally, or is uncommon, are indicated. Both urban and rural areas are shown, but these will be commented on separately. Figure 2 is based on the available information relating the number of proven cases to hospital admissions. Three groups are portrayed as (1) less than one case per 1000 admissions; (2) one to 10 cases per 1000 admission; (3) over 10 cases per 1000 admissions.

High- and Low-prevalence Areas

The existence of high and low prevalence areas is confirmed. High-prevalence areas occur along the west coast, in the Nile-Congo watershed, in northern Tanzania and in Ethiopia.

Along the west coast the highest prevalence is in the eastern area in the

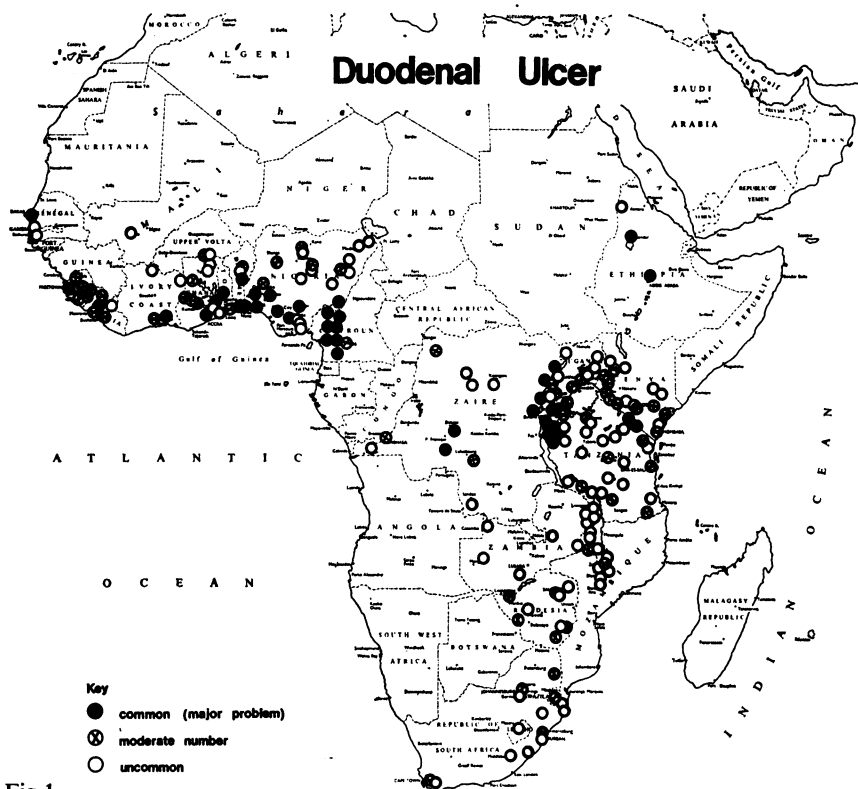


Fig 1

Cameroons, Nigeria, and on into Ghana.¹⁻⁴¹ There is some evidence that it is higher in the rain jungle than in the coastal zone. The prevalence is much lower to the north in the savannah regions. There are peculiar pockets of low incidence in the coastal zone, eg, in eastern Nigeria, around Itukmbang, and in Ghana, around Adidome, which are hard to explain. The latter area, however, is dry and described as 'coastal savannah'.

The highest prevalence of all seems to be in the Nile-Congo watershed,⁴²⁻⁶³ where duodenal ulcer surgery forms the major part of all abdominal surgery. The area includes Rwanda and Burundi, eastern Zaire around Lake Kivu, extreme western Tanzania adjacent to Burundi, and south-western Uganda. Thus at Matana in Burundi, a 58-bedded, one-doctor hospital, 780 operations for peptic ulcer were done in 10 years (79% of all major surgery), and at Buye, a 76-bedded hospital, 404 operations for peptic ulcer were done in a period of two years eight months.^{60,61,63}

Duodenal ulcer also occurs frequently in the Wachaggas around Kilimanjaro in northern Tanzania.⁶⁴ In Ethiopia the incidence is high in the highlands extending from Addis Ababa up to Gondar and Asmara.⁶⁵⁻⁶⁹ It is rare in the lower country to the south where maize, millet and wheat are grown.

The reports from the low-prevalence areas have been consistent in pattern except for a rising incidence in urban and adjacent areas, and some other exceptions which will be mentioned later. In rural areas duodenal ulcer is very uncommon in the northern savannah of the west coast, northern

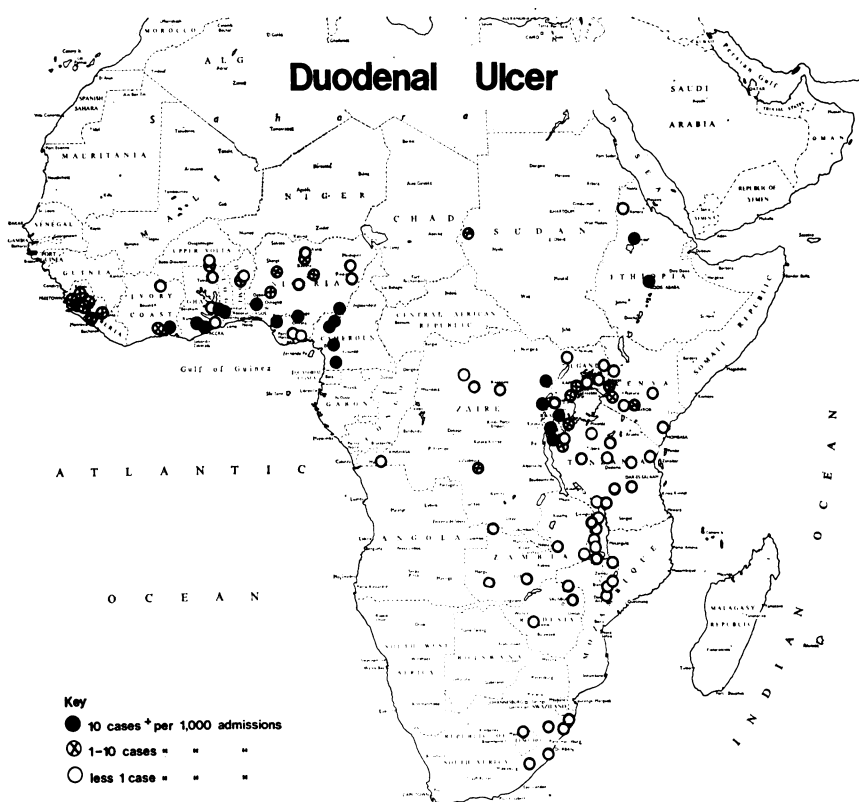


Fig 2

Uganda, most of Zaire, Tanzania, Zambia, Malawi, Basutoland, Natal, and Transvaal.⁷⁰⁻⁹¹ In Kenya there is a moderate incidence in the highlands on the rainward sides of Mount Kenya, but it is rare elsewhere. It is rare in the nomads of the Sahelle, in the Masai and Pokot tribes of Kenya, and the Borana of southern Ethiopia whose diet is made up of milk with occasional blood and meat.

In the northern savannah areas of the west coast duodenal ulcer was apparently virtually unknown until a few years ago, since when a few cases have been seen in Zaria (N Nigeria) and Bawku (NE Ghana). The number, however, is still very small.

In central Zaire there was a puzzling report from A. M. Verwilghen in 1957 and 1958 of a high incidence at Yasa.⁹² Dautrebunde in 1962 also reported from Kinshasa 25 duodenal and 26 gastric ulcers seen in 18 months,⁹³ but all other reports are consistent in emphasizing its rarity.^{9, 100}

In Nairobi the incidence in the black population has been rising since 1950 and is now high. A small but increasing incidence is being seen in other large cities, Mombasa in Kenya, Dar-es-Salaam in Tanzania,¹⁰¹⁻¹⁰² Salisbury in Rhodesia,¹⁰³⁻¹⁰⁵ Durban, Johannesburg, and Capetown in South Africa,¹⁰⁶⁻¹⁰⁹ although the incidence is still very low as compared with the white population and with western countries.

The reports from India on the distribution of duodenal ulcer¹¹⁰⁻¹²² have suggested that duodenal ulcer as seen in the rural areas of high incidence has different characteristics from that seen in the urban areas and also in western

countries. Duodenal ulcer predominates greatly over gastric ulcer, tends to be fibrosing with early pyloric stenosis, and haemorrhage and perforation are uncommon. It is rare in women and the peak age incidence is about 10 years younger.

The reports from the high-prevalence areas of Africa tend to support this picture.

Duodenal Ulcer: Gastric Ulcer Ratio

In the United Kingdom the ratio of duodenal ulcer to gastric ulcer in 1950 was between 3:1 and 4:1 and in recent years has fallen to between 2:1 and 3:1.¹²³⁻¹²⁷ In India the mean of 18 reported series was 19:1 (range 5:1 to 32:1). There is likewise a wide range in the reports from the high-incidence areas of Africa. The picture is a little confused by some reports which classify juxtapyloric ulcers as gastric ulcers, but the overall picture confirms that the situation is much the same as in India. (Concomitant ulcers have been classified as duodenal ulcers.) Many of the reports received just state that gastric ulcer is either not seen or is very uncommon. The mean of 31 surgical reports where figures are quoted is 33:1 (range 4:1 to 156:1).

Complications

In the United Kingdom the most frequent complications are haemorrhage and then perforation. Pyloric stenosis has become uncommon. The incidence in any surgical series in India and black Africa depends on the accepted criteria for surgical intervention and therefore is extremely variable. In India, however, there is widespread agreement about the frequent occurrence of pyloric stenosis in the rural areas where duodenal ulcer is common and surgeons have quoted incidence rates varying from 24¹²⁰ to 68%.¹¹⁹

Twenty published surgical reports from the high-incidence areas of black Africa refer to the high frequency of fibrosis, often occurring early in the disease, sometimes amounting to tumour-like masses, and resulting in pyloric stenosis. Out of 55 further reports received by the authors from these areas in which definite information is given about complications, 45 mention pyloric stenosis as the most frequent complication. In many hospitals it is the main indication for surgery. At Buye (Burundi) severe stenosis was seen in 11%, at Agogo (Ghana) in 32% and at Ilesha (W Nigeria) in 26%.

In contrast, haemorrhage and perforation are rare, haemorrhage occurring more frequently than perforation in most areas.

It has been suggested that the picture may be partly an artificial one, because patients with pyloric stenosis can often travel long distances to hospital whereas patients with haemorrhage or perforation may die at home. A. Van Enk (from Agogo in Ghana)²⁴ supports this view, showing that the incidence of haemorrhage and perforation in relation to stenosis is much higher as one gets nearer to the hospital. Nonetheless, workers in close contact with rural areas are convinced that if haemorrhage or perforation occurred more frequently they would know about it, and it is universally accepted that pyloric stenosis is the commonest complication of the three in the high-incidence rural areas.

Sex Ratio

In the United Kingdom the incidence of duodenal ulcer in men has fallen in recent years and in 1970 the sex ratio (male:female) was only 1.9:1.¹²⁶ In India the ratio of male to female in 11 reported series was as high as 17.6:1 (range 9:1 to 33:1). In the high-incidence areas of black Africa the ratio (male:female) in 18 reported series is 9:1 (range 2.1:1 to 30:0). In addition 25 out of 26 replies from these areas in response to our enquiries, in which the sex distribution is specifically mentioned, say that male patients greatly predominate without giving exact figures. In developing countries men tend to come to hospital more readily than women (although in India many hospitals were founded specifically for women and still admit a greater percentage of females), but even allowing for this tendency the marked male predominance is probably real.

Peak Age Incidence

In the United Kingdom the peak age incidence at present is between 45 and 55 years.¹²⁸ The reports from India give the peak age as a decade earlier. The mean peak age of six published reports from West Africa is 34 years and in 22 replies to our enquiries from the same area the mean peak age is 31. Many reports mention the occurrence of duodenal ulcer in teenagers, not infrequently associated with pyloric stenosis.

Differences between Rural and Urban Areas

In India it was noted that in the larger cities the characteristics of duodenal ulcer more closely resembled those of western countries,^{114,118,119,121,122} and that a certain number of duodenal ulcer patients would be seen in towns even when they were situated in parts of India where the incidence in the rural population was low. The same phenomenon seems to be occurring in and around Nairobi, Mombasa, Salisbury, Durban, and Johannesburg. This seems to be a recent change.^{82,87,89,91,107-8,76,105}

Historical Changes

Duodenal ulcer is a relatively new disease in the United Kingdom, appearing about the turn of the century. Medical records in India suggest that a similar change in the high-incidence areas may have occurred, but the evidence is scanty.^{112,120} The evidence in black populations in Africa is even more scanty and contradictory. Whittaker¹³¹ reports a pathologist who found duodenal ulcers frequently at necropsy in Kenya early in the century. Mattlet⁴² in a series of necropsies performed in Burundi from 1926-30 found only two cases of gastric ulcer and no duodenal ulcers. Braimbridge,⁷³ Vint,⁷¹ and Enzer⁷² (Kenya), and Beyers⁸² (Johannesburg) all report a low incidence in the early 1930s. Bergsma in 1931, however, reports 200 cases of peptic ulcer in Addis Ababa.⁶⁵ Aitken in 1932 comments on the frequency of duodenal ulcer in Lagos⁷ and Roberts reports on 44 peptic ulcers in the period 1931-32 (ratio DU:GU = 2:1) in Kampala.⁴⁴

Perhaps the most helpful evidence by inference is from the United States of America, where the incidence of duodenal ulcer was low in the negro

population until 1930, since when it has increased to become level with that of the white population.^{10,65,132-136}

Aetiology

The high frequency of duodenal ulcer in localized rural areas and its rarity in other areas strongly suggests that local environmental factors may be important in its aetiology. The peculiar characteristics of duodenal ulcer in these areas also adds support to this possibility, and the fact that these characteristics differ from the pattern of duodenal ulcer seen in the cities suggests that other factors may be operative in urban life. The possibility that the present high incidence in certain rural areas may have appeared in recent years means that the recognition of changes which have occurred in the way of living may also be of importance. In the same way the rising incidence in the larger towns in those areas where the incidence remains low in the surrounding rural areas needs to be related to changes which occur on moving into an urban environment. With this in mind various suggested aetiological factors are considered in the light of the geographical information available, and the situation in Africa is related to that in India.

INCREASED ALCOHOL CONSUMPTION

Alcohol consumption is high in some areas of high incidence, eg, Burundi, Rwanda, Southern Nigeria, but is low in other areas, eg, South India. It is also high in areas of low incidence where maize is the staple food and is used for brewing beer, eg, in Zaire, Tanzania, Zambia, and South Africa. In the 'west' a high incidence has been noted among alcoholics, but the peptic ulcer often precedes the alcoholism.

INCREASED CAFFEINE CONSUMPTION

There is no evidence that there has been a greater increase in tea or coffee drinking in high-incidence areas of India or Africa than in low-incidence areas and in many regions it is unknown. There is also no evidence that it is a factor in western countries.

SMOKING

Beedi and cigarette smoking is increasing throughout southern India, but the sale of tobacco is still much less than in the Punjab, where duodenal ulcer is uncommon. Tobacco smoking or chewing varies from area to area in black populations in Africa and no difference has been discovered between high- and low-incidence areas. Although smoking has been shown in the 'west' to be a definite factor in gastric ulceration, it has not been proven to be an aetiological factor in duodenal ulcer, although it may interfere with healing and determines chronicity.

INTRODUCTION AND CONSUMPTION OF REFINED CARBOHYDRATES

Cleave^{129,130} suggests that the introduction of refined carbohydrate foods (white flour, polished rice, sugar) or of starchy foods (manioc) results in a loss of buffer (principally protein) and that this may be an important factor. This concept fits in with much of the Indian distribution where duodenal ulcer is common in the rice-eating areas of the south and along the coast, in the plains of Assam and Kashmir, in West Bengal and Bangladesh, and

is uncommon in the Punjab and Rajasthan where the staple diet is unrefined wheat. In the areas of highest incidence in Kerala manioc is also an important item of food.^{119,122,129} The hypothesis also fits in with the situation in the Wachaggas around Mount Kilimanjaro whose staple diet is banana, and along the west coast of Africa, where the diet in the high incidence area tends to be starchy and often refined, eg, yams, cocoyams, plantains, manioc, rice, with some white flour or maize. In the low-incidence areas in the north millet and sorghum form the staple diet and the protein content is much higher.⁵ It is also consistent with the low incidence in N Uganda, much of Zaire, Tanzania, Zambia, Malawi, Basutoland, Natal, and Transvaal, where the diet is unrefined maize. It also fits in with the rising incidence in cities where more and more refined carbohydrate is being consumed. There are exceptions, however, which are difficult to fit in, the major one being the very high incidence in Burundi and Rwanda, where bananas, unrefined maize, millet, sorghum, peas, beans, and potatoes are the main items of diet. Manioc is eaten in times of shortage, but its consumption seems to bear no relation to the incidence of duodenal ulcer.¹³⁷ The diet on the rainward sides of Mount Kenya is similar. In the Ethiopian highlands the diet is mainly teff eaten as enjera and the incidence of duodenal ulcer is unrelated to refined carbohydrate food. There are areas too of Zaire where the staple food is manioc and duodenal ulcer is nonetheless rare. It is true that in these areas the manioc is not leached in its preparation and therefore contains more protein,¹³⁰ but the same method of preparation is used in some areas of the west coast where the incidence is high.

The possible effect of natural buffers in unrefined food on gastric secretion has been investigated,^{138,139} and the picture is confusing. After an initial fall in acidity they may act as antral stimulants.

Malhotra and Choudhrie^{140,141} suggest that the amount of mastication required in consuming the staple carbohydrate food may be important. They suggest that the alkaline and mucus content of the saliva protects the gastric mucosa. Chapattis, the staple diet of the low-incidence areas of the Punjab and Rajasthan, require a lot of mastication with increased production of saliva. This contrasts with the sloppier rice diet of South India which requires little mastication. No such difference in the amount of mastication required, however, exists between the high- and low-incidence areas in Africa and there is no evidence to support this hypothesis.

OTHER POSSIBLE FACTORS

Spices

The consumption of peppers and spices has often been blamed for the occurrence of duodenal ulcer in South India, in Ethiopia and along the west coast of Africa. Solanke¹⁴² from Ibadan in Nigeria and Johnson⁶⁹ from Gondar in Ethiopia have separately shown that peppers will produce a maximal acid output in duodenal ulcer patients yet have relatively little effect on acid output in normal people. Peppers and spices are not taken in any great quantity in the Nile-Congo watershed where the incidence of stenosing duodenal ulcer is at its highest. The consumption of peppers is also high in areas in Zaire where the incidence of duodenal ulcer is low. The consumption of spices is also not a factor in other areas where duodenal ulcer is common (Iran, USA, the United Kingdom), and the consumption is high in the Malaysians and Javanese who have very few duodenal ulcers.

Protective factors in food

The presence of possible protective factors in foods received considerable support by Cheney, Singh *et al*, and Adami¹⁴³⁻¹⁴⁵, who showed that certain green vegetables—in particular cabbage—milk, and egg yolk offered a degree of protection to animals against experimental ulceration. The factor is thermolabile and destroyed by cooking. In the case of cabbage the protective action varies with season and freshness. Recent experimental work¹⁴⁶ has confirmed the efficacy of cabbage and also of brinjall and dhal. Jayaraj¹⁴⁷ has also shown that the Punjabi diet is protective and the South Indian diet is not. No protective action was found using unrefined rice or wheat or their brans, unrefined maize, or a millet (*Eleusine coracana*) alone. This suggests that protective factors are more likely to be found in supplements, eg, green vegetables, milk, dhal, than in the staple carbohydrate food, but extensive enquiries in the high- and low-incidence areas of Africa have failed to identify any pattern of differences to fit the possibility that the diet in the low-incidence areas might be supplemented by foods which could contain such a protective factor.

Hookworm

Chandler¹⁴⁸ noted that hookworm was more prevalent in India in the areas where duodenal ulcer was common. Any association of duodenal ulcer with actual hookworm infestation in India, however, was not substantiated.^{149,150} In Africa hookworm infestation, which is low in the high-incidence areas of Rwanda and Burundi, yet common along the west coast, does not correspond with the distribution of duodenal ulcer. There is a possibility that the fibrosis and inflammatory reaction that frequently accompany duodenal ulceration may be related to the presence of hookworms.¹⁵¹

Infrequent meals

In many areas of India and Africa only one meal a day is taken, but this habit is similar in areas of low and of high incidence of ulceration.

Malnutrition and vitamin deficiencies

These vary from situation to situation and are unrelated to areas where duodenal ulcer is common or rare.

Stress

While certain areas of high incidence have recently been under considerable stress, eg, Nigeria, Rwanda, and Burundi, the high incidence of duodenal ulcer preceded the times of stress. In many rural areas the traditional way of life has changed very little and there is no marked difference in the stresses accompanying the more primitive ways of living between the high- and low-incidence areas.

The more acute character of duodenal ulceration in cities associated with more frequent haemorrhage and perforation may be due partly to the increased pace of living associated with urban life and its resulting stresses and strains.

Conclusion

This survey has established that there is a definite geographical pattern to

the distribution of duodenal ulcer in black Africa with significant high- and low-incidence areas, and that the characteristics of duodenal ulcer in rural areas of black Africa resemble those described in India, differing from the pattern in the cities and in western countries.

So far the survey has not revealed any definite aetiological factors, except that the incidence is consistently low in areas of low rainfall where the staple diet is either unrefined wheat, millet, or maize. Conversely the incidence is high in certain areas where the staple diet is either refined or starchy, but there are important inconsistencies. It is noteworthy that the areas of high-incidence are fertile and normally have a good rainfall.

The disease is probably multifactorial, with different factors being of varying importance from area to area. It is important that geographical trends in prevalence should be discovered and, in particular, areas of high and low incidence in close proximity be identified, so that suspected aetiological factors may be investigated more fully.

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References

(Only selected personal communications are mentioned)

West Coast

CAMEROONS

- ¹Reihmer, V. A. (1956). Peptic ulcers in Africans of the French Cameroons. *J. int. Coll. Surg.*, **25**, 289-298.
²Cazenave, M. (1956). A propos de l'ulcère gastroduodenale au Cameroun. Rapport de A. Mouchet. *Mém. Acad. Chir.*, **82**, 845-848.
³Touze, M. E. (1960). Ulcères gastro-duodénaux en Afrique équatoriale. *Méd. Afr. noire*, **7**, 381-382.
⁴Parodi, L., Bourthe, F. le., and Dicka, E. N. (1961). Les aspects étiologiques, anatomiques et thérapeutiques de la pathologie chirurgicale gastroduodenale en Afrique centrale. *J. Chir. Paris*, **82**, 445-456.
⁵Haaf, E. (i) (1974). Personal communication. (ii) (1972). Ernärungsbedingte Krankheiten in West Afrikanischen gebieten. Eine Studie. *Ethno medicine*, **1**, 411-425.
⁶Dieterle, J. C. (i) (1974). Personal communication. (ii) (1971). Report to Conseil des Eglises Baptiste et Evangélique du Cameroun. Hôpital de Bangwa.

NIGERIA

- ⁷Aitken, A. B. (1933). Remarks on peptic ulcer in West Africa. *W. Afr. med. J.*, **6**, 63-65.
⁸Ellis, M. (1948). A study of peptic ulcer in Nigeria. *Brit. J. Surg.*, **36**, 60-65.
⁹Konstam, P. (1954). Peptic ulceration in Southern Nigeria. *Lancet*, **2**, 1039-1040.
¹⁰Konstam, P. G. (1958). Peptic ulcer in W. Africa and India. *Schweiz. Z. Path.*, **21**, 229-333.
¹¹Joly, B. M. (1956). Peptic ulcer in Western Nigeria and Southern United States. *W. Afr. med. J.*, **5**, 55-63.
¹²Bohrer, S. P., Solanke, T. F., and Williams, A. O. (1968). Gastric ulcers in Nigeria. *Brit. med. J.*, **4**, 515.
¹³Barton, C. J., and Cockshott, W. P. (1961). Post-bulbar duodenal ulceration in Nigeria. *Brit. J. Radiol.*, **34**, 216-220.
¹⁴Nwokolo, C. (1966). Gastric ulceration in Southern Nigeria. *W. Afr. med. J.*, **15**, 210-213.
¹⁵Amure, B. O. (1967). Aspects of duodenal ulcer disease in Nigeria. *Practitioner*, **199**, 330-335.
¹⁶Solanke, T. F., and Antia, A. U. (1968). Peptic ulceration in Nigerian children. *W. Afr. med. J.*, **17**, 110-114.
¹⁷Lewis, E. A., and Bohrer, S. P. (1970). Gastric outlet obstruction in adults in Ibadan. *W. Afr. med. J.*, **19**, 59-64.
¹⁸Kolawole, T. M., and Solanke, T. F. (1973). Duodenal ulcers in Ibadan, Nigeria. *Trop. geogr. Med.*, **25**, 325-334.

TOGO

- ¹⁹Gögler, H. (i) (1974). Personal communication. (ii) (1973). Peptic ulcer in rural Togo (West Africa). *Trop. geogr. Med.*, **25**, 335-340.

DAHOMÉY

- ²⁰Tournier-Lasserre, C., Gerome, M., and Badarou. (1961). Ulcères duodénaux en Afrique noire. *Méd. trop.*, **21**, 554-564.
²¹Robert, H., Bouffard, A., and Gnanhui-David, M. (1964). Traitement chirurgical de l'ulcère duodénaux au Dahomey. *Bull. Soc. méd. Afr. noire Langue franç.*, **9**, 544-552.

GHANA

- ²²Onori, E. (1959). Peptic ulcer at the Gold Coast Hospital. *W. Afr. med. J.*, **8**, 84-86.
²³Badoe, E. A. (1972). (i) Gastric outlet obstruction in adults (Korle Bu Teaching Hospital, Accra). *W. Afr. med. J.*, **21**, 154-158.
²⁴Badoe, E. A. (1972). Gastroduodenal perforation in Accra. *Ghana med. J.*, **2**, 248-252.

- ¹⁵Achampong, E. Q. (1974). Statistics from Korle Bu Hospital, Accra. (Personal communication).
¹⁶Van Enk, A. (1974). Thesis on Peptic Ulcer in Ghana. (In preparation).

IVORY COAST

- ¹⁷Merle, H., Kone, A., and Vergnolle, R. (1959). La Chirurgie gastroduodenale en milieu Africain. *Afr. franç. Chir.*, 17, 71-75.
¹⁸Angate, Y. (1971). Aspects chirurgicaux des ulcères gastroduodénaux en Coté d'Ivoire. *Afr. Méd.*, 88, 213-216.
¹⁷Wragg, P., and Snell, J. (1974). Reports from Dabou Hospital. (Personal communication.)

SIERRA LEONE

- ¹⁹Rose, J. R. (1955). Peptic ulcer in Southern Nigeria. *Lancet*, 1, 107.
²⁰Carter, F. S. (1960). Peptic ulcer in Africans. *Brit. med. J.*, 1, 505-506.
²⁰Wilkinson, L. (1973). Peptic ulcer in the Nixon Memorial Hospital, Sebgwema. (Personal communication.)

SENEGAL

- ²¹Bèzes, H. (1957). Quarante-cinq gastrectomies en milieu Africain. *Méd. trop.* 17, 843-861.
²²Bèzes, H., and Zinsou, R. (1958). Ulcère duodénal chez l'Africain de la région de Dakar et son traitement chirurgical. *Mém. Acad. Chir.*, 84, 488-490.
²³Bèzes, H., Zinsou, R., and Goudoté, E. (1958). Les ulcères duodénaux 'sténosants en pratique chirurgicale Africaine. *Méd. Afr. noire*, 5, 423-455.
²⁴Payet, M., Pellegrino, A., and D'Assomption, V. (1959). Un an de radiologie gastro-duodénale en milieu Africain à Dakar. *Bull. Soc. méd. Afr. noire Langue Fr.*, 4, 369-390.
²⁵Carayon, A., and Courbil, L.-J. (1961). Evolution des opérations conservatrices dans le traitement de l'ulcère duodénal. *Bull. Soc. méd. Afr. noire Langue franç.*, 6, 379-385.
²⁶Bezes, H., and Richir, Cl. (1963). Aspect chirurgical des ulcères gastroduodénaux chez le noir Africain. *Lyon chir.*, 59, 367-381.
²⁷Cave, L., Sankale, M., Pineau, P., and Feral, J. (1963). Un an de radiologie gastro-duodénale à Dakar. *Med. Afr. noire*, 10, 385-386.
²⁸Carayon, A., and Foucher, G. (1968). A propos de 163 ulcères duodénaux traités chirurgicalement chez l'Africain. *Bull. Soc. méd. Afr. noire Langue franç.*, 13, 217-222.
²⁹Izarn, R. L. M. (1969). La thérapeutique chirurgicale de l'ulcère gastroduodénal à Dakar. Thesis, Faculté de Médecine. Paris.
³⁰Chabal, J. (1970). Aspect actuel du traitement chirurgical des ulcères gastro-duodénaux, bilan de 300 interventions chez les Noirs Africains. *Méd. Afr. noire.*, 17, 29-31.
³¹Chabal, J., and Izarn, R. (1970). Point de vue actuel à Dakar sur le traitement des ulcères gastroduodénaux. *W. Afr. med. J.*, 19, 30-32.

NILE-CONGO WATERSHED AND SOUTH WEST UGANDA

- ³²Mattlet, G. (1933). Deux cas d'ulcère gastrique chez le noir. *Ann. Soc. belge méd. trop.*, 13, 317-318.
³³Mowat, A. H. (1934-35). Gastric and duodenal ulcer. *E. Afr. med. J.*, 11, 63.
³⁴Roberts, C. E. (1937). Peptic ulcer in Uganda. *E. Afr. med. J.*, 14, 88-89.
³⁵Goodchild, R. T. S. (1949). Peptic ulcer in Africans (Proceedings of a Mulago Staff Clinical Meeting). *E. Afr. med. J.*, 26, 137-138.
³⁶Sergel, C. J. S. (1952). Peptic ulcers at CMS Mengo Hospital. *E. Afr. med. J.*, 29, 271.
³⁷Buxton, K. L. (1954). Peptic ulceration in tropical Africa. *Lancet*, 2, 1231.
³⁸Centerick, J. (1955). Pathologie gastrique chirurgicale chez le Congolais de Kivu. *Ann. Soc. belge méd. trop.*, 35, 119-128.
³⁹Croot, H. J. (1955). Surgery of chronic peptic ulcer in the African. *E. Afr. med. J.*, 32, 199-201.
⁴⁰de Becker, R. (1957). Frequence des ulcères gastro-duodénaux chez les Banyaruanda. *Ann. Soc. belge méd. trop.*, 37, 127-133.
⁴¹Raper, A. B. (1958). The incidence of peptic ulceration in some African tribal groups. *Trans. roy. Soc. trop. Med. Hyg.*, 52, 535-546.
⁴²Allbrook, D. B. (1955). A Student Health Service at a colonial university. *Lancet*, 2, 417-419.
⁴³Allbrook, D. B. (1958). The importance of peptic ulcer and other disease among Africans. *E. Afr. med. J.*, 35, 97-98.
⁴⁴Shaper, A. G., and Shaper, L. (1958). Analysis of medical admissions to Mulago Hospital in 1957. *E. Afr. med. J.*, 35, 647-678.
⁴⁵Shaper, A. G., and Williams, A. W. (1959). Peptic ulcer in Africans. *Brit. med. J.*, 2, 757-758.
⁴⁶De Bellevaux, J. N., Vanderick, F., and Louant, P. (1962). Importance des ulcères gastro-duodénaux dans la pathologie digestive au Ruanda. *Ann. Soc. belge méd. trop.*, 42, 55-64.
⁴⁷Snyder, C. A., and Alexander, M. J. (1963). Peptic ulcer in Africa. *Arch. Surg.*, 87, 205-203.
⁴⁸Yates, P. (1964). Surgical experiences in the Republic of Congo, 1973; with special reference to peptic ulcer. *Canda. med. Ass. J.*, 91, 343-344.
⁴⁹Taylor, W. H. (1965). Peptic ulceration in Western Uganda. *E. Afr. med. J.*, 42, 397-400.
⁵⁰Moore, E. W. (1967). Radiological experience of upper intestinal tract disease in Kampala, Uganda. *E. Afr. med. J.*, 44, 513-517.
⁵¹Hamber, G. (1971). Personal communication.
⁵²Hamber, G., and Van Bergen, M. (1971). Peptic ulcer in the Burundi Republic and Nile-Congo Watershed. *Trop. geogr. Med.*, 23, 213-219.
⁵³Hamber, G., and Van Bergen, M. (1972). Anastomotic ulcer in Burundi. *E. Afr. med. J.*, 49, 448-457.
⁵⁴Hamber, G., and Van Bergen, M. (1973). Gastric ulcer in Tropical Africa. Clinical features and incidence in Burundi. *Trop. geogr. Med.*, 25, 1-7.

N. TANZANIA

- ⁵⁵Taylor, J., and Wright, F. (1972). Kilimanjaro Christian Medican Centre. (Personal communication.)

ETHIOPIA

- ⁵⁶Bergsma, S. (1931). Gastric and duodenal ulcer in the black people of Abyssinia. *Arch. intern. Med.*, 47, 144-148.
⁵⁷Sorge, E. (1946). Il trattamento chirurgico dell' ulcera gastro-duodenale in Eritrea. *Bol. Soc. Ital. Med. Ig. Trop.*, 6, 431-432.

- ⁶⁷Ferro-Luzzi, G. (1946). Studio sull' ulcera gastro-duodenale in Eritrea. *Boll. Soc. ital. Med. Ig. Trop.*, **6**, 407-430.
- ⁶⁸Diesfield, H. J. (1967). Die Verbreitung des Magen et Duodenal ulkas in Afrika. (Literature review of the last 40 years). *Ther. d. Gegen.*, **106**, 500-512.
- ⁶⁹Johnson, L. P. (1967). Gastroduodenal disease in Ethiopia. Thesis, Public Health College, Gondar, Ethiopia. (Personal communication.)

Reports of Low Incidence

KENYA

- ⁷⁰Braimbridge, C. V., and Trowell, H. C. (1933-34). A case of chronic duodenal ulcer in an African native. *E. Afr. med. J.*, **10**, 365-366.
- ⁷¹Vint, F. W. (1936-37). Postmortem findings in the natives of Kenya. *E. Afr. med. J.*, **13**, 332-340.
- ⁷²Enzer, J. (1937). Gastric and duodenal ulcer at Mombasa. *E. Afr. med. J.*, **14**, 91.
- ⁷³Braimbridge, C. V. (1937). Gastric and duodenal ulcer in Kenya. *E. Afr. med. J.*, **14**, 90-91.
- ⁷⁴Miller, J. R. M. (1955). Five years abdominal surgery at Kisumu. *E. Afr. med. J.*, **32**, 219-231.
- ⁷⁵Wilkinson, J. (1957). The influence of heredity and environment upon disease amongst the Kikuyu people. *E. Afr. med. J.*, **34**, 628-641.

RHODESIA

- ⁷⁶Gelfand M. (1957). *The Sick African*, 3rd ed. Juta, Cape Town.
- ^{76a}Gelfand, M. (1965). Haematemesis in an African Ward. *Centr. Afr. med. J.*, **12**, 366-368.
- ⁷⁷Dent, R. I. (1975). Salisbury. (Personal communication.)

TANZANIA

- ⁷⁸Connell, W. K. (1955). Duodenal ulcer in Tanganyika. *E. Afr. med. J.*, **14**, 89-90.

ZAIRE

- ⁷⁹Dubois, A. (1944). La pathologie du Congolais. *Ann. Soc. belge méd. trop.*, **24**, 13-28.

MALAWI

- ⁸⁰Williams, A. D., (1937). Duodenal ulcer in Nyasaland. *E. Afr. med. J.*, **14**, 91-92.
- ⁸¹Humphries, S. V. (1959). Peptic ulcer in Africans. *Brit. med. J.*, **2**, 1253.

SOUTH AFRICA

- ⁸²Beyers, C. F. (1927). Incidence of surgical diseases among the Bantu races of South Africa. *J. med. Ass. S. Afr.*, **1**, 606-612.
- ⁸³Barnes, H. D., and Gordon, M. S. (1937). Fractional gastric analysis in the South African Bantu. *S. Afr. J. med. Sci.*, **2**, 75-81.
- ⁸⁴Eagle, P. C., and Gillman, J. (1938). The incidence of peptic ulcer in the South African Bantu. *S. Afr. J. med. Sci.*, **3**, 1-6.
- ⁸⁵Charlewood, G. P., and Frylinck, R. (1951). Some discrepancies in disease incidence between the European and South African Negro. *S. Afr. med. J.*, **25**, 551-556.
- ⁸⁶Erasmus, J. F. P. (1955). Gastroduodenal ulcers and neoplasms. *Acta med. scand.*, **152**, Suppl. 306, 26-38.
- ⁸⁷McKenzie, M. B. (1957). Peptic ulceration in the African of Durban. *S. Afr. med. J.*, **31**, 1041-1045.
- ⁸⁸Keely, K. J. (1958). Alimentary disease in the Bantu. *Med. Proc.*, **4**, 281-286.
- ⁸⁹Higginson, J., and Simson, I. (1958). Lesions of the gastro-intestinal tract in the non-white population of South Africa. *Schweiz. Z. Path.*, **21**, 577-581.
- ⁹⁰Esser, H. R., and Coetzee, T. (1960). Peptic ulcer in Indians and Africans in Natal. *Med. Proc.*, **6**, 153-158.
- ⁹¹Kark, A. E. (1961). The incidence and pattern of peptic ulcer in Indians and Africans in Durban. *Gut*, **2**, 363-369.

ANOMALOUS REPORTS FROM ZAIRE

- ⁹²Verwilghen, A. M. (1957). Contribution à l'étude de l'ulcère gastroduodénal au Kwango. *Ann. Soc. Belge méd. trop.*, **37**, 757-772.
- ^{92a}Verwilghen, A. M. (1958). Gastroduodenal ulcer in Kwango. *Trop. geogr. Med.*, **10**, 117-125.
- ⁹³Dautreband, J. (1962). Les ulcères du 3 supérieur du versant postérieur de la petite courbure gastrique. *Ann. Soc. Belge méd. trop.*, **42**, 39-54.

Changing Incidence in Urban Areas

NAIROBI

- ⁹⁴Khan, A. A. (1958). Duodenal ulcer amongst Africans in Nairobi. *E. Afr. med. J.*, **35**, 679-684.
- ⁹⁵Whittaker, L. R. (1961). On peptic ulceration in Kenya Africans. *E. Afr. med. J.*, **38**, 449-451.
- ⁹⁶Ojiambo, H. P. (1965). The pattern of duodenal ulceration in Nairobi. *E. Afr. med. J.*, **42**, 629-633.
- ⁹⁷Whittaker, L. R. (1966). A review of a series of radiological examinations of the upper alimentary tract in African patients. *E. Afr. med. J.*, **43**, 336-340.
- ⁹⁸Miller, J. R. M. (1966). Duodenal ulcer in Nairobi. *E. Afr. med. J.*, **43**, 259-263.
- ⁹⁹Gatumbi, I., and Roy, A. D. (1970). The prevalence of peptic ulcer dyspepsia in a rural community in Kenya. *E. Afr. med. J.*, **47**, 627-633.
- ¹⁰⁰Roy, A. D. (1975). Personal communication.

DAR-ES-SALAAM

- ¹⁰¹Grech, P. (1965). Radiological analysis of lesions of the upper intestinal tract during a 4-year period in Tanganyika (now Tanzania). *E. Afr. med. J.*, **42**, 106-116.
- ¹⁰²Nhonoli, A. M. (1969). Some aspects of duodenal ulcer in Dar-es-Salaam. *E. Afr. med. J.*, **46**, 64-66.

RHODESIA

- ¹⁰³Balachin, B. J., and Palmer, P. E. S. (1959). Peptic ulcer in Africans. *Brit. med. J.*, **2**, 304.
- ¹⁰⁴White, A. (1963). Surgery and the Rhodesian African. *J. roy. Coll. Surg., (Edinb.)*, **9**, 37-51.
- ¹⁰⁵Wapnick, S., and Gelfand, M. (1973). Peptic ulcer in the Rhodesian African. *S. Afr. med. J.*, **47**, 625-628.

SOUTH AFRICA

- ¹⁰⁶Roberts, W. M. (1967). (Cape Town.) Gastro-duodenal haemorrhage. *S. Afr. med. J.*, **41**, 207-214.
¹⁰⁷Bremner C. G. (1971). The changing pattern of disease seen at Baragwanath Hospital. *S. Afr. J. Surg.*, **9**, 127-131.
¹⁰⁸Bremner, C. G. (1972). Duodenal ulcer in the Johannesburg Urban African. *S. Afr. J. Surg.*, **10**, 139-141.
¹⁰⁹Levy, J. I. (1974). Johannesburg. (Personal communication.)

India

- ¹¹⁰Somervell, T. H., and Orr, I. M. (1936). Some contribution to the causation, pathology and treatment of duodenal ulcer and its complications. *Brit. J. Surg.*, **24**, 227-245.
¹¹¹Somervell, T. H. (1943). Further contributions to the causation and treatment of duodenal ulcer and its complications. *Brit. J. Surg.*, **30**, 113-125.
¹¹²Dogra, J. R. (1940). Studies on peptic ulcer in S. India. *Indian J. med. Res.*, **28**, 145-161.
^{112a}Dogra, J. R. (1941). Incidence of peptic ulcer in India—with special reference to South India. *Indian J. med. Res.*, **29**, 665-676.
¹¹³Hadley, G. G. (1958). A study of peptic ulcer as found in South India. *Schweiz. Z. Path.*, **21**, 472-474.
^{113a}Hadley, G. G. (1959). A study of peptic ulcer as found in South India. *Indian Counc. med. Res. Rep.*, **39** 31-33.
¹¹⁴Konstam, P. G. (1959). Peptic ulcer in India. *Indian J. med. Sci.*, **13**, 486-492.
¹¹⁵Raghavachari, C. A. (1959). A note on peptic ulcer. *Indian Counc. med. Res. Rep.*, **39**, 48-51.
¹¹⁶Gopal Rao, V. A. (1959). Note on the problem of peptic ulcer in Hyderabad. *Indian Counc. med. Res. Rep.*, **39**, 16-26.
¹¹⁷Hancock, D. M. (1960). Peptic ulcer as encountered in a surgical unit in South India. *Brit. J. Surg.*, **48**, 128-133.
¹¹⁸Raghavan, P. (1962). Epidemiology and clinical behavior of peptic ulcer in Bombay, India. *Gastroenterology*, **42**, 130-143.
¹¹⁹Varma, R. A. (1969). Peptic ulcer in developing countries. In *After Vagotomy*, edited by J. A. Williams and A. G. Cox, pp. 382-395. Butterworths, London.
¹²⁰Tovey, F. I. (1972). Duodenal ulcer in Mysore. *Trop. geogr. Med.*, **24**, 107-117.
¹²¹Tovey, F. I. (1974). The geographical distribution and possible factors in the aetiology of peptic ulcer. *Tropical Doctor*, **4**, 17-21.
¹²²Tovey, F. I. (1975). Peptic ulcer. In *Refined Carbohydrate Foods and Disease*, edited by D. Burkitt and H. Trowell. Academic Press, London. (In press.)

United Kingdom

- ¹²³Ivy, A. C., Grossman, M. I., and Bachrach, W. H. (1950). *Peptic Ulcer*. Churchill, London.
¹²⁴Doll, R. (1952). Peptic ulcer: epidemiology. In *Modern Trends in Modern Gastroenterology*, edited by F. Avery Jones, pp. 361-379. Butterworths, London.
¹²⁵Pulvertaft, C. N. (1968). Comments on the incidence and natural history of gastric and duodenal ulcer. *Postgrad. med. J.*, **44**, 597-602.
¹²⁶Wastell, C. (1972). Duodenal ulcer—incidence, appearances and complications. In *Chronic Duodenal Ulcer*, edited by C. Wastell, pp. 3-18. Butterworths, London.
¹²⁷Langman, M. J. S. (1973). Changing patterns in the epidemiology of peptic ulcer. *Clin. Gastroent.*, **2**, 219-226.
^{127a}Langman, M. J. S. (1974). The changing nature of the duodenal ulcer diathesis. In *Westminster Hospital Symposium on Chronic Duodenal Ulcer*, edited by C. Wastell, pp. 3-12. Butterworths, London.

Other References

- ¹²⁸Watkinson, G. (1961). Geographical aspects of peptic ulcer. In *Modern Trends in Gastroenterology*, edited by W. I. Card, pp. 23-48. Butterworths, London.
¹²⁹Cleave, T. L. (1962). *Peptic Ulcer*. J. Wright, Bristol.
¹³⁰Cleave, T. L. (1974). *The Saccharine Disease*. J. Wright, Bristol.
¹³¹Whittaker, L. R. (1970). (Personal communication). Quoted by Gatumbi, I., and Roy, A. D. (1970). The prevalence of peptic ulcer dyspepsia in a rural community in Kenya. *E. Afr. med. J.*, **47**, 627-633. (Also personal communication, 1975).
¹³²Kirchner, A. A. (1944). The digestive disturbances of the negro soldier as seen in a large army general hospital. *Rev. Gastroent.*, **11**, 397-408.
¹³³Maes, U., and McFetridge, E. M. (1936). Racial trends of the Negro and White in certain surgical diseases. *Amer. J. Surg.*, **33**, 5-17.
¹³⁴Portis, S. A., and Jaffé, R. H. (1938). A study of peptic ulcer based on necropsy records. *J. Amer. med. Ass.*, **110**, 6-13.
¹³⁵Boland, F. K. (1942). [Vitamin deficiency as a factor in the aetiology of surgical diseases of the digestive system. *Ann. Surg.*, **115**, 939-944.
¹³⁶United States Department of Commerce (1943). Vital statistics rates in the United States, 1900-1940. U.S. Government Printing Office, Washington, D.C.
¹³⁷Hamber, G. (1974). Personal communication.
¹³⁸Lennard-Jones, J. E., Fletcher, J., and Shaw, D. G. (1968). Effect of different foods on the acidity of the gastric contents in patients with duodenal ulcer. Part 3. Effect of alternating the proportions of protein and carbohydrates. *Gut*, **9**, 177-182.
¹³⁹Tovey, F. I. (1974). Aetiology of duodenal ulcer: an investigation into the buffering action and the effect on bran and unrefined carbohydrate foods. *Postgrad. med. J.*, **50**, 683-688.
¹⁴⁰Malhotra, S. L. (1964). Peptic ulcer in India and its aetiology. *Gut*, **5**, 412-416.
¹⁴¹Choudhrie, A. V. (1974). Duodenal ulcer—possible aetiology: an observation. *J. Christian med. Ass. India*, **49**, 160-161.
¹⁴²Solanke, T. F. (1973). The effect of red pepper (*Capsicum Frutescens*) on gastric acid secretion. *J. surg. Res.*, **15**, 385-390.
¹⁴³Cheney, G. (1950). Anti-peptic ulcer dietary factor. *Amer. Dietet. Ass.*, **26**, 668-672.
^{143a}Cheney, G. (1952). Vit. U therapy of peptic ulcer. *California Med.*, **77**, 248-252.
^{143b}Cheney, G. (1950). The nature of the anti-peptic ulcer dietary factor. *Stanford med. Bull.*, **8**, 144-161.
¹⁴⁴Adami, E. (1955). Ricerche sperimentale sur "gattone antiulcera". *Att. Soc. Lombard Sci. Med. Biol.*, **10**, 60-64.

- ^{144a}Adami, E. (1964). A new class of drugs active in gastro-duodenal ulcers. *Clinica Europa*, Vol. 3. (Typescript copy only available.)
- ¹⁴⁵Singh, G. B., Zaidi, S. H., and Bajpai, R. P. (1962). Effect of *Brassica oleracea* var *capitata* in the prevention and healing of experimental peptic ulceration. *Indian J. med. Res.*, 50, 741-749.
- ¹⁴⁶Tovey, F. I., Jayaraj, P., and Clark, C. G. (1975). The possibility of dietary protective factors in duodenal ulcer. *Postgrad. med. J.*, in press.
- ¹⁴⁷Jayaraj, P. (1975). Personal communication.
- ¹⁴⁸Chandler, A. C. (1926). The prevalence and epidemiology of hookworm and other helminthic infection in India. Parts I and II. *Indian J. med. Res.*, 14, 185-218.
- ^{148a}Chandler, A. C. (1927). The prevalence and epidemiology of hookworm and other helminthic infection in India. *Indian J. med. Res.*, 15, 143-158.
- ¹⁴⁹Leslie, H., and Tovey, F. I. (1955). Relation of hookworm infestation with duodenal ulcer. *J. Indian med. Ass.*, 25, (14) 548-551.
- ¹⁵⁰Raju, S., and Narielvala, F. M. (1965). Study of gastric acid secretion in hookworm duodenitis. *Gut*, 6, 540-544.
- ¹⁵¹Konstam, P. G. (1970). The stomach and duodenum. In *Alimentary and Haematological Aspects of Tropical Disease*, edited by A. W. Woodruff, pp. 52-59. Arnold, London.