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Scientific evidence of anticonvulsant activity of medicinal plants in Iringa, Tanzania

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ABSTRACT

Introduction: Medicinal plants used traditionally to treat various ailments provide a solid lead towards drug discovery. However, the majority of medicinal plants locally used to treat various health problems lack scientific approval and documentation. This study aimed to identify medicinal plants traditionally used for treating epilepsy in Mufindi and Kilolo districts, Iringa region, and to explore scientific evidence of the anticonvulsant activity.

Methods: The study was conducted in the Hehe society in Iringa region, which mainly relies on medicinal plants in treating various ailments. Data were collected through focus group discussions, key informant interviews, field visits, and online literature reviews.

Results: A total of 37 medicinal plant species were identified by both local and scientific names, with the Fabaceae family leading with five species, followed by the Verbenaceae and Rubiaceae families with four species each. Asteraceae and Araliaceae had only two plant species each, while the remaining twenty plant families had one species each. However, the literature review confirmed documented anticonvulsant activity in only 46% of these plants, indicating a need for comprehensive phytochemical analyses to explore potential unreported anticonvulsant activities. Despite limited literature on anticonvulsant properties, the identified plants have already been reported to possess medicinal properties for treating other diseases.

Conclusion: The study underscores the potential of traditional medicinal knowledge and identifies potential medicinal plants traditionally used by the Hehe society, with limited scientific evidence from the literature. This reveals areas for further research to fully leverage their therapeutic benefits in modern medicine.

Implication for health policy/practice/research/medical education:
The findings underscore the need to scientifically validate the anticonvulsant properties of medicinal plants traditionally used within the Hehe community, as only 46% possess documented efficacy. This situation necessitates the formulation of inclusive health policies that acknowledge and regulate traditional medicine, foster collaboration between traditional healers and biomedical researchers, and promote rigorous interdisciplinary research to evaluate safety, efficacy, and dosage.

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Introduction

Epilepsy is a collective term for chronic disorders of the central nervous system that are characterized by the spontaneous occurrence of seizures with loss of consciousness and body balance (convulsion). Approximately 60 million people worldwide suffer from this disease, with the majority (85%) residing in developing countries (1-3). The disease burden in low-income countries is twice as much as in high-income countries due to the high incidence of risk factors. The mortality rate associated with this disease is higher in impoverished countries. Besides death, the disease is accompanied by many physical, social, psychological, and economic effects, with stigmatization and discrimination among people, which affect the proper diagnosis and treatment of the affected individuals (4).

Though antiepileptic drugs are currently available in hospitals and other health centres, many patients are

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suffering from chronic disease due to the development of drug resistance. It is reported that about 30 to 40% of epileptic patients are suffering due to antiepileptic resistance (5). Other undesired side effects, including toxicity and failure to give birth, are also reported to be associated with the long-term use of antiepileptic drugs (6,7). Since the disease is neurological, several disorders associated with cognitive ability are reported, including distractibility, insomnia, somnolence, sedation, and dizziness (8). In addition, synthetic antiepileptic drugs are highly expensive and thus not easily affordable by most poor people, especially in rural areas. Thus, the majority of the local community turns to medicinal plants for disease treatment due to their easy accessibility and affordability, even in remote areas where medical facilities are inaccessible. Traditional medicines are largely harmless and very effective, with fewer side effects since they are easily metabolized and absorbed in the body (9).

The development of plant-based drugs is accompanied by several challenges, including unauthorized treatments, consumption of medicinal plants with toxic or unhealthy compounds, allergic reactions and errors in identifying the appropriate plants and their uses (10). The local communities usually harvest medicinal plants in the wild and use them to treat various diseases based on their experiences. However, the uses of some of these medicinal plants have never been documented, while others require scientific evidence of the presence of bioactive medicinal compounds. Proper documentation of medicinal plants used traditionally, along with scientific evidence of the available bioactive compounds, is crucial for informed action towards verifying their use and for drug development. This study was conducted to investigate the medicinal plants used in the treatment of convulsions among the Hehe community, to explore the literature on the available information about the medicinal plants for evidence-based medicinal properties, and to inform further research on undocumented medicinal plants.

Methods

Study site

A botanical survey to explore the medicinal plants used to treat convulsions among the Hehe society was conducted in two districts, namely Mufindi and Kilolo, in Iringa region. The districts were purposively selected based on their geographical locations and the availability of traditional healers and medicinal plant users. Kilolo District lies between 7.8835° S and 36.0893° E, covering a total area of 7,882 km². Mufindi District, on the other hand, lies between 8.6441° S and 35.1269° E. The primary economic activities in the region include crop cultivation, livestock production, and business.

Sampling procedure

Two wards from each district were strategically selected based on the availability of traditional healers and users of medicinal plants in the treatment of convulsions. Two villages were randomly selected from each ward, resulting in a total of 8 villages. Again, purposive sampling was used to select traditional healers, village leaders, and clan elders. A total of 30 key informants from the two districts were interviewed based on their role in the use of medicinal plants. Additionally, 24 focus group discussions, with a minimum of 3 and a maximum of 8 individuals in each group, were also conducted to gather detailed information on the use of medicinal plants for treating convulsions, which is among the common health disorders in the Hehe Society.

Data collection and analysis

Key informant interviews were conducted with the village leaders, traditional healers, clan leaders, and traditional medicine officers to explore the most commonly used plants in the treatment of convulsions, which was mentioned as one of the common health problems in the area. Three separate focus group discussions were conducted in each village, involving males, females, and youths who were well-experienced in medicinal plants, to collect information on their knowledge and practices regarding medicinal plants. During the interviews and focus group discussions, the participants shared their experiences in the use of medicinal plants, particularly in the treatment of convulsions and the availability of such plants in the area. A field survey of the medicinal plants used followed the discussions and interviews. The survey was accompanied by traditional healers, village leaders, and other influential people who assisted in the identification and collection of medicinal plants. The researchers were accompanied by an experienced botanist from the University of Dar es Salaam for the identification of the plants in the field, and where necessary, a sample specimen was taken for herbarium preparation and further identification. Most plant species were found in the public forests, and a few in the peri-urban areas and farmed lands. A list of medicinal plants mentioned by the respondents in the local language (Hehe) observed in the field to treat convulsions from each district was compiled.

A literature survey was also conducted online, including Google Scholar, PubMed, Web of Science, Scopus, Science Direct, and Elsevier, to explore scientific evidence of the reported anticonvulsant activity of medicinal plants. The keywords used in searching the online literature were primarily the scientific names of medicinal plants and their associated medicinal properties, particularly anticonvulsant activity. Similar words to 'anticonvulsant', like 'epilepsy' or 'antiepileptic activity', were also used during the literature search. All medicinal properties of the identified plants reported in the literature, apart from the anticonvulsant activity, were also documented as evidence of the therapeutic potential of the identified medicinal plants.

Results

Identified medicinal plants for the treatment of convulsions

A total of 37 medicinal plants for the treatment of convulsions in Mufindi and Kilolo districts were identified in local and scientific names. The Fabaceae family was the leading in terms of the number of plant species, followed by Verbenaceae and Rubiaceae. Asteraceae and Araliaceae had only two plant species each. The remaining 20 plant families had only one species per family (Table 1).

Literature evidence of the reported anticonvulsant activity of the medicinal plants

Among the 37 reported medicinal plants with anticonvulsant activity, literature searches showed evidence of the documentation of anticonvulsant activity in only 46% (17 plants), belonging to 12 plant families (Table 1). However, most of the medicinal plants with limited scientific evidence of anticonvulsant activity showed that related species possessed anticonvulsant properties. For example, *Croton sylvaticus* is among the identified medicinal plants with limited scientific evidence, though relative species like *Croton tiglium* are well known for their antiepileptic effects (11). Similarly, *Dracaena reflexa* has demonstrated anticonvulsant properties in *in vivo* tests using animal models (12), while scientific evidence is limited for *Dracaena steudneri*. This gives evidence of the possible medicinal properties in the identified species, thus the need for further research. Other medicinal plants like *Cussonia spicata* are reported to be traditionally used in tropical Africa to treat epilepsy, but with limited scientific evidence (13,14). The majority of the plants reported to treat epilepsy in Hehe society were also documented to be used in the treatment of other diseases, as summarised in Table 2.

Discussion

Traditional medicinal plants offer a promising opportunity for further research towards drug discovery. The plants used traditionally in the treatment of a wide range of ailments usually contain bioactive compounds, such as alkaloids, flavonoids, and terpenoids, with potential pharmacological activities (126,127). They exhibit anti-inflammatory, antimicrobial, or antioxidant effects, which are crucial in treating various ailments. Currently, many pharmaceutical drugs are derived from natural products, where the base of information for a particular medicinal plant is usually obtained from traditional use (128-130). This is evidenced in this study, where the literature confirms the presence of bioactive compounds with anticonvulsant activity in the medicinal plants reported to treat epilepsy in the Hehe society. Many of these plants contain bioactive compounds that influence the central nervous system by modulating neurotransmitters, ion channels, or oxidative stress mechanisms similar to those targeted by conventional medications (131). The medicinal plants enhance GABAergic activity, which promotes inhibitory neurotransmission and helps reduce neuronal excitability, a key factor in seizure generation (132,133). Several antiepileptic drugs and potential therapeutic compounds have been directly or indirectly derived from various medicinal plants. For example, reserpine, derived from *Rauwolfia serpentina,* has antihypertensive and antipsychotic effects on seizure modulation (134). Tetrahydrocannabinol and cannabidiol are also antiepileptic compounds derived from *Cannabis sativa* (135).

The literature review shows that most studies that assessed the anticonvulsant activity involved in vivo experiments using mice or rats (Table 2). In vivo testing offers several significant advantages over in vitro methods in terms of physiological relevance, pharmacokinetics, and safety profiling (136). They more accurately replicate the complex interactions within a living organism, which is critical for evaluating the therapeutic potential of anticonvulsant agents. Unlike in vitro testing, in vivo testing shows the physiological response of the body, such as absorption, distribution, metabolism, and excretion, as a result of the dosage employed. These parameters confirm the bioavailability of plant-derived compounds and their ability to cross the blood-brain barrier, which is essential for anticonvulsant activity. While in vitro studies may reveal the pharmacological properties, such as antioxidants and neuroprotective, in vivo studies help to determine the extent of their absorption and CNS penetration (137).

The in vivo seizure models that were used in most of the surveyed studies, including pentylenetetrazole (PTZ) and maximal electroshock MES) (Table 2), provide a more accurate representation of epileptic conditions in humans. These seizure models assess prevention or delay and behavioural, cognitive, and long-term neurological effects of treatment (138). Using live organisms also helps assess the toxicity and other side effects within the animal, such as sedation, motor impairment, or organ toxicity (139). Therefore, in vivo studies are crucial for evaluating the safety profile of medicinal plants, considering their synergistic or antagonistic properties within the body.

The medicinal plants used to treat epilepsy in the Hehe society, although with limited evidence from the literature, provide scientists with an opportunity for detailed biochemical analysis. Therefore, despite insufficient scientific information, the anecdotal evidence and historical use of these plants underscore their potential value. Traditional medicinal plants continue to play a vital role in healthcare delivery, especially in rural areas with limited access to modern healthcare (140,141). They provide a cost-effective and culturally appropriate alternative for the majority of rural communities. However,

Table 1. Scientific evidence of the identified medicinal plants for the treatment of convulsions in the Hehe society

Local name (Hehe)	Family	Scientific name	Plant part used in Hehe	Reported plant part used	Details of the study	References
Mchechefu/Mchechefwa	Anacardiaceae	*Searsia chirindensis*	Leaves and roots	Stem bark	In vivo, using pentylenetetrazole (PTZ), picrotoxin (PCT), and bicuculline (BCL)-induced seizures in mice	(15)
Lisonyi	Cucurbitaceae	*Cucumis dipsaceus*	Leaves	Fruits	In vivo, using the maximal electroshock (MES) induced model	(16)
Muhanza/Lihanza	Fabaceae	*Senna singueana*	Leaves	Roots, bark and leaves	In vivo, seizure was induced by MES, PTZ, and pilocarpine (PC) in mice.	(17,18)
Mkunde	Fabaceae	*Desmodium sp*	Barks	Leaves	In vivo, using PTZ, isoniazid or isonicotinic hydrazide (INH) and MES induced convulsions in mice.	(19,20)
Lidupala	Fabaceae	*Neorautanenia mitis*	Tuber and leaves	Roots	In vivo, using mice and rats	(21)
Lwenyi/Luhenyi/Mnyafwiwi	Lamiaceae	*Ocimum spp*	Leaves and roots	Leaves	In vivo, using mice, induced seizures with PTZ.	(22-24)
Mvengi	Myrtaceae	*Syzygium guineense*	Leaves and barks	Roots	In vivo, using albino Wistar rats	(25,26)
Mpaina	Pinaceae	*Pinus roxburghii*	Leaves	Bark	In vivo, using MES and PTZ to induce seizures in Wistar albino rats	(27)
Kijogolo/Lisogolo/Mkwegatango	Polygalaceae	*Securidaca longipedunculata*	Roots	Leaves and roots	In vivo, using mice for seizures by PTZ, strychnine and MES for convulsions	(28-31)
Mpongolo	Rubiaceae	*Catunaregam spinosa*	Roots	Rooots	In vivo, using PTZ induced seizures in zebrafish larvae	(32)
Not given	Rutaceae	*Clausena anisata*	Leaves	Leaves, roots and stems	In vivo, using mice induced by PTZ	(33,34)
Lihahi/Lihai/Muhahi/Lidasi	Sapindaceae	*Dodonaea viscosa*	Leaves	Stem, leaves, seeds and roots	In vivo, using mice induced PTZ	(35,36)
Likolekole	Malvaceae	*Grewia asiatica*	Leaves and roots	Leaves	In vivo, using PTZ and MES induced seizures in mice	(37-39)
Mnusi	Lamiaceae	*Clerodendrum capitatum*	Leaves	Leaves	In vivo, using mice and chicks induced by PTZ, strychnine and MES	(40)
Mpendaduma	Lamiaceae	*Rotheca myricoides*	Leaves	Leaves	In vivo, using mice induced PTZ	(41)
Lipombogati	Araliaceae	*Cussonia arborea*	Leaves	Leaves	In vivo, using chicks induced by MES	(42)
Litembuliga/Litembwiliga/ Timbuliga	Asteraceae	*Elephantopus scaber*	Roots and leaves	Leaves	In vivo, using rats induced by PTZ and MES	(43)
Linung'anung'a/Manung'anung'a	Asteraceae	*Tagetes minuta*	Leaves	Limited scientific evidence		

Table 1. Continued

Local name (Hehe)	Family	Scientific name	Plant part used in Hehe	Reported plant part used	Details of the study	References
Linyonzolo/Mnyonzolo	Araliaceae	*Cussonia spicata*	Leaves	Limited scientific evidence		
Kinyalulomo/Linyalulomo	Bignoniaceae	*Tecomaria capensis*	Leaves	Limited scientific evidence		
Mlelulelu/Lilelulelu	Fabaceae	*Bobgunnia madagascariensis*	Leaves and barks	Limited scientific evidence		
Kashwalina	Casuarinaceae	*Casuarina cunninghamiana*	Leaves	Limited scientific evidence		
Ndetema/Mdetema/Lisale	Asparagaceae	*Dracaena steudneri*	Leaves and roots	Limited scientific evidence		
Mhulugu/Lihulugu/Livulugu	Euphorbiaceae	*Croton sylvaticus*	Roots and leaves	Limited scientific evidence		
Mgunga	Fabaceae	*Acacia* sp	Leaves, bark and roots	Limited scientific evidence		
Lunyasambala	Fabaceae	*Indigofera buchananii*	Roots and leaves	Limited scientific evidence		
Ngulukila/Lingulukila/ Mngulukila	Loranthaceae	*Plicosepalus meridianus*	Leaves	Limited scientific evidence		
Mpeme	Francoaceae	*Bersama abyssinica*	Leaves	Limited scientific evidence		
Msana	Fabaceae	*Vachellia sieberiana*	Barks	Limited scientific evidence		
Muhanyi	Primulaceae	*Embelia schimperi*	Leaves and roots	Limited scientific evidence		
Mdupa/Mdumpa	Rhizophoraceae	*Cassipourea malosana*	Leaves and bark	Limited scientific evidence		
Kilemwandembwe	Rubiaceae	*Gardenia ternifolia*	Roots and bark	Limited scientific evidence		
Mngogo	Rubiaceae	*Leptactina prostrata*	Roots	Limited scientific evidence		
Lipumba	Rubiaceae	*Rothmannia engleriana*	Leaves	Limited scientific evidence		
Songwe/Lisongwe	Solanaceae	*Physalis peruviana*	Leaves	Limited scientific evidence		
Kihongole/Mhongole/ Lihongole	Verbenaceae	*Lipia javanica*	Leaves and roots	Limited scientific evidence		
Msasati	Lamiaceae	*Vitex madiensis*	Roots and leaves	Limited scientific evidence		

Table 2. Reported therapeutic potentials of the identified medicinal plants other than anticonvulsant activities

Identified medicinal plant	Reported therapeutic potential of the plant species	References
Cucumis dipsaceus	Antioxidant activity	(16,44,45)
	Antidiarrheal, anti-inflammatory and antimicrobial activities	(46)
	Hepatoprotective activity	(47)
	Hypoglycaemic activity	(48)
	Antibacterial activity	(49)
Senna singueana	Antioxidant activity	(50)
	Antibacterial	(18,51,52)
	Antidiabetics	(18,53)
	Antifungal	(18)
	Antioxidant and anticancer	(52,54)
	Treatment of malaria, typhoid, gonorrhoea, bilharzia, cancer and ulcers	(18,55)
	Antinociceptive (pain killer)	(56)
Desmodium sp	Antifungal activity	(57)
	Antioxidant activity	(58)
	Treatment of neurological imbalances	(59)
	Treatment of rheumatism, pyrexia, dysentery, wounds, cough, malaria, hepatitis and hemoptysis	(60)
Neorautanenia mitis	Antidiarrhoeal activity	(61,62)
	Anthelmintic activity	(63)
	Treatment of neuropsychiatric disorders	(21)
	Anti-nociceptive activity (treatment of dysmenorrhea)	(64)
	Anti-inflammatory activity	(64)
	Antimicrobial activity	(65,66)
Ocimum sanctum	Antimicrobial and antioxidant	(67,68)
	Treatment of coughs, ear and eye complaints, haemorrhoids, tuberculosis and stomach pains	(69)
	Anticancer, hepatoprotective, antifungal, antidiabetic, antimicrobial, cardioprotective, antispasmodic, analgesic, antiemetic, diaphoretic, antithyroidic, antiarthritic, antistress, antileucodermal, antiulcer, anticoagulant, immunomodulatory, antifertility, anti-inflammatory actions	(22,24)
Syzygium guineense	Immunological activities	(69)
	Antibacterial activities	(70,71)
	Anti-inflammatory and analgesic activities	(72)
	Treatment of dermatosis, pain, fever and wound	(73)
	Antimalarial activity	(73,74)
	Treatment of hypertension and anticancer	(75)
	Antidiabetic activity	(25,76)
	Anti-tuberculosis activity	(77)
	Organo-protective and antioxidant activities	(78,79)
	Treatment of diarrhoea	(25,26)
Securidaca longipedunculata	Antimicrobial activity	(28,80-83)
	Anti-inflammatory activity	(28,84)
	Anthelmintic activity and analgesic activities	(85,86)
	Treatment of hernias, coughs, fever, ascariasis, constipation, headaches, rheumatism, stomach ache, malaria, tuberculosis, pain, pneumonia, skin infections, sexually transmitted diseases, and it is also used as an aphrodisiac for men	(31)
	Antioxidant, antiparasitic, histopathological, antidiabetic, antiplasmodial, antitrypanosomal,	(28)
Clausena anisata	Hypoglycaemic activity	(87)
	Antioxidant and wound healing activities	(88,89)
	Antimicrobial activity	(89-92)
	Antiplasmodial and analgesic activities	(93)
	Treatment of diabetes, eye problems, malaria, snake envenomation, and malignancies,	(94)
	Anti-inflammatory, analgesic and antipyretic activities	(95,96)
	Antifungal activity	(97)

Table 2. Continued

Identified medicinal plant	Reported therapeutic potential of the plant species	References
Dodonaea viscosa	Antimicrobial, anti-inflammatory, laxative, antiviral, spasmolytic, and hypotensive	(98-101)
	Antidiabetic, antioxidant, cytotoxic, antifertility, wound healing, analgesic, anti-ulcer, antispasmodic, anti-diarrheal and detoxification activities	(99-103)
	Anticancer activity	(104)
	Antifungal activity	(105,106)
Grewia asiatica	Antioxidant/anti-inflammatory activity	(107,108)
	Antimicrobial activity	(107-109)
	Treatment of diabetes, dyspepsia, typhoid, smallpox, hepatitis, diarrhea, malaria, eczema and syphilitic ulcers	(110,111)
	Hepatoprotective, antiemetic, antimalarial, analgesic, and antipyretic activities	(108,112)
	Antianxiety activities	(37-39)
Clerodendrum capitatum	Management of mental illness	(113)
	Antioxidant activity	(114)
	Hypoglycemic and hypolipidemic activities	(115)
	Anti-inflammatory and analgesic activities	(116)
	Erectogenic activity	(117)
	Antimicrobial and antitubercular activities	(118-120)
Rotheca myricoides	Antimicrobial activity	(121,122)
	Antimalarial activity	(123,124)
	Antidiarrheal activity	(125)
	Treatment of coughs, skin diseases, rheumatism, asthma, vermifuge, febrifuge and inflammatory diseases	(124)

rigorous scientific research, including phytochemical analysis, is essential to fully harness their potential. Such studies can provide scientific evidence on their safety, efficacy, and mechanisms of action, paving the way for their integration into mainstream healthcare systems and ensuring their responsible use for future generations. The scientific evidence on the safety of the medicinal plants used locally is important since some plants may be associated with toxic compounds. For example, among the identified anticonvulsant medicinal plants in the Hehe Society, *Syzygium guineense* is reported to have an acute oral effect (25).

Collaborative efforts between traditional healers, ethnobotanists, pharmacologists, and pharmaceutical researchers are essential to unlock the full potential of traditional medicinal plants for modern healthcare (142). Traditional healers possess invaluable knowledge of medicinal plants, accumulated over generations, and understand their cultural and practical applications. Ethnobotanists are important in documenting and studying the plants, elucidating their chemical composition and biological activities. Pharmacologists bring scientific rigour to evaluate the safety and efficacy of plant-derived compounds through laboratory and clinical studies. Pharmaceutical researchers contribute expertise in drug development, transforming promising leads into viable therapeutic agents. These collaborative efforts ensure that traditional knowledge is respected, validated, and integrated into evidence-based medicine, potentially offering new treatments and enhancing healthcare systems.

Limitation of the study

The lack of scientific evidence of the anticonvulsant activity in some of the identified medicinal plants used by the Hehe society in treating epilepsy may be associated with several factors, including limited access to all online materials. Additionally, relevant scientific data may exist in unpublished materials, ongoing publications, or forthcoming drafts that were not included in this study. However, even with these limitations, existing evidence remains scarce. This highlights the need for further research on medicinal plants with potential anticonvulsant activity, as identified in this study.

Conclusion

The majority of medicinal plants traditionally used for treating various health disorders lack sufficient scientific evidence to validate their efficacy and safety. With the growing use of plant-based drugs, further research is essential to support drug discovery and development. Many medicinal plants contain bioactive compounds that may cause adverse effects, including toxicity, necessitating thorough scientific evaluation. Identifying and isolating active compounds can help determine their therapeutic potential and possible risks. Rigorous clinical studies are required to establish standardized dosages, minimize side effects, and ensure safety. Therefore, scientific validation

of medicinal plants is crucial to promote their safe and effective use in modern medicine.

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Authors' contribution

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Writing–review & editing: Onesmo Simon Nyinondi and Prisila Andrea Mkenda**.**

Conflict of interests

The authors declare that there is no conflict of interest.

Ethical considerations

This research was reviewed and approved by the SUARIS Awarding Committee and registered under SUA's Directorate of Postgraduate Studies, Research, Technology Transfer and Consultancy (Reg. No. DPRTC/R/126/CSSH/2/2022). The team obtained a research permit from SUA and an introduction letter to the Permanent Secretary of the Ministry of Local Government and Regional Administration, who issued permission to conduct the study in the selected region.

Subsequent approvals were obtained from the Regional and District Administrative Secretaries, and Ward Executive Officers were notified accordingly. All participants were informed about the purpose of the study, assured of voluntary participation, and their right to withdraw at any time. The research followed SUA's ethical code, ensuring informed consent, confidentiality, and respect for participants throughout the process.

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