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Epidemiology, causes, and treatment of epilepsy in sub-Saharan Africa

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Abstract

Epilepsy is a common neurological disease in tropical countries, particularly in sub-Saharan Africa. Previous work on epilepsy in sub-Saharan Africa has shown that many cases are severe, partly a result of some specific causes, that it carries a stigma, and that it is not adequately treated in many cases. Many studies on the epidemiology, aetiology, and management of epilepsy in sub-

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AB-D and P-MP were responsible for the conception of the article. AB-D, MD-C, CRN, and P-MP did the literature review and BM did the statistical analysis. AB-D and P-MP created the tables, and BM and P-MP created the figures. AB-D, BM, EBN, CRN, and P-MP wrote the article. All authors revised the article and were part of the decision to submit for publication.

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Saharan Africa have been reported in the past 10 years. The prevalence estimated from door-to-door studies is almost double that in Asia, Europe, and North America. The most commonly implicated risk factors are birth trauma, CNS infections, and traumatic brain injury. About 60% of patients with epilepsy receive no antiepileptic treatment, largely for economic and social reasons. Further epidemiological studies should be a priority to improve understanding of possible risk factors and thereby the prevention of epilepsy in Africa, and action should be taken to improve access to treatment.

Introduction

Epilepsy is a major public health problem: it is common and can have serious physical and psychological consequences, including premature death, traumatic injury, and mental health disorders.1 Epilepsy was defined by the International League Against Epilepsy in 1993 as a condition characterised by recurrent seizures, at least two unprovoked, occurring in a period of more than 24 h.2 The prevalence of epilepsy is higher in less developed than in more developed countries.3,4

The stigma of epilepsy can be profound because it is widely thought to be contagious and associated with witchcraft or evil spirits.5,6 In Tanzanian and Kenyan studies,7,8 disturbed behaviour was significantly more common in children with active epilepsy than in those without the disorder (66 *vs* 19%; odds ratio [OR] 8·2, 95% CI 4·3–15·6; p<0·001), and children with active epilepsy had more behavioural problems than did those with inactive epilepsy (49% *vs* 26%; OR 7·86, 95% CI 1·23–50·06; p=0·029).7,8 The Global Burden of Diseases, Injuries, and Risk Factors Study 2010 found that the burden resulting from epilepsy is very high; only one other disorder (HIV infection) had greater disability weight than uncontrolled, severe epilepsy.9–11 Comorbidities greatly affect children with epilepsy in terms of quality of life, and life chances are reduced for adults with epilepsy in terms of employment and marriage.12 Left untreated, people with epilepsy face devastating social consequences, including stigma and discrimination, and premature mortality.13

Although effective antiepileptic drugs are available, a substantial treatment gap is evident in developing countries, because human and financial resources for diagnosis and treatment are limited and misconceptions and stigma surround the disorder.4

In 2005, Preux and Druet-Cabanac published a Review3 of studies on the epidemiology and aetiology of epilepsy in sub-Saharan Africa, which highlighted the paucity of studies in Africa. Since then, many studies have been published, particularly a major comparison of clinical features across continents14 and a large multisite epidemiological study (figure 1). 15 New insights have been gained into the association between several parasitic diseases (malaria, onchocerciasis, cysticercosis, toxocariasis) and epilepsy,16–18 and epileptic syndrome (nodding disease) has re-emerged.19 Thus, an update of understanding of the epidemiology, aetiology, and management of epilepsy in sub-Saharan Africa is timely, to provide an overview of the situation now. We have not reviewed publications on stigma, comorbidities, consequences such as burns, or the role of traditional healers in the management of epilepsy in sub-Saharan Africa.

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Incidence

Few studies on the incidence of epilepsy in sub-Saharan Africa have been published, but the overall information suggests a high annual incidence of epilepsy in less developed countries of 81·7 per 100 000 (95% CI 28·0–239·5) compared with 45·0 per 100 000 (30·3–66·7) in more developed countries.20 We identified only eight studies estimating the incidence of epilepsy in sub-Saharan Africa, including four done after 2005 (table 1).21–28 These studies cannot be directly compared with one another because they used different methods.

Prevalence

The prevalence of epilepsy in sub-Saharan Africa15,23–25,27,29–66 varied both between and within countries (table 2). The variation could result from the heterogeneity of the methods used, which could result from differences in the definitions of epilepsy used,1,2 the nature of the epilepsy studied (lifetime or active), the sample population (general or selected),14 and the incidence of the risk factors.67 Variations can also result from the use of differing screening methods and questionnaires. The most widely used questionnaires were the modified WHO questionnaire67,68 and that from the Institute of Epidemiology and Tropical Neurology, Limoges.69 A 2013 multicentre study, which used the same method in all centres, confirmed that the prevalence of active convulsive epilepsy in sub-Saharan Africa is high and within the range estimated for active epilepsy in countries of low and middle income.15 The prevalence in sub-Saharan Africa is related to the distribution and types of risk factors for epilepsy.

Our meta-analysis (figure 2) shows that the global prevalence of epilepsy in sub-Saharan Africa is 9·39 per 1000. By meta-analysis and meta-regression methods, we were able to calculate mean weighted estimates that took sample size into account. The stratified estimated prevalences according to the method used are shown in figure 3; the prevalence was higher in door-to-door than in cross-sectional studies. Estimates for each geographical African region are shown in figure 4. Although this estimate did not take account of the sample sizes of the included studies, we estimated the median prevalence so that we could compare our results with the 2005 Review.3 The median prevalence was 14·2 per 1000 (IQR 8·0–33·2), similar to that found in 2005 (15·4 per 1000; 5·0–74·0) and higher than that in more developed countries (5·8 per 1000; 2·7–12·4).4,71 In meta-regression, as in meta-analysis, door-to-door studies found higher prevalence than cross-sectional studies ($p=0·078$; table 3). Studies in west Africa reported significantly higher incidence than those in east Africa ($p=0·027$), as did those from central Africa ($p<0·0001$) though the number of studies in that region was small.

Case-fatality rate

Worldwide, mortality among people with epilepsy is reported to be two to three times higher than that in the general population.72 Few studies have estimated the mortality of epilepsy in sub-Saharan Africa; only six were identified for this Review.21,29,30,72–74 One study in Ethiopia in 199721 estimated the crude death rate in the general population as 16·4 per 1000 person-years; for people with epilepsy the estimated death rate was 31·6 per 1000 person-years. A 2 year community study in Kenya29 reported mortality of 3·5 per 100 person-years

in people with epilepsy aged over 5 years, with 77% of the deaths occurring during status epilepticus. In a 10-year cohort study in Cameroon,72 the mortality rate was 28·9% in people with epilepsy compared with 4·7% in a control group (OR 5·6, 95% CI 2·0–12·6; p<0·0005).72 In The Gambia, mortality among people with epilepsy was 77 per 1000 person-years over a 2 year period, whereas that of the general population was eight per 1000 person-years (p<0·005).30 A 2007 study in Uganda reported a standardised mortality ratio in 61 patients with epilepsy of 7·2 (95% CI 4·4–11·6; p<0·0001) with a high proportion in patients aged between 10 and 20 years.73 In Kilifi, Kenya, the mortality from active convulsive epilepsy was 33·3 per 1000 person-years 25·9–42·8), with an overall standardised mortality ratio of 6·5 (5·0–8·3).74 Mortality was highest in the age-group 18–24 years. Risk factors for mortality among people with active convulsive epilepsy were non-adherence with antiepileptic drug treatment (adjusted rate ratio 3·4, 1·8–6·2), cognitive impairment (4·6, 2·5–8·3), and age over 50 years (relative risk 4·6, 1·3–15·9). Most deaths (56%) were directly related to epilepsy, with status epilepticus (38%) the most frequent cause of death.

Sociodemographic characteristics

According to a WHO report,75 the incidence of epilepsy in more developed countries is highest in the age-group 30–50 years. By contrast, in less developed countries, especially in sub-Saharan Africa, more than 90% of people with epilepsy are younger than 20 years (table 2).23,25,32,36,37,41,46,54,60 Of these patients, on average, the first seizure occurred before the age of 10 years in 35% and before the age of 20 years in 50% (table 4).

Most studies of epilepsy in more developed countries find that it is more common in men than in women, but the difference is rarely statistically significant. Outcomes in African countries are similar, although two studies in Benin37,53 found that the prevalence was higher in women than in the men (table 5). Some investigators suggested that the predominance in the female population can be explained by higher male mortality.36,39 Paul and colleagues66 showed that the prevalence of active epilepsy was very similar for the two sexes in age-groups 0–39 years, but the prevalence of active epilepsy was noticeably higher in women than in men in the age-group 40–59 years.66

Type of seizure

Only a few study reports describe the distribution of types of seizure. Furthermore, comparison of results from different studies is difficult because of the heterogeneity of classifications used. We have summarised only studies based on the general population (table 6). Screening methods for epilepsy in sub-Saharan Africa, especially in rural areas, cannot generally detect all simple partial seizures or absence seizures. The lack of neurologists and electroencephalographic facilities means that patients having generalised tonic-clonic seizures (average 67%) are more likely to be reported because of their conspicuous presentation. The proportion of secondarily generalised partial seizures (average 8%) will be underestimated because the early stages are difficult to recognise clinically.85

Causes and risk factors

The main risk factors for epilepsy in sub-Saharan Africa are family history of seizures, previous febrile seizures, perinatal trauma, head injury and CNS infections such as neurocysticercosis (table 7). However, there is little evidence from Africa on the association between risk factors and disease. The few case-control or cohort studies we identified are shown in table 8.43,79,80,84,86–91

Genetic factors

A family history of epilepsy is commonly taken as equivalent to genetic risk; but, as environmental exposure common to a family would also produce such findings, this assumption has a major limitation. A family history was found in 6–60% of cases in the studies in sub-Saharan Africa compared with only 5% in the USA.92 To date, no evidence has been found for a dominant gene that could explain familial epilepsy, but individual polymorphisms seem to act synergistically with environmental factors.81 For cultural reasons, consanguineous marriages are common in certain African ethnic groups, which could increase the risk of genetic epilepsy, but this association is not well documented.23,93 Pedigree analysis of 23 patients with epilepsy in a study in Côte d'Ivoire showed that the incidence of the disease was 1·4 times higher in children of consanguineous marriages than in those of non-consanguinous marriages.60 In many cases, heredity has been shown to account for a large proportion of the expression of epilepsy. In 1951, Lennox94 found a high degree of concordance in the occurrence of seizures in monozygotic twins. By contrast, consanguinity in the families of patients with epilepsy was reported in 37% of cases in Mali. 43 In a case-control study in Tanzania, a first-degree family history of epilepsy was recorded for 47% of patients compared with 18% of controls; 33% of patients were from consanguineous marriages.88

Perinatal causes

In sub-Saharan Africa, perinatal causes are implicated in between 2% and 65% of cases of epilepsy.30,54,83 Sequelae of birth injuries, often due to a difficult pregnancy or childbirth, can lead to epilepsy. Hypoxia and hypoglycaemia are frequently cited. In the absence of neuroimaging facilities, the association of epilepsy with a prenatal, perinatal, or early postnatal event is difficult. The link is commonly based on the history, which is not always recorded and is subject to recall bias.90 Traditional beliefs and large distances to maternity facilities lead frequently to deliveries at home without qualified assistance.62 A 2012 case-control study showed a strong association (OR 10·2, 95% CI 1·1–93·4) between epilepsy and adverse perinatal events, although this was based only on maternal recall.63 Ngugi and colleagues15 showed that risk factors during the antenatal and perinatal periods were most strongly associated with active convulsive epilepsy in children (population attributable fraction 0·33, 0·21–0·43).

Febrile seizures

Among children, the population most prone to epilepsy, febrile seizures are reported at all health facilities in Africa, and they are commonly associated with epileptic seizures, especially if prolonged.95 The studies in sub-Saharan Africa found that 6–38% of patients

with epilepsy had a history of febrile seizures.32,51,61 In a case-control study in Nigeria, Ogunniyi and colleagues96 found an odds ratio of 11 for the association between febrile seizures and epilepsy, adjusted for other factors such as head trauma. In malaria-endemic areas, most acute seizures are caused by malaria, but whether they are febrile seizures or acute symptomatic seizures is unclear. Malaria-associated seizures were implicated in the occurrence of epilepsy in 71% of Tanzanian children in one study.97

Malnutrition

Few studies on a possible link between epilepsy and malnutrition in less developed countries have been published. Such a link has been suspected for many years.3 However, because of attitudes toward epilepsy and food taboos in sub-Saharan Africa, epilepsy could also contribute to malnutrition. In one study in Benin, a link between epilepsy and malnutrition was detected; the prevalence of malnutrition was higher in cases than in controls (22 *vs* 9%, p=0·0006).98

Neurological infections

Infectious causes that can lead to generalised seizures in equatorial Africa are mainly of parasitic origin. Among these conditions are malaria,88 cysticercosis, onchocerciasis, and toxocariasis.99

Neurocysticercosis is the most common neurological infection and a major cause of epilepsy in many countries in Africa, Asia, and Latin America.100–102 Neurocysticercosis is the main cause of partial epilepsy in adults in areas where *Taenia solium* is endemic. 101,103,104 Cysticercosis is not common in Jewish and Muslim countries (there is little contact between people and pigs, and pork is not eaten) because of the low risk of infection with adult worms or environmental contamination by parasite eggs.105 An estimated 30% of epilepsy in endemic regions results from neurocysticercosis. Winkler17 calculated on the basis of this estimate that the number of people with neurocysticercosis in sub-Saharan Africa, who were therefore at risk of developing epilepsy, was between 1·9 and 6·16 million. 17 In many resource-poor areas, with no access to neuroimaging, serological detection of anticysticercal antibodies or cysticercal antigen is the method of choice to assess the prevalence of human cysticercosis or neurocysticercosis.106 The prevalence of neurocysticercosis varies throughout sub-Saharan Africa. A meta-analysis in 2010 on eight African countries found a significant association between cysticercosis and epilepsy (overall OR 3·4, 95% CI 2·7–4·3).104

In Burundi, an OR of 3·8 (2·5–5·1) indicated a strong link between cysticercosis and epilepsy.86 The prevalence of cysticercosis in Togo is estimated at 38 per 1000 in the general population but 135 per 1000 in people with epilepsy.49 Neuroimaging is essential for diagnosis of neurocysticercosis. Access to CT is rare in sub-Saharan Africa. Winkler and colleagues24 found that in rural Tanzania more than half of people with epilepsy and abnormalities on CT had lesions related to neurocysticercosis. They also found that neurocysticercosis-related pathology on CT was significantly more common in people with epilepsy than in controls (38 of 212 [18%] *vs* ten of 198 [5%]; OR 4·1, 95% CI 2·0–8·5; p<0·0001).107

Another study in Tanzania found that among people with epilepsy, those who had neurocysticercosis were older and had their first seizure later in life than those without the infection.108 Neurocysticercosis should be considered as an underlying cause of epilepsy especially among patients with late-onset seizures. A 2011 study in the Democratic Republic of Congo found a prevalence of *T solium* antigen of 21·6%; the adjusted prevalence of active epilepsy in the community was 12·7 per 1000.109 Campaigns to increase awareness of the unknown burden of neurocysticercosis and improve prevention and care for patients in endemic areas are greatly needed.

Onchocerciasis (river blindness), caused by *Onchocerca volvulus,* has also been implicated in seizure disorders. Several studies have reported an association between the prevalence of onchocerciasis and of epilepsy in different areas of east, west, and central Africa,110–113 but the methods used have been subject to substantial criticism and other studies did not confirm the association.114 Studies from Mali,43 Burkina Faso,115 the Central African Republic,84 and Tanzania116 have shown no significant differences in microfilarial density or load between people with and without epilepsy. The Tanzanian study included analysis of CSF, which showed no trace of the parasite.116 A meta-analysis of these epidemiological studies in 2004 found no clear relation between onchocerciasis and epilepsy.117 However, other meta-analyses have shown an association (OR 2·82, 95% CI 1·43–5·56; p<0·005;16 and 2·49, 1·61–3·86; p<0·001118).

In Uganda, a prevalence of epilepsy of six to seven per 1000 was found in areas where onchocerciasis endemicity was below 50% compared with eight to 25 per 1000 where onchocerciasis endemicity was higher than 50%.42 In Nigeria, where the prevalence of onchocerciasis in 11 villages ranged from 8·3% to 36·0%, the highest frequency of the disease and the greatest densities of microfilariae were found in the villages with the highest prevalence of epilepsy.118 In case-control studies, the prevalence of onchocerciasis among patients with epilepsy was 40% versus 36% in controls in the Central African Republic (OR 1·21, 95% CI 0·81–1·80)84 and 24% versus 22% (1·02, 0·47–2·19) in Mali.43 In 2005, Pion and colleagues111 concluded that the average prevalence of epilepsy increased by 0·4% for each 10% increase in the prevalence of onchocerciasis. Overall, the evidence is conflicting and difficult to interpret.

Nodding syndrome is an epilepsy disorder that mainly affects children and has been confirmed only in three African regions so far: northern Uganda, South Sudan, and southern Tanzania.119,120 Nodding syndrome seems to be an epileptic encephalopathy found in children from the age of 5 years and in young adults, characterised by nodding of the head, often precipitated by food.121,122 The disease course in patients deteriorates, with multiple seizures, including myoclonic jerks, malnutrition, and cognitive impairment, and some die. 123–125 The latest statistics from the Ugandan Ministry of Health reported about 3000 affected children and 170 deaths.126 Idro and colleagues127 thoroughly described clinical, electrophysiological, and brain imaging features and complications of nodding syndrome in 22 Ugandan children. The aetiology is unknown, but all studies that have assessed the association with onchocerciasis detected a trend toward more positive results for patients than for controls.128 In a study by Foltz and co-workers,129 positive onchocerciasis serology was associated with nodding syndrome (age-adjusted OR 14·4, 2·7–78·3).129

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However, onchocerciasis has long been endemic in large parts of west and central Africa, as well as parts of Central and South America, but nodding syndrome has been reported only in small localised areas.119 Further investigations into nodding syndrome are needed to identify the cause, preventive measures, and treatments.

Malaria is one of the tropical parasitic diseases commonly thought to have a role in the development of epilepsy.130 The brain damage that occurs during falciparum malaria is acute encephalopathy, which can be fatal or have polymorphic sequelae. Seizures can occur in children with cerebral malaria who present with neurological sequelae.89,90,131 The first study to show an association between falciparum malaria and epilepsy found that epilepsy occurred in 9% (4·4, 1·4–13·7) of children exposed to cerebral malaria and 12% (6·1, 2·0–18·3) exposed to malaria and complex seizures.89

Two studies that used differing but complementary approaches to epidemiology found a relation between cerebral malaria and epilepsy with an adjusted relative risk of 14·3 (95% CI 1·6–132·0; p=0·01) in Mali90 and an adjusted odds ratio of 3·9 (1·7–8·9; p=0·001) in Gabon.132 In Malawi, 12 of 132 children with retinopathy-positive cerebral malaria developed epilepsy (p<0·0001).133 The other risk factors for epilepsy were a high maximum temperature (39·4°C [SD 1·2] *vs* 38·5°C [1·1]; p=0·01) and acute seizures (11 of 12 *vs* 76 of 120; OR 6·37, 95% CI 1·02–141·2).134

Toxocariasis is a zoonotic infection seen mainly in children and transmitted by *Toxocara canis* or *T cati.* The association between toxocariasis and epilepsy is known and a significant relationship has been observed in Burundi (OR 2·1, 1·2–3·8).79 A meta-analysis by Quattrocchi and colleagues18 showed a positive association between toxocariasis and epilepsy (OR 1·92, 1·50–2·44; p<0·001). Toxocara was associated with active convulsive epilepsy in five studies in Africa, with a population attributable fraction of 0·16 (0·08–0·24).15 However, two other studies found no significant relation between epilepsy and seropositivity.106,135 A positive association between seropositivity for *Toxocara* spp and epilepsy can be hypothesised, but even the association shown in the meta-analysis18 does not prove causality. Further studies are needed to estimate the effect of toxocariasis on the global burden of epilepsy.

Traumatic brain injury

In Africa, road accidents are the most common cause of brain injury owing to the lack of traffic regulation and failure to wear a seat belt or helmet (for motorcyclists). Brain damage can also result from accidents, assault, and injury in war, or violent sport.136 The risk of post-traumatic epilepsy depends on the degree and severity of the injury and the resulting complications. In a study in Mali, post-traumatic epilepsy was found in 7% of 70 patients with epilepsy.43

Brain tumours

The prevalence of brain tumours was low in the population in whom seizures occurred.137 A lack of diagnostic equipment, such as CT and MRI, in many developing countries means that brain tumours are not detected, and most are diagnosed in the terminal stages.

Cerebrovascular disease

Epilepsy can be an early or late complication of stroke, which is one of the most common causes of epilepsy in elderly people.138 Most studies in sub-Saharan Africa are biased and provide little reliable information about the incidence and prevalence of stroke. Indeed, because expertise and cerebral imaging are scarce, many cases of stroke are not diagnosed, especially transient ischaemic attacks.139,140 Most available studies of stroke in sub-Saharan Africa are hospital series, so do not reflect the true incidence of cerebral infarction in the population, owing to selection bias. Brain imaging is necessary for confirmation of the types of stroke but is not generally available.141

The reported frequency of epilepsy in cerebrovascular diseases in Africa varies widely (1% to 42%; mean 7% [SD 10]), whereas in more developed countries, 3–4% of patients with epilepsy have a history of cerebral stroke.137

Treatment

The management of epilepsy involves identification of the cause, administration of antiepileptic drugs to control seizures, and the prevention and treatment of the comorbidity. Epilepsy surgery is rarely available in sub-Saharan Africa. Early and appropriate care in more developed countries achieves seizure control in 70–80% of cases.142

The treatment gap is defined as the difference between the number of people with active epilepsy and the number whose seizures are treated appropriately in a given population at a given time, expressed as a percentage. It reflects the proportions seeking treatment for epilepsy and who adhere to the prescribed treatment.143 Support for people with epilepsy is very difficult in Africa, especially in rural areas, for several reasons: the scarcity of knowledgeable staff and investigative resources to ensure a diagnosis;69,144 non-acceptance and non-compliance with care by patients and their families because of their beliefs about the causes of epilepsy; the high cost of drugs and their relative unavailability; and the psychosocial effects of the disease.144–146 Several reasons for the treatment gap identified in a systematic review were lack of skilled manpower to make the diagnosis, cost of treatment, cultural beliefs, and unavailability of antiepileptic drugs.147 The distribution of health-care resources between rural and urban areas is probably crucial.148 A systematic review by WHO reported a treatment gap greater than 95% to exist in Ethiopia, The Gambia, Nigeria, Togo, Uganda, Tanzania, and Zambia.149

Procedures (identification, treatment, and follow-up) that will improve the identification and management of people with epilepsy in rural and semi-rural areas in sub-Saharan Africa must be implemented within the existing system of primary health care and with the participation of the community. The WHO Mental Health Gap Action Programme aims to scale-up services for mental, neurological, and substance-misuse disorders, especially for countries with low and middle income. The programme asserts that with proper care, psychosocial assistance, and medication, tens of millions could be treated for epilepsy,

For the **WHO Mental Health Gap Action Programme** see http://www.who.int/mental_health/mhgap/en/

prevented from suicide, and allowed to lead normal lives—even where resources are scarce.150

About 80–85% of people with epilepsy are not treated adequately,151,152 because of economic, cultural, social, and legislative barriers, compounded by the lack of incentive for pharmaceutical companies because drug distribution is not lucrative.153 In sub-Saharan Africa, an average of 59% (95% CI 32–85) of patients do not take any antiepileptic treatment,37,38,52,53 and on average only 33% of patients receiving antiepileptic treatment are properly managed (table 9).29,61,80

The sensitivity and specificity of self-reported adherence is poor, but by detection of antiepileptic drugs in blood, almost two-thirds of patients with epilepsy were not taking treatment.62,143 The risk factors for not seeking biomedical treatment in Kenya were traditional animistic religious beliefs (adjusted OR 1·85, 1·11–2·71), living more than 30 km from health facilities (3·89, 1·77–8·51), paying for drugs (2·99, 1·82–4·92), having learning difficulties (2·30, 1·29–4·11), having had epilepsy for longer than 10 years (4·60, 2·07–10·2), and having focal seizures (2·28, 1·50–3·47).143 The risk factors for non-adherence, as measured by blood concentrations of antiepileptic drugs, were negative attitudes about epilepsy (1·10, 1·03–1·18) and treatment with antiepileptic drugs for longer than 5 years (3·78, 1·79–7·98).

Phenobarbital is effective in all forms of epilepsy except typical absences. It is especially effective in generalised seizures, either immediately or secondarily, and because of its low cost it is the most prescribed antiepileptic drug worldwide. In Cameroon, phenobarbital is used in 75% of cases, carbamazepine in 15%, and phenytoin in 3%; each is prescribed as monotherapy in 94% of cases.80 With treatment, remission of seizures was observed in 70% of patients, a decrease in frequency in 16%, and failure to improve in 14%. A study in Mali found that almost 60% of the people who took phenobarbital were free of seizures at the last follow-up.154 However, phenobarbital is not always available in most pharmacies. A survey of pharmacies in Zambia found that almost half did not stock any antiepileptic drugs at all and that only a fifth stocked phenobarbital.155 The low availability of antiepileptic drugs in the public sector suggests that poor people are especially disadvantaged in terms of access to the drugs. Oral antiepileptic drugs are more likely to be available in the private than in the public sector, but availability is still inadequate.156 The border regulation procedures for importation of phenobarbital are a constraint; it is deemed to be a narcotic substance.

In most people with epilepsy, antiepileptic treatment is interrupted, resulting in ineffective control and drug resistance. The reasons given for treatment interruption are inconsistent drug supplies to clinics, and the cost to the patients or their families of the antiepileptic drugs and the visit to pick them up from the clinics. For example, in Rwanda, 74% of patients stop their treatment owing to lack of financial resources.33 The morbidity and premature mortality associated with epilepsy and the large economic burden that it imposes on health-care systems can only be mitigated by greater availability of effective antiepileptic treatment.

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For the few individuals whose condition does not respond to pharmacotherapy, surgery is the only option for cure. Epilepsy surgery is not available in most of sub-Saharan Africa because of cost, the absence of neurosurgeons, and the lack of infrastructure to maintain advanced technology.157,158

Conclusion

Since the 2005 Review by Preux and Druet-Cabanac,3 several valid epidemiological studies have been carried out in sub-Saharan Africa. However, even now insufficient evidence is available on the incidence and mortality of epilepsy in the region. The use of different methods and variations in sample size and populations studied make the comparison of studies and drawing of robust conclusions very difficult. We have applied random-effects models to take into account this heterogeneity in a meta-analyses, and our meta-regression indicated that methodology and geographical area might explain 60% of variability in prevalence. Epidemiologists therefore must establish standard methodological rules that are applicable in less developed countries. These rules could be adapted from guidelines published lately.159

Despite the variety of survey methods and definitions, these studies consistently show that the prevalence reported in African studies is underestimated and does not reflect reality because of the social stigma surrounding epilepsy. Many people in Africa believe that epilepsy is contagious and some people avoid touching patients, especially during seizures, when some simple forms of help can avoid dangerous situations.160–162 Given the social morbidity of the condition, the need for interventions to reduce stigma is also urgent; few such intervention studies have been done and the capacity to measure stigma meaningfully is limited.

Many risk factors for epilepsy in sub-Saharan Africa are infectious and preventable. Perinatal factors have an important role in the onset of epilepsy, but are still very little studied. Better understanding of the relation between the risk factors and epilepsy is a key issue in improving prevention of epilepsy in Africa.

Finally, despite the importance of epilepsy and the availability of medication that is effective in many cases, epilepsy is rarely a public-health priority in Africa. For economic and social reasons, three-quarters of people with epilepsy worldwide, most of whom live in less developed countries, are not properly treated. Many of the risk factors for the treatment gap can be addressed, but appropriate strategies to prevent epilepsy and reduce the stigma and treatment gap in Africa are urgently needed.

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Search strategy and selection criteria

We searched eight electronic databases: PubMed, African Index Medicus, Scopus, Science Direct, African Journal of Neurological Sciences, African Journal Online, the African Virtual Library of Neurology, and the Sudoc Catalog of PhD Theses. The search was done without date limitation, for all 48 countries that make up sub-Saharan Africa, with the keyword “epilepsy”, combined with each of the following: “epidemiology”, “prevalence”, “incidence”, “aetiology”, “cohort”, “case-control”, “seizure”, and “treatment” for each country. Other keywords also used were: “malaria”, “neurocysticercosis”, “cysticercosis”, “mortality”, “therapy”, “risk factor”, “onchocerciasis”, and “toxocariasis”. The search was restricted to papers published in English or French.

The bibliographies of all articles included were searched for further references. Articles were included if they had at least an abstract in English or French and presented an explicit and correct epidemiological definition of epilepsy according to the International League Against Epilepsy, 1993.2

To avoid methodological biases, we selected only studies that focused on the general population, including cohort, cross-sectional (including door-to-door), and case-control studies; those based only on medical registries were excluded. There was no limitation on the date of publication of articles up to April 30, 2013.

We identified 1104 publications, covering 32 countries in sub-Saharan Africa. No information was found about epilepsy in 16 countries (Angola, Botswana, Cape Verde, Comoros, Djibouti, Eritrea, Guinea, Equatorial Guinea, Guinea-Bissau, Lesotho, Mauritius, Namibia, São Tomé and Príncipe, Seychelles, Somalia, and Chad). 119 articles were selected for review (figure 1). We have aggregated data as much as possible, but the paucity of published work means we also have to discuss some specific results.

For the **African Virtual Library of Neurology** see http://wwwient.unilim.fr
For the **Sudoc Catalog of PhD Theses** see http://www.sudoc.abes.fr/

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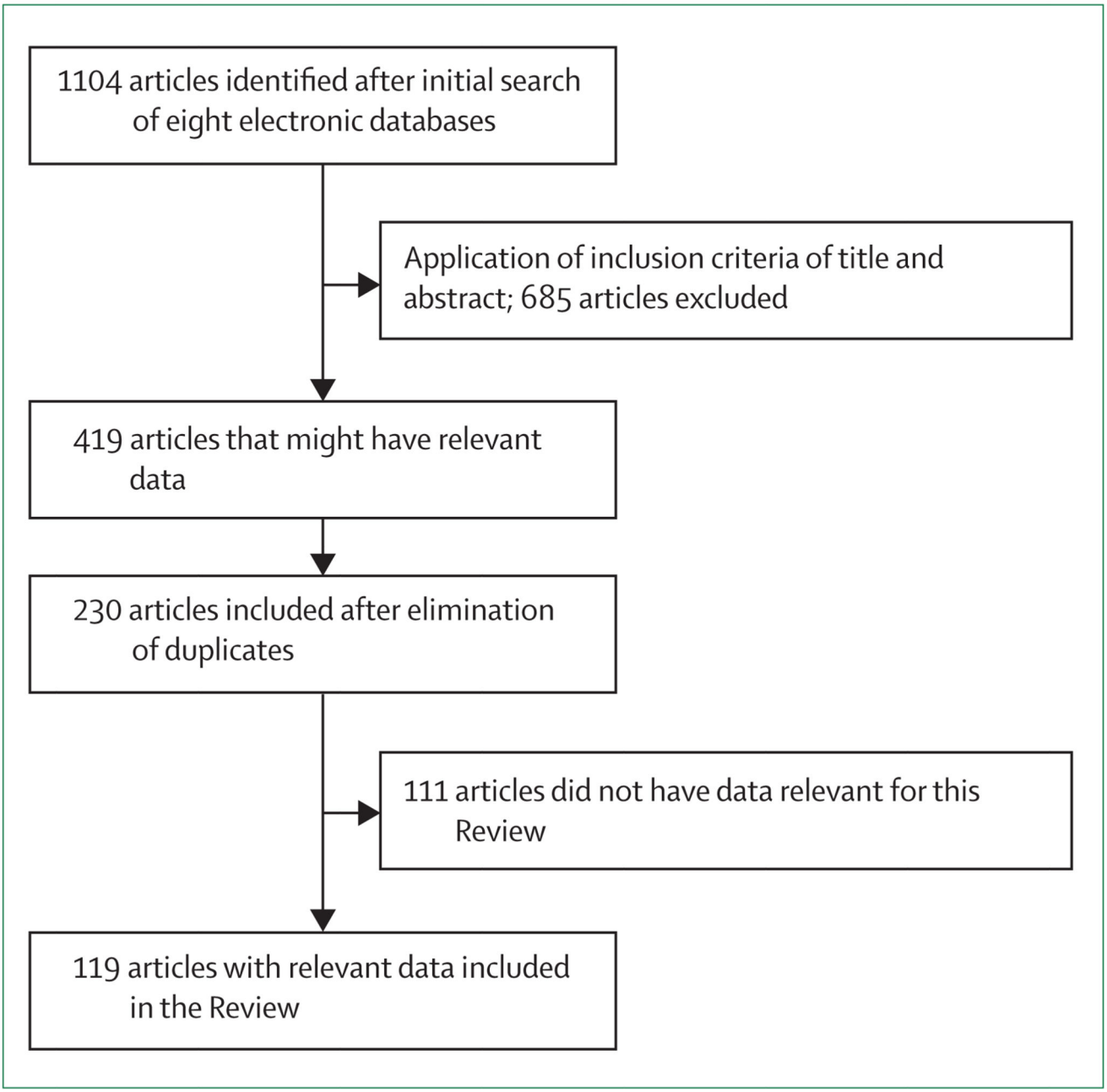

Figure 1. Flow chart showing selection procedure for articles in this Review

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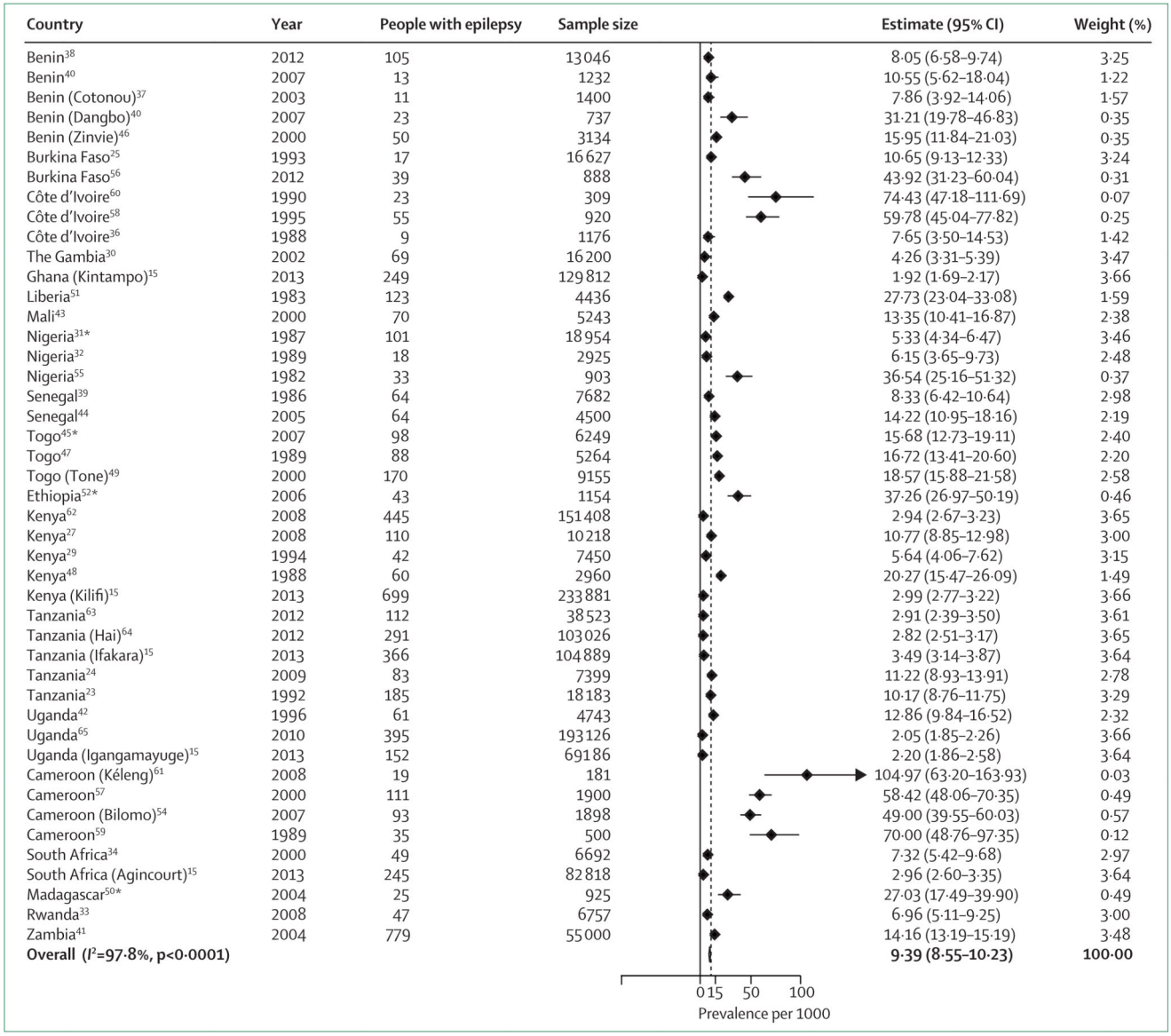

Figure 2. Global meta-analysis of epilepsy prevalence in sub-Saharan Africa

For each item in figures 2–4, the following information was collected: authors, year of publication, journal, country, type of study, study population, method of data collection, and results on prevalence, incidence, seizure types, causes and risk factors, and treatment. Raw or adjusted prevalence expressed as the number of cases per 1000 population was presented in a summary table with 95% CI. Incidence is expressed as number of cases per 100 000 inhabitants per year. 95% CI were calculated by an exact method when not provided in the publication. Median prevalence was calculated from all studies that reported prevalence. Random-effects meta-analysis was done and forest plots obtained. Weighted prevalence rates were calculated.70 Weights were based on the precision of the estimates for each study (ie, SE of prevalence assuming a Poisson distribution for calculation of 95% CI). We also calculated I^2, which reflects the percentage of total variation across studies that is due to

heterogeneity rather than chance. Because heterogeneity was statistically significant, random-effects models were used. We calculated an overall pooled prevalence as well as one stratified by method (door-to-door *vs* cross-sectional) and geographical region (west, east, central, and southern Africa). Analyses used Stata v11.1. *Studies in which the estimates are based only on active epilepsy.

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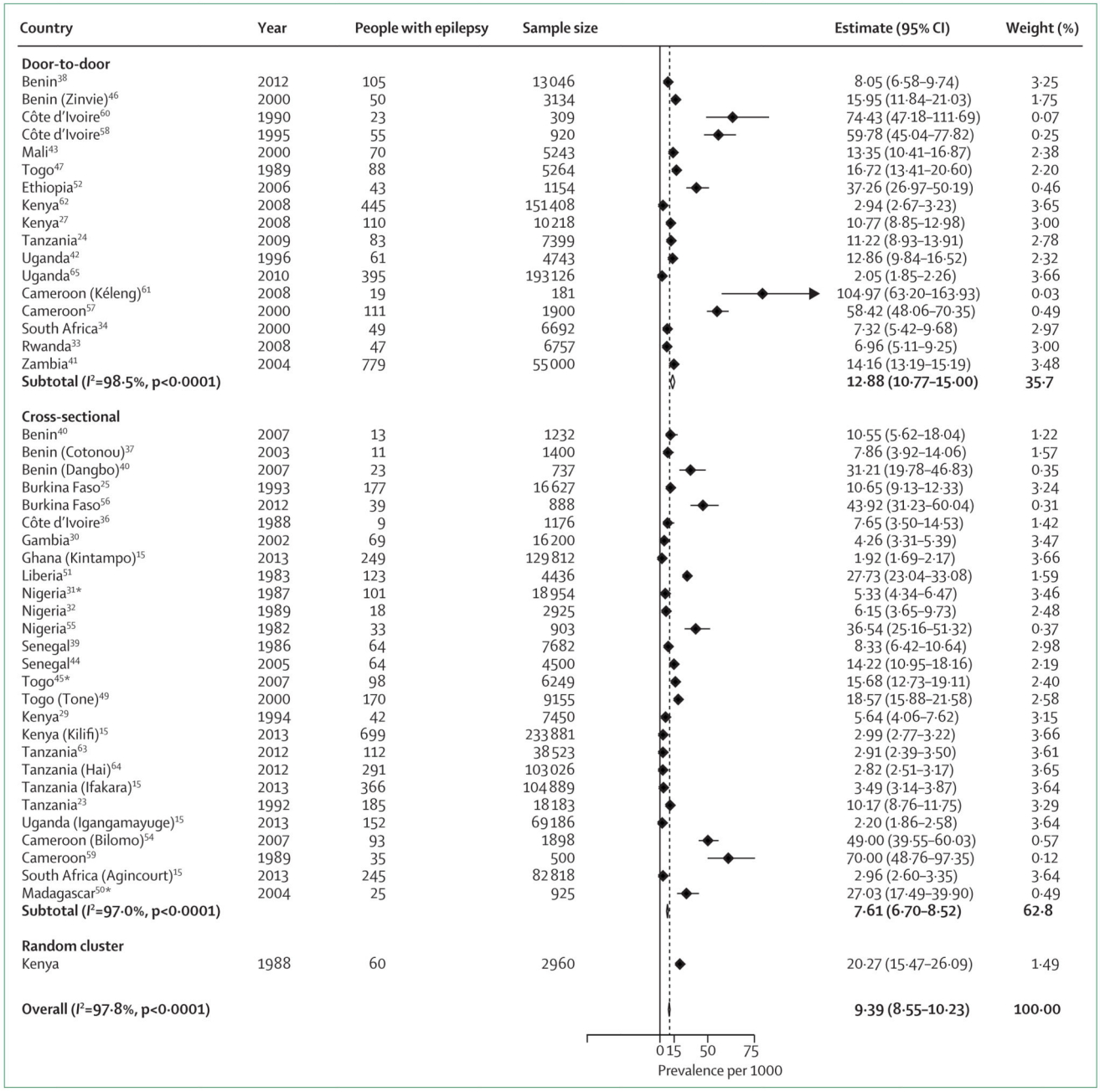

Figure 3. Meta-analysis of epilepsy prevalence in sub-Saharan Africa according to the type of study

*Studies in which the estimates are based only on active epilepsy.

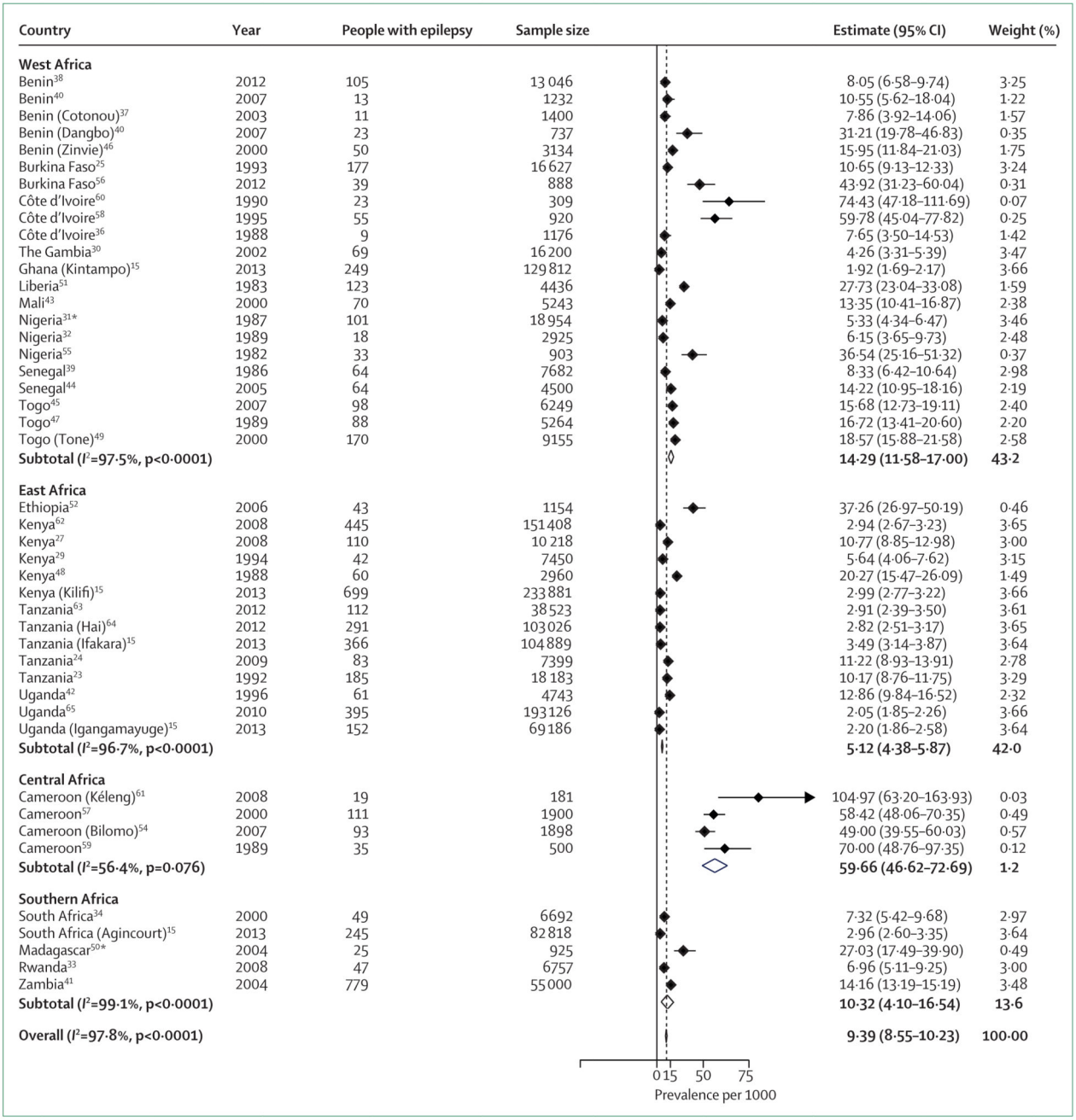

Figure 4. Meta-analysis of epilepsy prevalence in sub-Saharan Africa according to geographical region

*Studies in which the estimates are based only on active epilepsy.

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Table 1
Studies of the incidence of epilepsy in sub-Saharan Africa

	Year	N	Incidence (95% CI)*	Sex ratio (M/F)	Proportion aged <20 years	Type of study
Ethiopia21	1997	61686	64·0 (44–84)	1·2	79·0%	Prospective
Benin (Djidja)22	2013	11668	69·4 (30–137)	0·9	NA	Prospective
Tanzania23	1992	18183	73·3 (34–113)	0·9	60·8%	Retrospective
Tanzania24	2009	7399	81·0 (65–101)	1·0	59·1%	Prospective
Burkina Faso25	1993	16627	83·0 (40–126)	1·7	76·2%	Retrospective
Uganda26	1998	4389	156·0 (145–166)	1·2	97·5%	Prospective
Kenya27	2008	10218	187·0 (133–256)	1·0	NA	Prospective
Kenya28	2013	623004	77·0 (68–87)	0·9	54·5%	Retrospective

NA=not available.

* Per 100 000 person-years of follow-up.

Table 2
Studies of the prevalence of epilepsy in sub-Saharan Africa

	Year	N	Prevalence, per 1000 (95% CI)	Sex ratio (M/F)	Proportion aged <20 years	Method	Population
West Africa							
Benin38	2012	13046	8·0 (6·59–9·74)	0·7	18·1%	DTD	Rural
Benin40	2007	1232	10·6 (5·9–18·5)	NA	NA	CS	Urban
Benin (Cotonou)37	2003	1400	7·9 (4·5–14·5)	1·6	82·0%	CS	Urban
Benin (Dangbo)53	2007	737	31·0 (18·4–43·5)	0·8	45·7%	CS	Rural
Benin (Zinvie)46	2000	3134	15·9 (22·3–44·3)	0·8	52·4%	DTD	Rural
Burkina Faso25	1993	16627	10·6 (9·1–12·2)	1·7	76·2%	CS	Rural
Burkina Faso56	2012	888	45·0 (33·0–60·0)	NA	NA	CS	Rural
The Gambia30	2002	16200	4·9 (4·5–5·3)	NA	NA	DTD	Rural
Ghana (Kintampo)15	2013	129812	4·9 (4·4–5·3)	0·8	NA	DTD	Rural
Côte d'lvoire36	1988	1176	7·6 (2·6–12·6)	0·7	88·8%	CS	Rural
Côte d'lvoire58	1995	920	59·0 (43·7–74·2)	1·4	36·4%	CS	Rural
Côte d'lvoire36	1990	309	74·4 (43·0–104·9)	0·5	91·3%	CS	Rural
Liberia51	1983	4436	28·0 (23·1–32·8)	1·1	NA	CS	Rural
Mali43	2000	5243	13·3 (10·5–16·7)	0·1	NA	DTD	Rural
Nigeria32	1989	2925	6·2 (3·4–9·0)	0·1	61·5%	CS	Rural
Nigeria (Aiyété)55	1982	903	37·0 (24·7–49·3)	0·6	NA	CS	Rural
Nigeria (Igbo-Ora)31 *	1987	18954	5·3 (4·2–6·3)	0·9	NA	CS	Urban
Senegal39	1986	7682	8·3 (6·2–10·4)	NA	65·6%	CS	Rural
Senegal44	2005	4500	14·2 (10·7–17·7)	NA	39·1%	CS	Urban
Togo (Kozah)47	1989	5264	16·7 (13·2–20·2)	1·6	NA	CS	Rural
Togo (Tone)49 *	2000	9155	18·6 (15·8–21·3)	0·9	NA	DTD	Rural
Togo (Batamariba)45 *	2007	6249	15·7 (12·7–19·2)	1·4	29·6%	CS	Rural
East Africa							
Ethiopia52 *	2006	1154	29·5 (19·7–39·3)	1·1	57·0%	DTD	Rural
Kenya29	1994	7450	4·0 (2·6–5·4)	0·8	50·6%	DTD	Rural
Kenya48	1988	2960	18·2 (13·3–23·0)	NA	NA	DTD	Rural
Kenya (Kilifi)27	2008	10218	41·0 (31·0–51·0)	1·0	NA	CS	Rural
Kenya (Kilifi)15	2013	233881	3·8 (3·5–4·0)	1·0	NA	DTD	Rural
Kenya62	2008	151408	2·9 (2·6–3·2)	1·0	44·2%	DTD	Rural
Tanzania24	2009	7399	13·2 (11·9–14·5)	1·0	59·1%	CS	Rural
Tanzania63	2012	38523	2·9 (2·4–3·5)	1·0	23·9%	CS	Rural
Tanzania (Hai)64	2012	104889	2·9 (2·5–3·2)	1·0	NA	CS	Rural
Tanzania (Ifakara)15	2013	104889	7·2 (6·5–7·8)	1·4	NA	CS	Rural
Tanzania35 *	2005	4905	7·4 (5·0–9·8)	0·8	NA	DTD	Rural
Tanzania23 *	1992	18183	12·1 (10·5–13·7)	0·9	60·8%	CS	Rural
Uganda42	1996	4743	13·0 (9·7–16·2)	NA	NA	DTD	Rural
Uganda65	2010	440	2·0 (1·94–2·20)	1·0	100%	DTD	Rural

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	Year	N	Prevalence, per 1000 (95% CI)	Sex ratio (M/F)	Proportion aged <20 years	Method	Population
Uganda (Igangamayuge)15	2013	69186	5·0 (4·4–5·6)	1·8	NA	CS	Rural
Central Africa							
Cameroon54	2007	1898	35·4 (27·4–43·4)	1·2	89·2%	DTD	Rural
Cameroon (Kéleng)61	2008	181	134·5 (90·0–178·0)	1·2	NA	DTD	Rural
Cameroon (Bilomo)57	2000	1900	58·4 (47·8–69·0)	0·9	NA	CS	Rural
Cameroon59	1989	500	70·0 (47·6–92·3)	NA	NA	CS	Rural
Southern Africa							
Madagascar50 *	2004	925	23·5 (11·6–30·0)	0·5	NA	DTD	Urban
Rwanda33	2008	6757	7·0 (5·0–9·0)	0-8	NA	CS	Rural/urban
South Africa34	2000	6692	7·3 (5·3–9·3)	NA	NA	CS	Rural
South Africa (Agincourt)15	2013	82818	3·4 (3·0–3·8)	1·0	NA	DTD	Rural
Zambia41	2004	55000	12·5 (11·6–13·4)	1·3	70·9%	DTD	Rural

DTD=door-to-door. CS=cross-sectional. NA=not available.

* Active epilepsy.

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Table 3
Meta-regression of prevalence of epilepsy in sub-Saharan Africa

	Prevalence estimate (95% CI)
Door-to-door	
East Africa	12·3 (4·8 to 19·8)
West Africa	22·1 (14·2 to 30·0)
Central Africa	64·8 (48·4 to 81·1)
Southern Africa	13·7 (2·7 to 24·8)
Cross-sectional	
East Africa	5·1 (−2·3 to 12·4)
West Africa	14·9 (9·3 to 20·4)
Central Africa	57·5 (41·4 to 73·6)
Southern Africa	6·5 (0 to 18·2)

Random-effects meta-regression as weighted variance of prevalence was done using Stata v11.1. We introduced explanatory variables as dummy variables in the model. Adjusted R^2 of the model was 59%.

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Table 4

Age at onset of seizures

	Year	Proportion <10 years	Proportion 10–20 years	Proportion >20 years
Benin37	2003	18%	82%	NA
Benin (Dangbo)53	2007	NA	74%	26%
Burkina Faso25	1993	58%	19%	23%
Burkina Faso56	2012	42%	24%	34%
Cameroon76	2003	25%	68%	7%
Cameroon61 *	2007	14%	80%	4%
Kenya77	2010	51%	NA	NA
Rwanda33 †	2008	55%	23%	21%

NA=not available.

*Age unknown in 2%.

†Age unknown in 1%.

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Table 5
Prevalence of epilepsy in sub-Saharan Africa stratified by sex

	Year	Male individuals	Female individuals	Prevalence (per 1000) in male population	Prevalence (per 1000) in female population	People with epilepsy	Method
Benin37	2003	854 (61%)	546 (39%)	3·5	14·7	1400	CS
Benin53	2007	12 (94%)	1 (6%)	10·4	13·5	13	CS
Benin46	2000	30 (45%)	36 (55%)	NA	NA	66	DTD
Benin38	2012	54 (51%)	51 (49%)	9·7	6·8	105	DTD
Burkina Faso25	1993	NA	NA	13·8	8·1	177	CS
Togo (Kozah)47	1989	48 (54%)	30 (34%)	26·2	10·7	88	CS
Togo (Batamariba)45	2007	54 (61%)	34 (39%)	17·8	13·5	98	CS

NA=not available. DTD=door–to-door. CS-cross-sectional.

Table 6
Types of seizure among patients with epilepsy in sub-Saharan Africa

	Year	People with epilepsy	Proportion of patients with seizures of type							EEG
			GTC	Absence	PS	PC	PSG	Other	Not classified	
South Africa34	2000	49	96%	..	4%	..	..	..	..	No
Benin46	2000	66	68%	6%	6%	..	14%	6%	..	Yes
Benin37	2003	11	37%	18%	18%	9%	..	18%	..	No
Benin38	2012	105	80%	..	6%	..	14%	..	..	Yes
Burkina Faso25	1993	177	71%	..	13%	16%	..	..	..	No
Burundi78	2005	249	59%	..	..	..	31%	8%	2%	Yes
Burundi79	2007	191	39%	..	61%	..	..	..	<1%	Yes
Cameroon80	2004	125	86%	..	4%	..	..	9%	1%	No
Cameroon61	2008	19	52%	..	..	16%	32%	..	..	Yes
Democratic Republic of the Congo (Mayama)81	1995	20	80%	5%	..	..	15%	..	..	No
Democratic Republic of the Congo (Kibouend)81	1995	24	92%	..	4%	..	..	4%	..	No
Ethiopia82	1990	316	75%	<1%	14%	..	6%	..	5%	Yes
Ethiopia52	2006	82	82%	..	..	3%	6%	9%	..	No
The Gambia30	2002	69	48%	..	2%	6%	36%	8%	..	No
Kenya83	1991	302	59%	..	..	..	38%	3%	..	No
Kenya29	1994	30	53%	..	3%	17%	7%	..	20%	NA
Kenya27	2008	110	33%	4%	9%	7%	32%	13%	2%	Yes
Mali43	2000	70	67%	7%	..	..	18%	..	8%	No
Central African Republic84	1999	208	95%	..	1%	4%	..	..	..	NA
Senegal39	1986	64	60%	8%	16%	..	5%	6%	5%	No
Senegal44	2007	64	78%	..	3%	5%	14%	..	..	NA
Tanzania23	1992	207	57%	1%	1%	9%	22%	..	10%	No
Tanzania25	2009	83	54%	..	1%	..	22%	..	23%	No
Uganda85	2000	91	63%	..	24%	..	..	..	13%	Yes
Tanzania63	2012	112	17%	1%	2%	10%	64%	3%	3%	Yes
Tanzania 64	2012	291	2%	..	72%	..	..	..	26%	Yes
Uganda65	2010	395	61%	..	6%	27%	..	6%	..	Yes

GTC=generalised tonic-clonic. PS=partial simple. PC=partial complex. PSG=partial secondarily generalised. NA=not available.

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Table 7

Risk factors for epilepsy in sub-Saharan Africa

	Year	N	Cranial trauma	Perinatal cause	Infections	Tumour	Vascular	Febrile convulsions	Family history	Other or none
Burkina Faso25	1993	177	1%	10%	6%	2%	2%	NA	23%	56%
Cameroon54	2007	66	5%	19%	10%	NA	NA	NA	63%	9%
Cameroon61	2008	181	NA	NA	11%	NA	NA	22%	100%	33%
Côte d'lvoire58	1995	55	4%	2%	13%	NA	NA	16%	49%	16%
Democratic Republic of the Congo (Kibouende)81	1995	24	NA	NA	NA	NA	NA	NA	40%	60%
Democratic Republic of the Congo (Mayama)81	1995	20	NA	NA	NA	NA	NA	NA	60%	40%
Ethiopia82	1990	316	NA	NA	NA	NA	NA	NA	32%	68%
Ethiopia21	1997	139	6%	6%	1%	NA	1%	NA	22%	64%
The Gambia30	2002	69	NA	67%	NA	NA	NA	31%	67%	NA
Kenya83	1991	302	4%	6%	8%	NA	NA	NA	3%	79%
Liberia51	1983	123	3%	3%	NA	NA	NA	38%	53%	3%
Mali43	2000	70	7%	36%	47%	NA	NA	NA	30%	NA
Nigeria31	1987	100	6%	2%	NA	1%	2%	24%	5%	60%
Nigeria32	1989	580	3%	9%	7%	NA	NA	6%	NA	75%
Tanzania23	1992	207	<1%	1%	3%	<1%	<1%	13%	NA	75%

N=number of patients with epilepsy studied. NA=not available

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Table 8

Case-control studies of risk factors for epilepsy in sub-Saharan Africa

	Year	Cases	Controls	Multivariate analysis	Febrile convulsions	Family history	Cranial trauma	Perinatal cause	CNS infection	Onchocerciasis	Cysticercosis	Toxocariasis	Malaria
Burundi79 *	2007	191	191	Yes	NA	NA	NA	NA	NA	NA	NA	2·1 (1·2–3·8)	NA
Burundi86 †	2003	324	648	Yes	NA	3·3 (2·3–4·7)	NA	1·9 (1·1–3·7)	NA	NA	4·1 (3·0–5·6)	NA	NA
Cameroon80	2004	93	81	No	NA	NA	NA	NA	NA	NA	NS	NA	NA
Mali43	2000	70	140	No	NA	NA	NA	NA	NA	1·0 (0·5–2·3; NS)	NA	NA	NA
Uganda87	2011	38	38	No	NA	NA	NA	NA	NA	1·7 (0·6–4·6; NS)	NA	NA	NA
Central African Republic84	1999	187	374	No	NA	NA	NA	NA	NA	1·2 (0·8–1·8; NS)	NA	NA	NA
Tanzania88 ‡	2001	174	174	Yes	2·9 (1·6–6·2)	3·3 (1·2–5·8)	NA	4·5 (1·2–16·1)	3·7 (0·72–19·6)	NA	NA	NA	NA
Tanzania63 §	2012	112	113	Yes	2·4 (0·8–7·0)	5·7 (1·0–27·5)	7·6 (0·6–97·3)	14·9 (1·4–151)	NA	NA	NA	NA	NA
Kenya89	2004	254	273	No	NA	NA	NA	NA	NA	NA	NA	NA	4·4 (1·4–13·7)
Mali90	2006	101	222	No	NA	NA	NA	NA	NA	NA	NA	NA	14·3 (1·6–132)
Gabon91	2006	296	296	No	NA	NA	NA	NA	NA	NA	NA	NA	3·9 (1·7–8·9)

Data are odds ratio (95% CI), unless otherwise stated. NA=not available. NS=not significant.

* Adjusted for seropositivity for *Toxocara canis*, seropositivity for cysticercosis, occupation, and religion.

† Adjusted for seropositivity for cysticercosis, family history of epilepsy, severe disease during childhood, latrines near house, and exposure to pigs.

‡ Adjusted for family history of epilepsy, febrile convulsions, cranial trauma, and neonatal or intrapartum complications.

§ Adjusted for perinatal event, head injury, history of febrile seizures, and poor educational attainment.

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Table 9
Proportions of types of treatment and treatment deficit

	Year	N	Medical	Traditional	Mixed	None
Benin38	2012	105	13·3%	NA	29·5%	57·2%
Benin53	2007	13	46·2%	7·6%	NA	46·2%
Benin37	2003	11	9·1%	18·2%	9·1%	63·6%
Cameroon80	2004	125	68·8%	16·0%	9·6%	5·6%
Cameroon61	2008	19	68·0%	26·0%	NA	6·0%
Ethiopia82	1990	316	8·5%	55·9%	10·8%	24·8%
Ethiopia52	2006	82	38·0%	9·0%	9·0%	44·0%
Kenya29	1994	30	70·0%	23·0%	NA	7·0%
Mali43	2000	70	NA	61·0%	35·0%	4·0%
Rwanda33	2008	47	41·0%	38·0%	NA	21·0%
Senegal44	2005	64	42·2%	12·5%	34·4%	10·9%
South Africa34	2000	49	22·5%	22·5%	20·4%	34·6%
Tanzania7	2005	42	NA	35·7%	4·8%	59·5%

NA=not available.