

RESEARCH

Open Access



Assessing traditional medicine in the treatment of neurological disorders in Mali: prelude to efficient collaboration

Youssofa Maiga^{1,2,3*}, Leon Samuel Moskatel⁴, Seybou H. Diallo^{1,2}, Oumar Sangho², Housseini Dolo², Fatoumata Konipo², Salimata Diallo¹, Awa Coulibaly¹, Mariam Daou¹, Modibo Sangaré², Thomas Coulibaly², Adama Sissoko², Guida Landouré², Mohamed Albakaye¹, Zoumana Traoré⁵, Abdoul Karim Dao⁶, Mamadou Togo⁶, Saliou Mahamadou⁶, Souleymane dit papa Coulibaly², Najib Kissani⁷, Karamoko Nimaga⁸, Rokia Sanogo², Fabrice Berna⁹, Madani Ouologem¹⁰, Callixte Kuate¹, Robert Cowan⁴ and Julien Nizard^{3,11,12}

Abstract

Introduction Neurological disorders (ND) have a high incidence in sub-Saharan Africa (SSA). In this region, systemic challenges of conventional medicine (CM) and cultural beliefs have contributed to a large utilization of traditional medicine (TM). Yet, data on TM and those who use it in the treatment of ND in SSA are scarce. Here, we systematically analyze its role as a therapy modality for ND in Mali, the socio-demographic characteristics of its users, and propose next steps to optimize the dual usages of TM and CM for patients with ND.

Methods We conducted a questionnaire study in two phases. In phase one, patients with ND answered questions on their usage of and attitudes towards TM. In phase two, the TM therapists who provided care to the patients in phase one answered questions regarding their own practices for treating ND. Patients were recruited from the country's two university neurology departments.

Results 3,534 of the 4,532 patients seen in the Departments of Neurology in 2019 met the inclusion criteria. Among these 3,534 patients, 2,430 (68.8%) had previously consulted TM for their present ND. Patients over 60 years of age most often used TM (83.1%). By education, illiterate patients utilized TM the most (85.5%) while those with more than a secondary education used TM the least (48.6%). An income greater than the minimum guaranteed salary was associated with decreased use of traditional medicine (OR 0.29, CI 0.25–0.35, $p < 0.001$). Among those using TM, it was overwhelmingly thought to be more effective than CM (84.6%). Linking illness to supernatural causes and believing TM therapists had a better understanding of illnesses were the most common reasons patients used traditional medicine (82.3% and 80.5%, respectively).

We then interviewed 171 TM therapists who had provided care to the patients in phase one. These providers most commonly “sometimes” (62.6%) referred patients to CM and 4.1% never had. A majority of TM providers (62.6%) believed collaboration with CM could be improved by having doctor “take into account” our existence.

Conclusion Our work shows that TM plays a central role in the provision of care for patients with ND in SSA with certain cohorts using it at higher rates. Future development of treatment of ND in SSA will require optimizing

*Correspondence:

Youssofa Maiga
youssofamaiga@hotmail.com

Full list of author information is available at the end of the article



© The Author(s) 2024. **Open Access** This article is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which permits any non-commercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if you modified the licensed material. You do not have permission under this licence to share adapted material derived from this article or parts of it. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by-nc-nd/4.0/>.

TM with CM and needs buy-in from all stakeholders including conventional medicine clinicians, traditional medicine therapists, researchers, politicians, and most importantly, patients.

Keywords Neurological Disorders, Traditional Medicine, Conventional Medicine, Health Care Delivery, Mali, Africa

Introduction

Sub-Saharan Africa (SSA) faces complex challenges in the delivery of health care due to sociopolitical, economic, systemic, and cultural factors [1]. This is complicated by an increase in the incidence of neurological disorders (ND) over the past 25 years [2]. ND now represent 7 to 25% of all admissions to African university hospitals [3–5]. The situation described in African literature is similar in Mali, where neurological pathologies (stroke, cerebral malaria, meningitis, head trauma) account for over 25% of emergency admissions in Bamako.

In Africa, TM therapists and healers play an essential role in the provision of health care, with the World Health Organization (WHO) estimating that 80% of the SSA population has first contact with these providers [6–8]. Utilization of these individuals has been associated with a multitude of factors including sociocultural, spiritual, and religious beliefs; economic constraints; and dissatisfaction of patients with conventional medicine (CM) as well as a dearth and unequal distribution of conventional health care facilities and practitioners [9–13]. That said, it has only been more recently that these traditional providers have been factored into health care schematics with the WHO creating traditional medicine (TM) research institutes in 36 African countries, including Mali [14].

Although TM is thought to be frequently used in the treatment of ND in SSA, few studies have characterized these practices and those that utilize the services of TM therapists. One such study in Guinea noted 79% of patients with epilepsy reported having consulted a TM therapist, and 71% had visited a healer before pursuing conventional medicine [13]. Our work here seeks to better understand the current role of TM in the provision of care for patients with ND and to propose a framework for integration of traditional and conventional medicines in SSA. A controlled and regulated collaboration of the two types of medicine (traditional and conventional) would have a positive impact on the safety and quality of care in the interest of patients.

Methods

Reference definitions are available in Appendix 1.

Type and dates of study

We conducted a prospective study from the 1st of January 2019 to the 31st of December 2019.

Site of the study

Mali is a West African country, comprising 19 administrative regions. The capital and largest city, Bamako. Mali continues to develop but is currently 184th out of 189 in the UNDP's human development index [15].

According to the latest census (RGPH5, 2022), Mali's population is estimated at 22 million 395 thousand 485 inhabitants, including: 47.2% of young people under the age of 15; 49.9% of people aged 15 to 64. Mali has one of the highest fertility rates in the world, with over six children per woman in 2018. The guaranteed interprofessional minimum wage (SMIG) has, since January 1, 2016 been 40,000 FCFA (US\$80) or 230 CFA/US\$0.4 per hour.

It is estimated that 23.8% of the country's population live in urban areas and 69.2% in rural areas. With regard to access to basic services, according to the latest report by the Direction Nationale de l'Hydraulique du Mali (DNHM, 2021), some 81% of the urban population have access to drinking water, while only 67% of rural dwellers have access to this basic service.

Health care in Mali is organized into three levels: the district health level (community health centers and reference health centers), the second level represents the regional hospitals, and the third level is anchored by the national hospitals and university hospital centers (UHC).

The lack of access to health facilities, extreme poverty, insufficient and unevenly distributed human resources, a shortage of qualified personnel, precarious technical facilities and socio-political instability all contribute to the inadequate health coverage.

The Gabriel Touré UHC (GT UHC) and the Point G UHC (PG UHC) neurology units, both located in Bamako, provide for the treatment of ND. GT UHC also acts as the teaching hospital for Mali general practitioners and neurologists. They serve a large catchment area including Bamako, the country's interior, and adjoining countries.

Regarding the diagnostics, the department of medical imaging has two 64-bar Computed Tomography (CT-Scan) machines. In addition, there are two private clinics equipped with 1.5-T Magnetic Resonance Imaging (MRI) machines located nearby the hospital that work closely with the department.

The newly-created CHU GT laboratory is equipped with an Electro-Encephalogram (EEG) machine and an Electromyography (EMG) machine. Cardiovascular assessment (electrocardiogram, echocardiography, supra-aortic echo-Doppler) is carried out by the cardiology department. Genetic studies are possible within the framework of our partnership with the National Institutes of Health (NIH) and the H3Africa project. The CHU GT laboratory provides the standard serological work-up (blood count, blood glucose, renal work-up, liver work-up, lipid work-up, thyroid work-up, immunological work-up, folate and vitamin B12 assays, Human Immunodeficiency Virus (HIV) serology, malaria testing, Coronavirus Polymerase Chain Reaction (PCR) version 2019 (COVID 19), as well as routine cerebrospinal fluid (CSF) testing (cytology, chemistry, bacteriology). For the diagnosis of inflammatory diseases of the Central Nervous System (CNS), research into anti-AQP4 and anti-MOG antibodies is carried out within the framework of our partnership with foreign research collaborators. CHU GT also features a Neurosurgery Department staffed by five neurosurgeons and their teams.

Population of the study

For the first phase quantitative survey, the potential study population included all patients seen in hospitalization or in external consultation through the Department of Neurology at GT UHC.

For the second phase qualitative survey, the potential study population included the TM therapists who had treated the patients in phase one.

Inclusion criteria

Phase 1:

- Hospitalization or external consultation in the Department of Neurology at GT UHC
- Having provided informed consent (for adults)
- Having provided approval (for accompanied minors) and informed consent (for their legal representative)
- Having a definite or probable neurological diagnosis
- Having a complete chart with the clinical and the paraclinical information.

Phase 2:

- Being a TM therapist
- Having treated a patient included in Phase 1
- Having provided contact details to the patient and received their informed consent about their medical files.
- Having provided consent.

Exclusion criteria

Phase 1:

- A patient whose condition does not allow them to speak
- Refusal of a parent or relative.

Phase 2:

- Non-completion of the interview

Size of the sample and the sampling

Sample Size and Sampling

Sampling We conducted two types of sampling per participant group: (1) Patients and (2) traditional therapists. Patients were recruited based on predefined inclusion criteria, and those who met these criteria were subsequently invited to participate in the study. In fact, we used convenience sequential sampling method to interview 4,532 patients. These patients were either inpatients or outpatients in the Neurology Department of Gabriel Touré University Hospital.

For traditional therapists, we proceeded with snowball sampling that involved identifying traditional therapists who had provided services to phase 1 patients. We collected these therapists' contact information from the patients after obtaining their informed consent. We then called these practitioners by phone to obtain their informed consent before scheduling the interviews.

Minimum sample size The minimum sample size was calculated for each participant group using Daniel Schwartz's formula. For the surveyed patients, according to the study by Tegueu et al. in Cameroon [16], the hospital prevalence of neurological disorders was reported to be 20.15%. Starting from this prevalence with a precision of 2.5% and an alpha risk of 5%, we found a minimum sample size of 989 patients. To account for uncertainty related to non-response and incomplete data, we decided to increase this minimum sample size by 10%, resulting in a total of 1,088 patients. At the end, we sampled 4,532 patients, which increased the power of the study. For the traditional therapists; a previous study on cervical brachial neuralgia (a relatively common condition), carried out in the same Department of Neurology showed that 36% of patients with this condition sought the services of traditional therapists [17]. After adjusting for a precision of 6% and inflating by 10%, the minimum sample size was 271 traditional therapists. In order to increase

statistical power for this work, we surveyed 341 traditional therapists.

Data collection

For patients and TM therapists, the study protocol was presented in the local language (Bambara) or in the official language (French) before enrollment. We utilized two liaisons for minor patients and for patients who were unable to understand the questionnaire. We generated two semi-structured questionnaires, one for the patients and one for the TM therapists.

The Phase 1 questionnaire included sociodemographic data, data regarding the therapeutic approach including whether care was sought from a TM therapist, the interval between the consultation with the TM therapist and the present conventional medicine consultation, the motives of the patients, and the clinical data. If the patient reported consultation with a TM therapist, the contact details of the latter were noted by the research team.

We included the TM therapists whose contact details were provided by the patients in Phase 1 and for whom the patients consented for us to contact their providers. The TM therapists were then contacted by phone, and an interview scheduled. For those living in and nearby Bamako, the session was conducted in-person. For those living far from Bamako, the interview was carried out by phone.

The questionnaire for the TM therapists consisted of sociodemographic data; their professional experience; their knowledge, attitudes, and practices in the treatment of ND; and their collaborations with the Department of Neurology. This element of our study was facilitated by the Malian Federation of Traditional Therapists and Herbalists (FEMATH), who act as the umbrella body for the TM therapists of Mali. The questionnaire was devised with the leadership of FEMATH to best consider local traditions and customs.

Statistical analysis

Data are presented as frequencies. Frequencies were compared using a Z-test of the standard normal distribution. We performed a bivariate analysis with a simple logistic regression between our two dependent variables and the independent variables. The odds ratios (OR) generated by this regression and their 95% confidence intervals are presented. The threshold for significance of all tests was set at 5%.

Operational definition

We adopted the definition of a neurological disorder as any disease or dysfunction of the central or peripheral

nervous system. The International Classification of Diseases, 11th revision (ICD-11) of the WHO guided the categorization of patients included in our cohort [18]. To take into account the specificities of neurological pathologies in the African context, we adapted our methodology from previous studies on the same subject carried out in our department and in other African countries [19–23]. Thus, the following categorization was adopted: (1) movement disorders, (2) disorders related to neurocognitive deficits, (3) inflammatory disorders of the central nervous system (CNS) including multiple sclerosis, neuromyelitis optica (NMO) spectrum disorders, and other inflammatory diseases, (4) epilepsy/seizures, (5) headache and facial pain, (6) stroke, (7) non-traumatic spinal disorders, (8) motor neuron diseases and related disorders, (9) peripheral disorders related to root nerve damage, plexus, and peripheral nerves, (10) myopathy and muscle-nerve junction diseases, (11) cerebral palsy, (12) nervous system disorders related to nutritional or toxic causes, (13) disorders related to the dynamics of the cerebrospinal fluid, (14) autonomic nervous system disorders, (15) encephalitis/encephalopathies, (16) meningitis/meningoencephalitis, (17) human prion diseases, (18) consciousness disorders, (19) Neuropathic pain, (20) lower back pain/low back radiculopathy, (21) post-operative nervous system disorders, (22) sleep disorders, (23) stroke (24) and non-neurological disorders.

Results

Frequency of TM utilization by patients with ND in Mali, SSA

Between January 1st and December 31st 2019, a total of 4,532 patients were seen as both inpatients and outpatients in the Department of Neurology at GT UHC, which represented approximately 25% of all visits to the university hospital. Of these 4,532 patients, 3,534 (78.0%) met the inclusion criteria for this study. 2,430 of 3,543 (68.8%) patients reported pursuing TM for their current ND. For 341 of those 2,430 (14%) patients, identification of the TM therapists was possible, and 171 of the 341 (50.2%) TM therapists were interviewed.

Sociodemographic factors associated with pursuit of TM

Table 1 summarizes the sociodemographic factors associated with receiving care from TM in patients with NP.

Utilization of TM increased with age. Compared to patients younger than 30 years of age, those aged 31–60 were nearly twice as likely to use traditional medicine (OR 1.94, CI 1.64–2.29, $p < 0.001$) and patients older than 60 were more than four times as likely (OR 4.37, CI 3.57–5.35, $p < 0.001$). Women were also somewhat more likely than men to see TM therapists (OR 1.54, CI 1.33–1.78, $p < 0.001$).

Table 1 Sociodemographic characteristics associated with use of traditional medicine (TM)

	Demographic	% of patients followed by traditional medicine	Used TM (n = 2,430)	Did not use TM- (n = 1,104)	Odds ratio [95% CI]	p-value
Age	Less than 30 years	53.0	518	460	Reference	..
	31–60 years	68.6	1,002	459	1.94 [1.64–2.29]	< 0.001
	More than 60 years	83.1	910	185	4.37 [3.57–5.35]	< 0.001
Gender	Male	63.9	1,071	605	Ref	..
	Female	73.1	1,359	499	1.54 [1.33–1.78]	< 0.001
Socio-professional categories	Unemployed	53.6	103	89	Ref	..
	Housewives	70.9	528	217	2.10 [1.52–2.91]	< 0.001
	Civil servants and retired civil servants	65.1	429	230	1.61 [1.16–2.23]	0.004
	Merchants and economic operators	75.8	494	158	2.70 [1.93–3.78]	< 0.001
	Laborers, farmers and casual workers	77.3	534	157	2.94 [2.10–4.11]	< 0.001
	Pupils, Students, Apprentices, Workers	57.5	342	253	1.17 [0.84–1.62]	0.35
Residence	Bamako	82.9	1,580	325	4.46 [3.82–5.20]	< 0.001
	Outside of Bamako	52.2	850	779	Reference	..
Level of education	Illiterate	85.5	941	160	Reference	..
	Literate in Arabic or other local languages	63.2	716	417	0.29 [0.24–0.36]	< 0.001
	Primary or secondary level	75.5	825	267	0.53 [0.42–0.65]	< 0.001
	Higher study	48.6	246	260	0.16 [0.13–0.20]	< 0.001
Income level	No fixed income or salary	75.0	993	331	Reference	..
	Income less than the guaranteed minimum ^a	77.2	1,021	301	1.13 [0.95–1.35]	0.18
	Income greater than the SMIG	46.8	416	472	0.29 [0.25–0.35]	< 0.001

^a The guaranteed minimum salary in Mali is approximately 69–80 US dollars

Traditional medicine was most often used by laborers, farmers, and casual workers (77.3%), followed by merchants and economic operators (75.8%), housewives (70.9%), active and retired civil servants (65.1%), pupils, students, apprentices, and workers (57.5%), and the unemployed (53.6%). Patients residing in Bamako were 4.46 times more likely to have consulted TM therapists than those residing outside of Bamako (OR 4.46, CI 3.82–5.20, $p < 0.001$).

Visiting TM therapists decreased with increasing level of education. Compared to illiterate patients, those who had pursued higher levels of education much more rarely utilized TM (OR 0.16, CI 0.13–0.20, $p < 0.001$), as did those who had attained a primary or secondary education (OR 0.53, CI 0.42–0.65, $p < 0.001$), and those who were literate in Arabic or another local language (OR 0.29, CI 0.24–0.36, $p < 0.001$). Patients with no fixed income and those with incomes less than the SMIG were equally likely to visit TM therapists (OR 1.13, CI 0.95–1.35, $p = 0.18$). However, this utilization significantly decreased

in patients with incomes above the SMIG, compared to those with no income (OR 0.29, CI 0.25–0.35, $p < 0.001$).

Knowledge, attitudes, and practices of the patients

Table 2 summarizes attitudes of patients towards TM and the TM treatments received.

Patients who stated that TM is more effective than CM were 2.75 times (CI 2.17–3.48, $p < 0.001$) more likely to have seen a TM therapist than those who had stated that TM was complementary to CM. Conversely, patients who believed that TM was less effective than CM were only modestly less likely to see TM therapists compared to this same cohort (OR 0.77, CI 0.62–0.96, $p = 0.02$).

When assessing reasons patients would use TM, those who reported that the vast majority of illnesses are linked to supernatural causes utilized TM most frequently (82.3%). Patients who reported that TM therapists have a better understanding of illnesses used TM nearly as frequently (80.5%). Those who believe TM should be

Table 2 Attitudes towards Traditional Medicine (TM) and types of TM treatments

	Modalities	% of patients followed by traditional medicine [95% CI]	Used TM, n = 2,430 (%)	Did not use TM, n = 1,104 (%)	OR 95% CI	p-value
General opinion of the patients regarding TM	It is more effective than CM	84.6	701 (28.8%)	128 (11.5%)	2.75 [2.17–3.48]	< 0.001
	It is more suitable to our situation	63.6	805 (33.1%)	460 (41.6%)	0.88 [0.73–1.05]	0.16
	It is less effective than CM	60.6	350 (14.4%)	228 (20.6%)	0.77 [0.62–0.96]	0.02
	It can be complementary to CM	71.6	574 (23.6%)	288 (26%)	Ref	..
Reasons justifying use of TM	Access to CM is more difficult	61.2	415 (17%)	263 (23.8%)	Ref	..
	It costs less and is more accessible	53.7	117 (4.8%)	101 (9.1%)	0.73 [0.54–1.0]	0.05
	Traditional therapists have a better understanding of illnesses	80.5	864 (35.5%)	209 (18.9%)	2.62 [2.11–3.25]	< 0.001
	TM is part of our tradition	47.8	351 (14.4%)	384 (34.7%)	1.06 [0.85–1.34]	< 0.001
	Because the vast majority of our illnesses are linked to supernatural causes	82.3	683 (28.1%)	147 (13.3%)	2.94 [2.33–3.73]	< 0.001
What type of traditional treatment did you receive for this pathology?	Phytotherapy	..	882 (36.2%)	..	..	..
	Treatment by a healer	..	424 (17.4%)	..	..	..
	Treatment by a Marabout	..	272 (11.1%)	..	..	..
	I have had scarifications	..	149 (6.1%)	..	..	..
	Several traditional methods	..	703 (28.9%)	..	..	..
What are the reasons that led you to abandon TM for CM for this pathology?	The cost of the care became expensive	..	683 (28.1%)	..	..	..
	I did not notice any improvement	..	630 (25.9%)	..	..	..
	The therapist told me that my case could no longer benefit from traditional medicine	..	102 (4.1%)	..	..	..
	I came to complete by traditional treatment	..	229 (9.4%)	..	..	..
	I did not like the TM environment	..	725 (29.8%)	..	..	..
	The traditional therapists told me that the remainder of the treatment had to be in CM	..	61 (2.5%)	..	..	..

utilized due to its role in their cultural tradition used it least frequently (47.8%).

The most common traditional treatment received were “Phytotherapies”, “Several traditional methods”, and “Treatment by a Healer”, at 36.3%, 28.9%, and 17.4%, respectively. “Treatment by a Marabout” and scarifications were less commonly utilized at 11.2% and 6.1%, respectively.

The most common reasons patients abandoned TM in favor of CM included: “I did not like the TM care

environment” (29.8%), “the cost of the care became expensive” (28.1%), and “I did not notice an improvement” (25.9%).

Association of time to first neurology consultation with previous treatment by TM by category of ND

In 12/20 (60%) categories of ND, previous treatment with TM was associated with a statistically significant longer time to first CM neurology consultation (Table 3). The categories of ND associated with the greatest delays in

Table 3 Association of use of traditional medicine (TM) and time to first neurology consultation in patients with different neurological disorders

	Patients	% of early consultations [95% CI]	Elapsed time before the first consultation		OR	p
			≤ 3 (0 to 3 months)	> 3 months		
Headaches and craniofacial pain N=510	TM+ (319)	37.0	118	201	Reference	..
	TM- (191)	63.9	122	69	3.01 [2.07–4.37]	< 0.001
Stroke N=534	TM+ (319)	52.7	168	151	Reference	..
	TM- (215)	70.7	152	63	2.17 [1.50–3.13]	< 0.001
Lower back pain/ Lumbar-radiculopathy N=523	TM+ (428)	25.5	109	319	Reference	..
	TM- (95)	83.2	79	16	14.45[8.09–25.80]	< 0.001
Seizure disorders N=437	TM+ (296)	23.3	69	227	Reference	..
	TM- (141)	72.3	102	39	8.6 [5.45–13.59]	< 0.001
Encephalopathies and Encephalitis N=191	TM+ (109)	80.7	88	21	Reference	..
	TM- (82)	78.0	64	18	0.85 [0.42–1.72]	0.65
Neuropathic pain N=381	TM+ (277)	23.2	53	175	Reference	..
	TM- (104)	73.1	76	28	8.96 [5.27–15.24]	< 0.001
Movement disorders N=118	TM+ (89)	28.1	25	64	Reference	..
	TM- (29)	79.3	23	6	9.81 [3.57–26.96]	< 0.001
CNS inflammatory disorders (NMOSD ^b and MS ^c) N=65	TM+ (41)	12.2	5	36	Reference	..
	TM- (24)	47.1	16	8	14.4 [4.07–50.92]	< 0.001
Peripheral neuropathies: polyneuropathies, radicular and plexus disorders N=214	TM+ (177)	46.3	82	95	Reference	..
	TM- (37)	83.8	31	6	5.99 [2.38–15.06]	< 0.001
Non-traumatic medullary pathologies N=83	TM+ (53)	15.1	8	45	Reference	..
	TM- (30)	43.3	13	17	4.3 [1.52–12.2]	0.004
Motor neuron illnesses and associated disorders N=41	TM+ (31)	32.3	10	21	Reference	..
	TM- (10)	50	5	5	2.1 [0.49–8.96]	..
Neurocognitive impairment disorders N=73	TM+ (57)	28.1	16	41	Reference	0.8
	TM- (16)	31.3	5	11	1.16 [0.35–3.89]	..
Myopathy and neuromuscular junction diseases N=32	TM+ (19)	26.3	5	14	Reference	..
	TM- (13)	30.8	4	9	1.24 [0.26–5.92]	0.78
Malignancies of the central and peripheral nervous systems N=13	TM+ (7)	28.6	2	5	Reference	..
	TM- (6)	50.0	3	3	2.5 [0.25–24.72]	0.43
Meningitis/meningoencephalitis N=107	TM+ (69)	56.5	39	30	Reference	..
	TM- (38)	78.9	30	8	2.88 [1.16–7.19]	0.02
Sleep disorder N=71	TM+ (45)	53.3	24	21	Reference	..
	TM- (26)	57.7	15	11	1.19 [0.45–3.16]	0.72
Cerebral palsy N=24	TM+ (16)	31.3	5	11	Reference	..
	TM- (8)	50.0	4	4	2.2 [0.38–12.57]	0.37
Autonomic nervous system disorders N=12	TM+ (7)	57.1	4	3	Reference	..
	TM- (5)	80.0	4	1	3 [0.21–42.63]	0.41
Disorders due to nutritional or toxic causes N=61	TM+ (38)	26.3	10	28	Reference	..
	TM- (23)	39.1	9	14	1.8 [0.60–5.44]	0.29
Others ^a N=44	TM+ (33)	36.4	12	21	Reference	..
	TM- (11)	81.8	9	2	7.88 [1.46–42.61]	0.009

^a Others: disorders relating to the cerebrospinal fluid, consciousness disorders, non-neurological pathologies (psychiatric or other medical or surgical pathologies hospitalized in the department for reasons inherent to the functioning of the hospital)

^b Neuromyelitis optica spectrum diseases

^c Multiple sclerosis

receiving early CM neurology consultation included lower back pain/lumbar radiculopathy (OR 14.45, CI 8.09–25.80, $p < 0.001$), CNS inflammatory disorders (OR 14.40, CI 4.07–50.92, $p < 0.001$), movement disorders (OR 9.81, CI 3.57–26.96, $p < 0.001$), neuropathic pain (OR 8.96, CI 5.27–15.24, $p < 0.001$), and seizure disorders (OR 8.60, CI 5.45–13.59). Of note, no category had a statistically significant decrease in time to neurology consultation when TM was first used.

Survey of TM therapists

One hundred and sixty-one TM therapists met the inclusion criteria and could be interviewed (Table 4). TM therapists were majority men (64.3%) and had predominantly received more than 10 years of training (74.9%). Comparatively, conventional medicine doctors are even more male (88.76% male in 2018). TM therapist mostly also resided outside of Bamako (70.2%).

Table 5 summarizes the attitudes of TM therapists towards patients with ND.

ND accounted for 21–40% of patients seen by TM therapists within the prior 3 months for 61.4% of them. Symptoms that led TM therapists to recognize ND were most commonly “changes in the morphology of the body (one side and/or the face)”, (25.7%), “motor or sensory impairment” (18.7%) and the “epileptic fits” (15.8%). While 62.6% of the TM therapists stated they sometimes refer patients with ND to a hospital, only 4.1% of the TM therapists (i.e. 7 out of 171) had never referred these patients to a hospital.

The most frequently proposed methods by TM therapists to improve collaboration between them and conventional doctors included “The doctors should take into account our existence” (35.7%), “We should be promoted more by the State” (24%), and “The conventional doctors should provide us feedback after receiving our patients” (20.5%).

Table 4 Sociodemographic characteristics of traditional therapists ($n = 171$)

		Number (%)	p-value
Gender	Female	61 (35.7)	0.001
	Male	110 (64.3)	
Length of training	Less than 5 years	25 (14.6)	< 0.001
	5–10 years	28 (16.4)	
	More than 10 years	118 (69.0)	
Professional experience	Less than 5 years	7 (4.1)	0.01
	5–10 years	36 (21.1)	
	More than 10 years	128 (74.9)	
Residence	Bamako	51 (29.8)	< 0.001
	Outside of Bamako	120 (70.2)	

The most cited features that led TM therapists to refer patients to the hospital were: “We refer patients for whom the illness has a strictly physical cause” (33.9%), “When we have finished taking care of the non-physical supernatural aspects” (25.1%), and “The cases that need a mixed treatment (TM and CM)” (18.7%).

Reasons included by TM therapists for patients consulting them instead of going directly to the hospital were “Because they trust us” (35.7%), “We have better control of the environment of the patients” (24.6%), and “We have a better understanding of the local pathologies” (18.7%).

Discussion

To our knowledge, our work is one of the few studies in sub-Saharan Africa to have rigorously analyzed the role of TM in the treatment of ND. Our survey has enabled patients and TM therapists to voice their views in conjunction with well-documented clinical records for our ND patients. TM is a critical tool in the therapeutic arsenal of Africans and critical analysis is crucial to optimally integrating it with CM.

TM is highly prevalent in the treatment of ND in SSA

A review of the literature shows that TM therapists see nearly all neurological pathologies [24–31]. In our study, 68.8% of patients with ND acknowledged having consulted a TM therapist with this trend extending to all categories of ND; all categories of ND showed more patients using TM than not using TM. Yet, even these high percentages may be underestimations, as some patients may conceal the use of TM to conventional doctors out of fear of reprimand as most conventional doctors perceive TM poorly [29]. Our current study is consistent with our previous work that showed 84.7% of patients with diabetic neuropathic pain in two reference centers in Mali utilized TM with CM for treatment of their pain and 45.6% of patients admitted for stroke had first visited a TM therapist [30, 31]. This trend is similar to other SSA countries. In a Tanzanian cohort of 167 patients with epilepsy, 34% had first tried prayers, 9.6% phytotherapy, 7.2% healers, and 3.6% scarifications [32]. In Togo, 80% of epilepsy patients evaluated in a Department of Neurology had forehead scarifications [33].

The therapeutic modalities used for the treatment of neurological disorders stem directly from the socio-cultural representations and presumed causes of these pathologies including supernatural causes, magic spells, and anger of the spirits or the Gods. Our work shows that the many previously documented methods of traditional treatment are utilized to significant extent in the care of ND in Mali, with phytotherapy, treatment by a healer, and multiple combined methods being most common.

Table 5 Attitudes and practices of the traditional therapists (N= 171)

		Number (%)	p-value
Regarding the patients who you have seen in the past three months, what proportion do you think had neurological disorders?	Less than 20%	16 (9.4)	0.023
	21 to 40%	105 (61.4)	
	41 to 60%	32 (18.7)	
	61 to 80%	11 (6.4)	
	More than 80%	7 (4.1)	
What are the symptoms that allow you to recognize neurological disorders?	Impairments of normal behavior	12 (7.0)	< 0.001
	Epileptic fits	27 (15.8)	
	Psychomotor agitation	16 (9.4)	
	Motor or sensory disorder	32 (18.7)	
	Change of the morphology of the body (one side and/or the face)	44 (25.7)	
	Loss of neurosensory function (speech, sight)	17 (9.9)	
Have you already referred a patient with this type of illness to the hospital?	Rarely	38 (22.2)	0.001
	Sometimes	107 (62.6)	
	Very often	19 (11.1)	
	Never	7 (4.1)	
To improve the treatment of neurological disorders, what should be done to improve your collaboration with the conventional medicine physicians?	The doctors should take into account our existence	61 (35.7)	0.065
	We should be promoted more by the State	41 (24.0)	
	Mutual respect between CM and TM needs to be promoted	13 (7.6)	
	The conventional doctors need to provide us with feedback after receiving our patients	35 (20.5)	
	The state should promote this collaboration between TM and CM	21 (12.3)	
What are the elements that led you to refer patients to the hospital?	We refer the patients for who the illness has a strictly physical cause	58 (33.9)	0.03
	Certain patients ask to go to the hospital	19 (11.1)	
	The cases that require a mixed treatment (TM and CM)	32 (18.7)	
	When we have finished taking care of the non-physical supernatural aspects	43 (25.1)	
	When the patient is not able to pay our fees	19 (11.1)	
Why do you think patients consult with you instead of going directly to conventional medicine?	Because they trust us	61 (35.7)	0.060
	We have a better understanding of the local pathologies	32 (18.7)	
	We have better control of the environment of the patients	42 (24.6)	
	The conventional doctors are inaccessible to patients	23 (13.5)	
	We are less expensive than CM	13 (7.6)	

Phytotherapy may be of particular interest; one Ghanaian study regarding plants used in the treatment of neuropsychiatric disorders found 32 plant species used for this indication [34]. Furthermore, studies have documented the *in vitro* anticonvulsive activity of certain African plants [35, 36]. Other plants have also been shown to have applications in the treatment of neurodegenerative diseases [37, 38].

Surveyed reasons to justify the use of TM are revealing too. A predominance of our cohort stated that TM therapists have a better understanding of illness (80.5%)

and that the vast majority of our illnesses are linked to supernatural causes (82.3%). Consequently, the common usage of TM therapists stems from these beliefs; epilepsy, for example, is often construed as possession by a supernatural force, owing in part to the spectacular nature of certain episodes, such that, “modern Western” medicine would be an unsuitable solution [39, 40]. This is supported by 67.7% of our patients with epilepsy using traditional medicine. Similarly, 56.6–65.5% of patients with epilepsy in Nigeria initiated treatment with TM [41].

Use of TM is associated with specific demographic features

Our work shows that use of TM increases with age as patients 31–60 were nearly twice as likely to use TM compared to the under 30 cohort. Patients older than 60 were more than four times as likely to use TM. This may be explained by the older generation being more familiar with the traditional therapies and turning to them as first line as part of their cultural heritage. Female patients were also more likely to utilize TM, possibly due to women comprising nearly a third of traditional practitioners but only a tenth of CM doctors [42]; increasing the number of female CM doctors may be crucial to its increased use. Patients who were employed were more likely to receive care through TM potentially because their careers allowed them the economic flexibility to pursue the care of their choice. Certain jobs could also be linked to higher levels of education which we demonstrated are associated with lower utilization of TM. Conversely, students and those in training were as likely to pursue TM as their unemployed counterparts. Living in Bamako also strongly increased the likelihood of pursuing TM, potentially as a result of increased access to traditional practitioners who live there. Degree of education was also negatively associated with pursuing TM, likely as a result of increased knowledge pertaining to scientific topics or to materialistic conceptions of life and health.

Access to TM delays conventional neurology interventions

Initial access to TM delayed seeking a CM consultation for a majority of patients with ND, leading to a lag in starting conventional therapies, potentially resulting in worse outcomes. For example, consultation with a TM therapist for epilepsy significantly delayed neurological interventions that could have included initiation of effective anti-seizure medication with subsequent decreased seizure burden. Other studies corroborate this result; in Guinea, a country adjacent to Mali, a study regarding epilepsy showed that the average duration of a stay with a TM therapist before a consultation in CM was 39 months, time that should have been spent on effective anti-seizure medication [42]. Delay in the initiation of effective treatments can have a negative impact on long-term function and survival with prolonged traditional medicine treatment periods potentially contributing to the high mortality in neurology units in SSA [43, 44, 45].

Proposals towards optimizing the provision of care for ND with both traditional and conventional medicines

Given that the majority of patients already receive care through TM therapists and believe them to necessary

to their healing, optimizing the provision of care for patients with ND will require integration of TM and CM. We propose four next steps.

Increasing the number of neurologists in Mali

Utilization of traditional medicine may in part be due to the dearth of neurologists in Africa, with 35 of the 53 African nations having few or no neurologists [1–4]. This is exacerbated by most neurology units residing in the capitals, which are often the largest urban areas. These providers also teach classes at the medical schools and are often active in parallel private practice. As a result, patients not located in those cities have to travel long distances to consult with a neurologist [46–48]. Increasing the number of neurologists in Mali will require funding their training as this is currently often cost-prohibitive for trainees. This could occur through governmental contracts with medical students where in exchange for a four-year scholarship for neurology training, they, upon completion of training, are obligated to work for four years in a reference health district. We have termed this plan, “*The Four-by-Four Initiative*”.

Integrating traditional medicine topics into neurology training

We believe that the training of neurologists in Mali must include teaching the sociocultural milieu of their patients through exposure in residency to TM [49]. This will allow better understanding of the need for complementarity for their patients who perceive TM as necessary to the healing process. This will also serve to remove barriers between these two groups of practitioners to the benefit of the patient. There is strong precedent for this practice as 85% of Korean and 77% of Canadian medical school include topics on complementary medicine [50]. Additionally, many medical students may already be familiar with many of cultural practices as 59.1% of the medical students in Sierra Leone have reported using TM [51].

Promoting the collaboration between TM and CM

Precedent for this collaboration already exists in Africa with TM therapists in Gambia and Tanzania assisting in the fight against tuberculosis and HIV through training to advise, screen, and guide patients [49]. Central to this model is training the TM therapists to ensure psychosocial support for the patients and to compensate for the lack of qualified neurologists [52]. In Cameroon, this model has proved indispensable for improving the treatment of epilepsy [53]. Indeed, these ideas are already playing out with one study in Burkina Faso noting that 69.5% of patients with epilepsy acknowledged having used TM in parallel with CM during their therapeutic

journey [54]. Formalization of this relationship is the next logical step.

Regulating TM will facilitate a continued high standard of care as it is integrated into CM

TM is insufficiently regulated in Mali and across Africa [55]; only 32% of African countries have proper national regulation of TM. While most traditional treatments are benign, the lack of regulation has led to the proliferation of TM therapists with potentially harmful practices that could be prevented with a required supervisory body. Regulation will be best achieved through policies aimed at organizing traditional practitioners and healers into associations. A national regulatory system would also allow binding decisions regarding the practice of specific TM treatments. Such daunting regulation would require the input of all stakeholders, not only the TM therapists and doctors, but also anthropologists, sociologists, ethnobotanists, key members of the community including disease association personnel, historians, lawyers, and geographers.

Limitations

Our study uses quantitative aspects and, consequently, the specific context and sociocultural environment need to be taken into account when interpreting the answers. We also believe that certain patients and TM therapists provided socially acceptable, instead of true, answers as a result of the questioning setup. Furthermore, in this work, we did not study the influence of societal elements such as family, ethnicity, social rank, and customs in patient treatment choices. Future work will be necessary to examine these factors. Our study has potential selection bias as patients with insufficient clinical documentation were excluded. The poorest patients, who were unable to pay for care and were thus unable to receive care were also indirectly excluded. There is a selection bias in our study population as it consists of patients who voluntarily came to our hospital; those who were not seen in our facility were not included in our work and could have different utilization patterns of TM.

Lastly, the small percentage of TM therapists interviewed relative to the population of patients who had utilized TM constitutes another weakness.

Conclusion

Here, we confirm the central role of TM in the provision of care for patients with ND in Mali and report factors associated with its use including older age, female sex, and lower levels of education. We also examine prevailing thoughts and attitudes regarding TM. It is paramount that researchers and policy-makers implement

innovative strategies aimed at promoting collaboration between TM and CM and addressing these factors. Our work not only characterizes the reasons for using TM as well as details of its practitioners, but also provides a framework for next steps. We ultimately seek to tailor effective care to the sociocultural realities available to the community in order to reduce the burden of neurological disorders in sub-Saharan Africa.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12906-024-04645-5>.

Supplementary Material 1.

Supplementary Material 2.

Supplementary Material 3.

Acknowledgements

Our sincere thanks go to all the traditherapists who generously agreed to take part in this pilot project.

Intellectual property

Our work received approval from the Department of Traditional Medicine (DTM), who liaise between the Mali Ministry of Health and the traditional therapy associations. The DTM regulates traditional medicine and ensures the research, promotion, and protection of TM therapists. They are also responsible for recording the knowledge of traditional healers including the use of medicinal plants and the identification of the components of plants responsible for their purported bioactivities. Over the course of the survey, the TM therapists provided proprietary information, often transmitted from generation to generation [17]. The dissemination of this information was subject to their consent. No financial compensation was provided. Participation was strictly voluntary, with the possibility of discontinuing at any stage of the study. Measures were taken to protect the respondents from any potential risks of their participation, including through anonymization of the audio recordings and of the transcriptions.

Clinical trial number

Not applicable.

Authors' contributions

Contributors Conceptualization: Youssoufa MAIGA; Najib Kissani, Julien Nizard. Data curation: Youssoufa Maiga, Salimata Diallo, Awa Coulibaly, Karamoko Nimaga, Seybou Diallo. Investigation: Youssoufa Maiga, Seybou H Diallo, Salimata Diallo, Awa Coulibaly, Mariam Daou, Thomas Coulibaly, Adama Sissoko, Guida Landouré, Mohamed Albakaye, Zoumana Traoré, Abdoul Karim Dao, Mamadou Togo, Saliou Mahamadou, Souleymane dit papa Coulibaly, Karamoko Nimaga, Rokia Sanogo, Madani Ouologem. Methodology: Leon Samuel Moskatel, Fatoumata Nènè Konipo, Oumar Sangho, Housseini Dolo Modibo Sangaré. Analysis: Youssoufa MAIGA, Leon Samuel Moskatel, Fatoumata Nènè Konipo, Oumar Sangho, CAllixte Kuate, Housseini Dolo Modibo Sangaré. Supervision: Youssoufa MAIGA, and Julien Nizard. Writing – original draft: Youssoufa MAIGA. Writing – review & editing: Youssoufa MAIGA, Fabrice Berna, Robert Cowan, Julien Nizard. Funding source: No specific funding was received for this study. Conflicts of Interest: The authors of this work declare that there are no any financial, personal, or professional interests that could be construed to have influenced the

Funding

This research received no external funding.

Availability of data and materials

All data generated or analysed during this study are included in this published article and its supplementary information file.

Declarations

Ethics approval and consent to participate

Our protocol received approval from the ethics committee of the Faculty of Medicine, Pharmacy, and Odontostomatology (FMOS) of Bamako under the number 2019/209/CE/FMOS/FAPH.

Informed consent of the participants was obtained prior to their participation. In the case of minor participants, we obtained the informed consent of their parents or legal guardians and the assent of the children. Each participant signed a consent form and, after receiving details of the study through the shares study information sheet including the study's objectives, risks, and methods of the study. Participants were able to ask any questions relating to the study before deciding. Each participant had the right to withdraw from the study at any time.

Patient data were collected in a strictly anonymous manner and with the approval of the Medical Work Committee (MWC) of the GT. No compensation was provided to the patients participating in this study. The rights and well-being of the participants were protected, and patients were reassured that the quality of their medical care would not be affected by their decision to participate in the study. TM therapists were explicitly informed that they could refuse to answer certain questions.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Author details

¹Department of Neurology, Gabriel Touré Teaching Hospital, Bamako, Mali. ²Faculty of Medicine, University of Technical Sciences and Technologies, Bamako, Mali. ³Laboratory of Therapeutics (EA3826), Faculty of Medicine (EA3826), Nantes, France. ⁴Department of Neurology, Stanford University, Palo Alto, CA, USA. ⁵Medicine Unit, Hospital of Mali, Bamako, Mali. ⁶Department of Internal Medicine and Specialties, Gabriel Touré Teaching Hospital, Bamako, Mali. ⁷Neurology Department, University Teaching Hospital Mohammed VI, Marrakesh, Morocco. ⁸Clinique Médicale "DINANDOUGOU", Maracakoungo, Mali. ⁹Hôpitaux Universitaires de Strasbourg, 1 Place de L'Hôpital, Clinique Psychiatrique, 67091 Strasbourg Cedex, France. ¹⁰Service de Neurologie, Département de Médecine, Hôpital de Kati, Kati, Mali. ¹¹Faculty of Medicine, University of Nantes, Nantes, France. ¹²Federal Center of Palliative Care and Support, Laboratory of Therapeutics, UHCof, Nantes, France.

Received: 23 October 2023 Accepted: 16 September 2024

Published online: 03 October 2024

References

- Kaddumukasa M, Katabira E, Salata RA, Costa MA, Ddumba E, Furlan A, et al. Global medical education partnerships to expand specialty expertise: a case report on building neurology clinical and research capacity. *Hum Resour Health*. 2014;12:75.
- GBD 2015 Neurological Disorders Collaborator Group. Global, regional, and national burden of neurological disorders during 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. *Lancet Neurol*. 2017;16:877–97.
- Mpanya A, Boelaert M, Baloji S, Matangila J, Lubanza S, Bottieau E, et al. Diagnostic work-up of neurological syndromes in a rural African setting: knowledge, attitudes and practices of health care providers. *PLoS ONE*. 2014;9: e110167.
- Winkler AS, Mosser P, Schmutzhard E. Neurological disorders in rural Africa: a systematic approach. *Trop Doct*. 2009;39:102–4.
- Birbeck GL. Neurologic disease in a rural Zambian hospital. *Trop Doct*. 2001;31:82–5.
- World Health Organization. Program on Traditional Medicine. Stratégie de l'OMS pour la médecine traditionnelle 2014–2023. Genève: World Health Organization. Geneva 2013.
- Mahomoodally MF. Traditional medicines in Africa: an appraisal of ten potent african medicinal plants. *Evid Based Complement Alternat Med*. 2013;2013: 617459.
- Mukendi D, Lilo Kalo JR, Mpanya A, Minikulu L, Kayembe T, et al. Clinical Spectrum, Etiology, and Outcome of Neurological Disorders in the Rural Hospital of Mosango, the Democratic Republic of Congo. *Am J Trop Med Hyg*. 2017;97:1454–60.
- Lo T, Tindall A. Acute lower back pain mapped by dermatomal scarification in urban Malawi. *BMJ Case Rep*. 2012;2012:bcr1120103529. <https://doi.org/10.1136/bcr-11-2010-3529>.
- Maiga Y, Albakaye M, Diallo LL, Traoré B, Cissoko Y, Hassane S, et al. Current beliefs and attitudes regarding epilepsy in Mali. *Epilepsy Behav*. 2014;33:115–21.
- James PB, Wardle J, Steel A, Adams J. Traditional, complementary and alternative medicine use in Sub-Saharan Africa: a systematic review. *BMJ Glob Health*. 2018;3(3): e000895.
- Balogou AA, Dodzro KC, Grunitzky EK. Traditional tattoos with neurological diseases in Togo. *Bull Soc Pathol Exot*. 2000;93:361–4.
- Anand P, Othon GC, Sakadi F, Tassiou NR, Hamani ABD, Bah AK, et al. Epilepsy and traditional healers in the Republic of Guinea: A mixed methods study. *Epilepsy Behav*. 2019;92:276–82.
- James PB, Wardle J, Steel A, Adams J. Traditional, complementary and alternative medicine use in Sub-Saharan Africa: a systematic review. *BMJ Glob Health*. 2018;3: e000895.
- UNDP. 2019. Human Development Report 2019. Beyond income, beyond averages, beyond today: Inequalities in human development in the 21st century. New York. <http://hdr.undp.org/en/content/human-development-report-2019>
- Tegueu CK, Nguetack S, Doumbe J, Fogang YF, Mbonda PC, Mbonda E. The spectrum of neurological disorders presenting at a neurology clinic in Yaoundé, Cameroon. *Pan Afr Med J*. 2013;4(14):148.
- Maiga Y, Fara AA, Sogoba Y, Diango D, Diakite S, Diallo M, Ak H, Diallo G, Traore HA. Etude longitudinale de la névralgie cervico-brachiale dans le service de neurologie du CHU Gabriel Touré, Bamako (Mali). *Pan Afr Med J*. 2013;16:46.
- WHO. International Classification of Diseases, 11th Revision (ICD-11). <https://icd.who.int/dev11/>
- Maiga Y, Sangho O, Konipo F, Diallo S, Coulibaly SDP, Sangare M, et al. Neuropathic pain in Mali: The current situation, comprehensive hypothesis, which therapeutic strategy for Africa? *eNeurologicalSci*. 2021;22:100312.
- Adebayo PB, Aziz OM, Mwakabatika RE, Makakala MC, Mazoko MC, Adamjee SM, Mushi N, Jusabani AM, Aris E. Out-patient neurological disorders in Tanzania: Experience from a private Institution in Dar es Salaam. *eNeurologicalSci*. 2020;20:100262.
- Sarfo FS, Akassi J, Badu E, Okoroza O, Ovbiagele B, Akpalu A. Profile of neurological disorders in an adult neurology clinic in Kumasi. *Ghana eNeurological Sci*. 2016;3:69–74. <https://doi.org/10.1016/j.ensci.2016.03.003>.
- Siddiqi OK, Atadzhanov M, Birbeck GL, Koralnik IJ. The spectrum of neurological disorders in a Zambian tertiary care hospital. *J Neurol Sci*. 2010;290:1–5. <https://doi.org/10.1016/j.jns.2009.12.022>.
- Osuntokun BO. The pattern of neurological illness in tropical Africa. Experience from Ibadan, Nigeria. *J Neurol Sci*. 1971;12:417–42. [https://doi.org/10.1016/0022-510X\(71\)90110-9](https://doi.org/10.1016/0022-510X(71)90110-9).
- Hindley G, Kissima J, Oates L, Paddick SM, Kisoli A, Brandsma C, et al. The role of traditional and faith healers in the treatment of dementia in Tanzania and the potential for collaboration with allopathic healthcare services. *Age Ageing*. 2017;46:130–7.
- Nakibuuka J, Sajatovic M, Katabira E, Ddumba E, Byakika-Tusiime J and Furlan AJ. Knowledge and Perception of Stroke: A Population-Based Survey in Uganda. *ISRN Stroke* 2014;2014:1–12. <https://doi.org/10.1155/2014/309106>.
- Igwesi-Chidobe CN, Kitchen S, Sorinola IO, Godfrey EL. "A life of living death": the experiences of people living with chronic low back pain in rural Nigeria. *Disabil Rehabil*. 2017;39:779–90.
- Prince M, Patel V, Saxena S, Maj M, Masello J, Phillips MR, et al. No health without mental health. *Lancet*. 2007;370:859–77.
- Gona JK, Newton CR, Rimba K, Mapeenzi R, Kihara M, Van de Vijver FJ, et al. Parents' and professionals' perceptions on causes and treatment options

- for autism spectrum disorders (ASD) in a multicultural context on the Kenyan coast. *PLoS ONE*. 2015;10: e0132729.
29. James PB, Bah AJ, Kondorvoh IM. Exploring self-use, attitude and interest to study complementary and alternative medicine (CAM) among final year undergraduate medical, pharmacy and nursing students in Sierra Leone: a comparative study. *BMC Complement Altern Med*. 2016;16:121.
 30. Maiga Y, Diallo S, Konipo FD, Sangho O, Sangaré M, Diallo SH, et al. Diabetic polyneuropathy with/out neuropathic pain in Mali: A cross-sectional study in two reference diabetes treatment centers in Bamako (Mali). *Western Africa Plos one*. 2020;15: e0241387.
 31. Maiga Y, Albakaye M, Diango D, Kanikomo D, Seybou H, Minta I, et al. Modalities of stroke management in Mali (West Africa): a survey of practices. *Le Mali Medical*. 2013;28:30–5.
 32. Winkler AS, Mayer M, Ombay M, Mathias B, Schmutzhard E, Jilek-Aall L. Attitudes towards African traditional medicine and Christian spiritual healing regarding treatment of epilepsy in a rural community of northern Tanzania. *Afr J Tradit Complement Altern Med*. 2009;7:162–70.
 33. Balogou AA, Dodzro KC, Grunitzky EK. Les scarifications traditionnelles chez les malades neurologiques au Togo [Traditional tattoos with neurological diseases in Togo]. *Bull Soc Pathol Exot*. 2000;93:361–4.
 34. Amoateng P, Quansah E, Karikari TK, Asase A, Osei-Safo D, Kukuia KKE, et al. Medicinal Plants Used in the Treatment of Mental and Neurological Disorders in Ghana. *Evid Based Complement Alternat Med*. 2018;2018:8590381.
 35. Amabeoku GJ, Green I, Kabatende J. Anticonvulsant activity of *Cotyledon orbiculata* L. (Crassulaceae) leaf extract in mice. *J Ethnopharmacol*. 2007;112:101–7.
 36. Adeyemi OO, Yemitan OK, Adebiji OO. Sedative and anticonvulsant activities of the aqueous root extract of *Sansevieria liberica* Gerome & Labroy (Agavaceae). *J Ethnopharmacol*. 2007;113:111–4.
 37. Mathur D, Goyal K, Koul V, Anand A. The Molecular Links of Re-Emerging Therapy: A Review of Evidence of Brahmi (*Bacopa monniera*). *Front Pharmacol*. 2016;4(7):44.
 38. Chaudhari KS, Tiwari NR, Tiwari RR, Sharma RS. Neurocognitive Effect of Nootropic Drug Brahmi (*Bacopa monnieri*) in Alzheimer's disease. *Ann Neurosci*. 2017;24:111–22.
 39. Ba-Diop A, Marin B, Druet-Cabanac M, Ngougou EB, Newton CR, Preux PM. Epidemiology, causes, and treatment of epilepsy in sub-Saharan Africa. *Lancet Neurol*. 2014;13:1029–44.
 40. Keikelame MJ, Swartz L. 'A thing full of stories': Traditional healers' explanations of epilepsy and perspectives on collaboration with biomedical health care in Cape Town. *Transcult Psychiatry*. 2015;52:659–80.
 41. Lagunju IA. Complementary and alternative medicines use in children with epilepsy in Ibadan. *Nigeria Afr J Med Med Sci*. 2013;42:15–23.
 42. Anand P, Othon GC, Sakadi F, Tassiou NR, Hamani ABD, Bah AK, et al. Guinea Epilepsy Project. Epilepsy and traditional healers in the Republic of Guinea: A mixed methods study. *Epilepsy Behav*. 2019;92:276–82.
 43. Wilson DA, Selassie AW. Risk of severe and repetitive traumatic brain injury in persons with epilepsy: a population-based case-control study. *Epilepsy Behav*. 2014;32:42–8.
 44. Emberson J, Lees KR, Lyden P, Blackwell L, Albers G, Bluhmki E, et al. Effect of treatment delay, age, and stroke severity on the effects of intravenous thrombolysis with alteplase for acute ischaemic stroke: a meta-analysis of individual patient data from randomised trials. *Lancet*. 2014;384:1929–35.3.
 45. Opara JA, Jaracz K. Quality of life of post-stroke patients and their caregivers. *J Med Life*. 2010;3:216–20.
 46. Berkowitz AL. Neurology education in resource-limited settings. *Neurology*. 2014;22(82):1463–4.
 47. Bower JH, Zenebe G. Neurologic services in the nations of Africa. *Neurology*. 2005;8(64):412–5.
 48. Chitindingu E, George G, Gow J. A review of the integration of traditional, complementary and alternative medicine into the curriculum of South African medical schools. *BMC Med Educ*. 2014;14:1–5.
 49. Harper ME, Hill PC, Bah AH, Manneh K, McAdam KP, Lienhardt C. Traditional healers participate in tuberculosis control in The Gambia. *Int J Tuberc Lung Dis*. 2004;8:1266–8.
 50. Chitindingu E, George G, Gow J. A review of the integration of traditional, complementary and alternative medicine into the curriculum of South African medical schools. *BMC Med Educ*. 2014;14:40.
 51. James PB, Bah AJ, Kondorvoh IM. Exploring self-use, attitude and interest to study complementary and alternative medicine (CAM) among final year undergraduate medical, pharmacy and nursing students in Sierra Leone: a comparative study. *BMC Complement Altern Med*. 2016;16:1–8.
 52. Bitta MA, Kariuki SM, Gona J, Abubakar A, Newton CRJC. Priority mental, neurological and substance use disorders in rural Kenya: Traditional health practitioners' and primary health care workers' perspectives. *PLoS ONE*. 2019;14: e0220034.
 53. Njamnshi AK, Bissek AC, Yepnjio FN, Tabah EN, Angwafor SA, Kuate CT, et al. A community survey of knowledge, perceptions, and practice with respect to epilepsy among traditional healers in the Batibo Health District. *Cameroon Epilepsy Behav*. 2010;17:95–102.
 54. Millogo A, Ratsimbazafy V, Nubukpo P, Barro S, Zongo I, Preux PM. Epilepsy and traditional medicine in Bobo-Dioulasso (Burkina Faso). *Acta Neurol Scand*. 2004;109(4):250–4.
 55. Street RA, Stirk WA, Van Staden J. South African traditional medicinal plant trade-Challenges in regulating quality, safety and efficacy. *J Ethnopharmacol*. 2008;119:705–10.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.