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Knowledge, Experiences, First-Aid Practices and Healthcare-Seeking Behaviour Regarding Scorpion Stings Among Residents of Rural and Urban Communities in Imo State, Nigeria

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ABSTRACT

Introduction: Scorpion stings represent a public health concern because they can cause painful local reactions and, in severe cases, life-threatening systemic complications. Effective prevention and management depend on community knowledge, appropriate first-aid practices, and timely healthcare-seeking behaviour. This study assessed knowledge, experiences, first-aid practices, and healthcare-seeking behaviour regarding scorpion stings among residents of rural and urban communities in Imo State, Nigeria.

Methods: A descriptive cross-sectional study design involving 600 adult residents of selected rural and urban communities was proposed. Data were obtained using a structured questionnaire and analyzed using IBM SPSS Statistics, version 26.0. Frequencies and percentages summarized responses, while chi-square tests assessed rural–urban differences. Binary logistic regression was used to examine factors associated with previous scorpion-sting experiences. Statistical significance was set at $p < 0.05$.

Results: Regarding knowledge, 91.8% of respondents knew that scorpions sting, 77.8% could recognize scorpions, 70.2% knew the importance of urgent medical care, and 65.2% recognized that scorpion stings could cause serious illness. Previous scorpion-sting experience was reported by 30.2% of respondents, of whom 66.9% were rural residents. Pain was the most frequently reported symptom (90.1%), followed by swelling (60.2%). Among respondents with previous sting experiences, 30.4% reported washing the affected area, 24.3% used herbal remedies, and 20.4% applied cold compresses. Regarding healthcare-seeking behaviour, 45.3% sought hospital care, while 19.9% visited pharmacies, 19.9% consulted traditional healers, and 14.9% relied on home care. Among those who did not seek hospital care, 36.4% considered the sting insufficiently serious, 24.2% cited treatment costs, and 18.2% reported distance-related barriers. Rural–urban comparisons showed a higher reported history of scorpion stings among rural residents than urban residents (40.2% versus 20.1%; $p < 0.001$). Rural residence was associated with higher odds of previous scorpion stings AOR = 2.30; 95% CI: 1.55–3.42; $p < 0.001$). Outdoor exposure was also associated with increased odds (AOR = 2.10; 95% CI: 1.40–3.15; $p < 0.001$).

Conclusion: The findings suggest that scorpion-sting experiences may be more common among rural residents and that reliance on home-based and traditional remedies, alongside financial and geographical barriers, may influence healthcare-seeking behaviour. Community education, safer first-aid practices, and improved access to professional healthcare are important considerations for scorpion-sting prevention and management in Imo State.

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Introduction

Scorpion stings are an important public health concern in tropical and subtropical regions, where environmental conditions, human activities, and scorpion distribution influence the risk of exposure. Scorpion envenomation causes more than one million reported incidents globally each year and can result in substantial morbidity and occasional mortality, particularly among children [1-3]. Although most stings produce localised pain and inflammation, some result in serious cardiovascular, neurological, and respiratory

complications requiring urgent medical intervention [4-6]. The severity of envenomation depends on factors such as scorpion species, venom composition, the victim's age, and the time elapsed before appropriate treatment [3,7].

Scorpion exposure is influenced by ecological and socioeconomic conditions, including vegetation, housing characteristics, agricultural activities, and environmental disturbance. Rural residents and agricultural workers may encounter scorpions during farming, handling firewood, clearing vegetation, and working around household materials. However, urban residents may also experience stings around buildings, storage areas, and poorly maintained domestic environments [2,3]. Recent epidemiological evidence from Turkey demonstrates variations in sting occurrence according to age, season, and exposure circumstances [8]. These findings emphasise the importance of understanding local exposure patterns rather than assuming that scorpion stings are exclusively a rural health problem.

In Nigeria, published evidence specifically addressing scorpion envenomation remains limited, making community-level investigations particularly important [9]. reported the death of a two-year-old boy following a scorpion sting in Osogbo, southwestern Nigeria. The child developed severe clinical manifestations and died despite medical intervention, illustrating the potential consequences of serious envenomation. It also discussed the clinical challenge of managing pain associated with scorpion stings in the Nigerian healthcare setting [10]. More recently, reported a case series from southeastern Nigeria involving corrosive oesophageal strictures following ingestion of herbal preparations administered for scorpion stings [11]. These reports demonstrate the potential seriousness of scorpion-related incidents and the need to investigate community responses, particularly the use of traditional remedies and delays in seeking professional care.

Knowledge of scorpion habitats, sting symptoms, preventive measures, and appropriate first aid may influence how individuals respond to exposure. However, misconceptions and unverified remedies can complicate management. A recent study in Morocco identified deficiencies in healthcare workers' knowledge of scorpion identification and management, while research among Indian resident doctors highlighted gaps in training and clinical confidence [12,13]. Similarly, a 2026 study in Namibia identified potentially harmful first-aid practices and barriers involving transportation, distance, and treatment costs [14]. The World Health Organization recommends appropriate early management of scorpion stings, including wound cleansing, cold compresses where suitable, and medical assessment according to symptoms and severity [15].

Healthcare-seeking behaviour is therefore an important component of scorpion-sting prevention and management. Financial limitations, geographical distance, cultural beliefs, and perceived symptom severity may influence whether affected individuals seek formal medical care. In Imo State, differences in settlement patterns and access to healthcare may produce different experiences among rural and urban residents. Nevertheless, the extent of these differences cannot be assumed without empirical investigation.

This study therefore assessed knowledge, experiences, first-aid practices, and healthcare-seeking behaviour regarding scorpion stings among residents of rural and urban communities in Imo State, Nigeria. The findings are intended to identify knowledge gaps, describe reported sting experiences, examine factors influencing first aid and healthcare utilisation, and provide evidence to support targeted community education and improved access to appropriate care.

Study Area

The study was conducted in Owerri North Local Government Area of Imo State. It lies between Latitude 5° 27′ 24″N and Longitude 7° 6′ 10″E. The area comprises of rural and urban communities characterised by differences in population density, housing conditions, vegetation, land use, sanitation, and access to healthcare facilities. These environmental and socioeconomic differences may influence human contact with scorpions and the responses adopted following a sting. Rural communities may have greater exposure to vegetation, farms, and other potential scorpion habitats, while urban communities may experience exposure around buildings, household materials, and waste disposal areas. The inclusion of both settings provided an opportunity to investigate differences in scorpion-sting experiences and related health practices.

Study Population

The study population comprised of 600 adult residents of selected rural and urban communities in Owerri North Local Government Area. 300 participants from urban area and 300 participants from rural arrears. Orji served as the Urban areas while Owalla/Owelu served as rural areas. Eligible participants were individuals aged 18 years and above who had resided in the selected communities for a defined minimum period, preferably six months, and were willing to provide informed consent. Residents who were unable to provide informed consent or were unavailable during data collection were excluded.

Study Design and Sampling Technique

A descriptive cross-sectional study design was adopted to assess knowledge, experiences, first-aid practices, and healthcare-seeking behaviour regarding scorpion stings among residents of rural and urban communities in Imo State, southeastern Nigeria. The study involved 600 adult residents selected from designated rural and urban communities.

A multistage sampling technique was proposed for selecting respondents from rural and urban communities in Imo State. In the first stage, selected local government areas were stratified according to rural and urban characteristics. In the second stage, communities were selected from the identified strata using a documented random-selection procedure. In the third stage, households were selected systematically or randomly from an updated household listing or an appropriate community sampling frame. Where a complete listing was unavailable, a clearly defined household-selection procedure was to be established before data collection. In the final stage, one eligible adult was selected from each sampled household using a predetermined method, such as a simple random selection procedure among eligible household members. Where more than one eligible resident was available, the selection process was documented to minimise selection bias. The sample was distributed between rural and urban communities according to the prespecified allocation plan, with the number of respondents selected from each community recorded. Replacement of non-responding households, if permitted, followed the same predefined sampling procedure rather than interviewer discretion.

Data Collection and Questionnaire Administration

Data were collected using a structured questionnaire administered to 600 adult residents of selected rural and urban communities in Imo State, southeastern Nigeria. The questionnaire was designed to obtain information on respondents' sociodemographic

characteristics, knowledge of scorpions and their health effects, previous experiences of scorpion stings, first-aid practices, and healthcare-seeking behaviour following scorpion stings. Before the commencement of data collection, the purpose of the study was explained to community leaders and eligible participants. Informed consent was obtained from each participant before questionnaire administration. Trained research assistants administered the questionnaires through face-to-face interviews to facilitate participation among respondents with different educational backgrounds and literacy levels. The questionnaire was administered in English or translated into the appropriate local language when necessary to ensure that respondents understood the questions correctly. The questionnaire consisted of sections covering respondents' sociodemographic characteristics; knowledge of scorpions and their health effects; previous experiences and circumstances of scorpion stings; first-aid practices; and healthcare-seeking behaviour following a sting.

The knowledge section assessed respondents' understanding of scorpion habitats, potential exposure situations, symptoms associated with stings, possible complications, and appropriate responses. The experience section documented whether respondents had previously been stung, the circumstances surrounding the most recent incident, and the reported effects. First-aid questions focused on actions taken immediately after a sting, including home-based measures and traditional remedies. Healthcare-seeking questions assessed whether professional medical attention was obtained, the timing of care, and reasons for not attending a healthcare facility. Completed questionnaires were checked daily for completeness, consistency, and legibility. Where clarification was necessary, it was obtained from respondents without influencing their answers. The completed questionnaires were coded and entered into a database for statistical analysis. Confidentiality was maintained throughout the data collection process, and participation was entirely voluntary. The information obtained was used solely for the purposes of the research.

Data Analysis

Data were analysed using IBM SPSS Statistics, version 26.0. Frequencies, percentages, and appropriate descriptive statistics were used to summarise respondents' characteristics, knowledge, scorpion-sting experiences, first-aid practices, and healthcare-seeking behaviour. Pearson's chi-square test assessed associations between categorical variables and differences between rural and urban residents. Binary logistic regression identified factors associated with previous scorpion stings and selected healthcare-seeking outcomes. Statistical significance was set at $p < 0.05$, with results presented using appropriate odds ratios and 95% confidence intervals.

Results

Table 1 presents the sociodemographic Characteristics of Respondents. The study involved 600 respondents, comprising 300 (50.0%) rural residents and 300 (50.0%) urban residents. Males accounted for 317 (52.8%), while females represented 283 (47.2%). Respondents aged 28–37 years constituted the largest age group, with 173 (28.8%), followed by those aged 38–47 years, with 151 (25.2%). Regarding educational attainment, secondary education was the most common, accounting for 227 (37.8%), followed by tertiary education, with 181 (30.2%). Farming was the most frequently reported occupation, involving 143 (23.8%) respondents, followed by trading, with 133 (22.2%). Table 2 presents the knowledge of Scorpions and Their Potential Health Effects Knowledge of scorpions varied across the assessed indicators. Most respondents, 551 (91.8%), knew that scorpions could sting humans, while 509 (84.8%) recognized the potential danger of handling them. Furthermore, 467 (77.8%) could recognize a scorpion from a picture or description, and 443 (73.8%) knew that scorpions might shelter in dark crevices or clutter. A total of 421 (70.2%) understood that severe symptoms required urgent medical attention, while 391 (65.2%) knew that some scorpion stings could cause serious illness. However, only 271 (45.2%) knew that scorpion species differed in their medical importance, indicating a potential gap in detailed knowledge. Table 3 presents the experiences and Circumstances of Scorpion Stings. Of the 600 respondents, 181 (30.2%) reported having experienced a scorpion sting, while 419 (69.8%) had never experienced one. Among those reporting previous stings, 121 (66.9%) were rural residents and 60 (33.1%) were urban residents. The most frequently reported location of a sting was inside the house, accounting for 73 (40.3%) cases, followed by farms or bushes, with 63 (34.8%). Farming or outdoor work was the most frequently reported activity at the time of the sting, involving 64 (35.4%) respondents. Local pain was reported by 163 (90.1%), while 109 (60.2%) reported swelling. Table 4 presents first-Aid Practices Following Scorpion Stings. Among the 181 respondents who reported previous scorpion stings, washing the affected area was the most frequently reported first-aid practice, accounting for 55 (30.4%) respondents. Traditional herbal remedies were used by 44 (24.3%), while 37 (20.4%) applied a cold pack or cool compress. Applying an ointment or another topical substance and seeking advice from family or community members were each reported by 18 (9.9%) respondents. Another 9 (5.0%) reported using other practices. Table 5 diplicts healthcare-Seeking Behaviour Following Scorpion Stings. Among respondents with a previous history of scorpion stings, 82 (45.3%) reported visiting a hospital or health centre. A further 36 (19.9%) visited a pharmacy or patent medicine vendor, while another 36 (19.9%) consulted traditional healers. Home management without professional care was reported by 27 (14.9%) respondents. Among the 99 respondents who did not visit a hospital or health centre, the most frequently reported reason was the perception that the sting was not serious, accounting for 36 (36.4%). High healthcare costs were reported by 24 (24.2%), while 18 (18.2%) cited distance to a health facility. Table 6 shows the comparison of Knowledge and Scorpion-Sting Experiences between Rural and Urban Residents. The rural–urban comparison showed that 121 (40.2%) rural residents reported previous scorpion-sting experiences, compared with 60 (20.1%) urban residents. Knowledge that some scorpion stings could cause serious illness was reported by 181 (60.1%) rural residents and 210 (70.2%) urban residents. Similarly, 199 (66.1%) rural residents and 222 (74.2%) urban residents knew that severe symptoms required urgent medical attention. Recognition of scorpions was reported by 239 (79.4%) rural residents and 228 (76.3%) urban residents. Table 7 presents Factors Associated with Previous Scorpion-Sting Experience. The analysis suggested that previous scorpion-sting experience was more common among rural residents than urban residents. Specifically, 121 of 300 (40.3%) rural residents and 60 of 300 (20.0%) urban residents reported previous stings. Similarly, 109 of 241 (45.2%) respondents with outdoor occupational exposure reported previous stings, compared with 72 of 359 (20.1%) without such exposure. Previous sting experience was also reported by 115 (36.3%) male respondents and 66 (23.3%) female respondents. Regarding knowledge, 91 of 331 (27.5%) respondents with adequate knowledge and 90 of 269 (33.5%) with inadequate knowledge reported previous stings. Figure 1 shows the distribution of knowledge scores among the 600 respondents. The largest proportion, 29.7% (178), scored between 6 and 7, followed by 26.0% (156) who scored between 4 and 5. A further 21.3% (128) scored between 8 and 9, while 12.0% (72) scored between

2 and 3. Respondents who scored 10 accounted for 8.0% (48), whereas 3.0% (18) scored between 0 and 1. Figure 2 illustrates how long respondents had lived in their current communities. The largest proportion, 31.3% (188), had resided in their communities for 6–10 years, while 27.0% (162) had lived there for 11–20 years. Respondents who had resided for 1–5 years accounted for 19.3% (116), while 16.7% (100) had lived in their communities for more than 20 years. Only 5.7% (34) had resided in their communities for less than one year. Figure 3 presents the reported distance from respondents' residences to the nearest healthcare facility. The largest proportion, 35.3% (212), lived 1–5 km away, while 26.0% (156) lived 6–10 km away. Approximately 15.8% (95) lived less than 1 km from a healthcare facility, whereas 14.8% (89) lived 11–20 km away. The remaining 8.0% (48) lived more than 20 km away. Figure 4 shows the monthly household income distribution among the 600 respondents. The largest proportion, 29.7% (178), reported a monthly household income of ₦20,000–₦50,000, followed by 27.0% (162) who earned ₦50,001–₦100,000. Respondents earning ₦100,001–₦200,000 accounted for 19.3% (116), while 14.0% (84) reported incomes below ₦20,000. The smallest proportion, 10.0% (60), reported monthly household incomes above ₦200,000.

Table 1: Sociodemographic Characteristics of Respondents (N = 600)

Variables	Categories	Frequency (n)	Percentage (%)
Residence	Rural	300	50.0
	Urban	300	50.0
Sex	Male	317	52.8
	Female	283	47.2
Age (years)	18–27	127	21.2
	28–37	173	28.8
	38–47	151	25.2
	48–57	89	14.8
	58 and above	60	10.0
Educational level	No formal education	73	12.2
	Primary education	119	19.8
	Secondary education	227	37.8
	Tertiary education	181	30.2
Occupation	Farming	143	23.8
	Trading	133	22.2
	Civil service	103	17.2
	Artisan	95	15.8
	Student	67	11.2
	Other occupations	59	9.8
Total respondents		600	100.0

Table 2: Knowledge of Scorpions and Their Potential Health Effects (N = 600)

Knowledge indicators	Correct response	Percentage (%)	Incorrect or do not know	Percentage (%)
Recognized a scorpion from a picture or description	467	77.8	133	22.2
Knew that scorpions can sting humans	551	91.8	49	8.2
Knew that some scorpion stings can cause serious illness	391	65.2	209	34.8
Knew that scorpion species differ in medical importance	271	45.2	329	54.8
Knew that severe symptoms require urgent medical attention	421	70.2	179	29.8
Knew that scorpions may shelter in dark crevices or clutter	443	73.8	157	26.2
Knew that handling a scorpion can be dangerous	509	84.8	91	15.2

Table 3: Experiences and Circumstances of Scorpion Stings

Variables	Categories	Frequency	Percentage (%)
Previous scorpion sting (N = 600)	Yes	181	30.2
	No	419	69.8
Residence among previously stung respondents (n = 181)	Rural	121	66.9
	Urban	60	33.1
Location of sting (n = 181)	Inside the house	73	40.3
	Farm or bush	63	34.8
	Around the compound	27	14.9
	Other locations	18	9.9
Activity at the time of sting (n = 181)	Farming or outdoor work	64	35.4
	Walking or moving items	45	24.9
	Sleeping or resting	36	19.9
	Other activities	36	19.9
Reported local pain (n = 181)	Yes	163	90.1
	No	18	9.9
Reported swelling (n = 181)	Yes	109	60.2
	No	72	39.8

Table 4: First-Aid Practices Following Scorpion Stings

First-aid practice	Frequency	Percentage (%)
Washed the affected area	55	30.4
Applied a cold pack or cool compress	37	20.4
Used a traditional herbal remedy	44	24.3
Applied an ointment or other topical substance	18	9.9
Sought advice from family or community members	18	9.9
Used another practice	9	5.0
Total	181	100.0

Table 5: Healthcare-Seeking Behaviour Following Scorpion Stings

Healthcare-seeking behaviour	Frequency	Percentage (%)
Visited a hospital or health centre	82	45.3
Visited a pharmacy or patent medicine vendor	36	19.9
Consulted a traditional healer	36	19.9
Managed the sting at home without professional care	27	14.9
Total	181	100.0
Reasons for Not Seeking Hospital Care		
Considered the sting not serious	36	36.4
High cost of healthcare	24	24.2
Distance to a health facility	18	18.2
Preferred traditional treatment	15	15.2
Other reasons	6	6.1
Total	99	100.0

Table 6: Comparison of Knowledge and Scorpion-Sting Experiences between Rural and Urban Residents

Variables	Rural (%)	Urban (%)	Total (%)	Illustrative p-value
Recognized a scorpion	239 (79.4)	228 (76.3)	467 (77.8)	0.34
Knew that some scorpion stings can cause serious illness	181 (60.1)	210 (70.2)	391 (65.2)	0.01
Reported a previous scorpion sting	121 (40.2)	60 (20.1)	181 (30.2)	<0.001
Knew that severe symptoms require urgent medical attention	199 (66.1)	222 (74.2)	421 (70.2)	0.03

Table 7: Factors Associated with Previous Scorpion-Sting Experience

Variable	Category	Previous sting, n/N (%)	Crude OR	Adjusted OR	95% CI	Illustrative p-value
Residence	Rural	121/300 (40.3)	2.67	2.30	1.55–3.42	<0.001
	Urban	60/300 (20.0)	1.00 (Ref.)	1.00 (Ref.)	—	—
Sex	Male	115/317 (36.3)	1.77	1.50	1.00–2.25	0.05
	Female	66/283 (23.3)	1.00 (Ref.)	1.00 (Ref.)	—	—
Outdoor occupational exposure	Yes	109/241 (45.2)	2.50	2.10	1.40–3.15	<0.001
	No	72/359 (20.1)	1.00 (Ref.)	1.00 (Ref.)	—	—
Knowledge of scorpion hazards	Adequate	91/331 (27.5)	0.75	0.85	0.57–1.27	0.43
	Inadequate	90/269 (33.5)	1.00 (Ref.)	1.00 (Ref.)	—	—

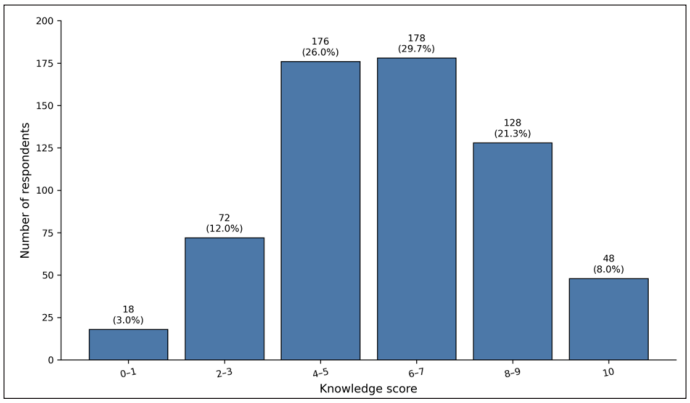


Figure 1: Distribution of Knowledge Scores among Respondents

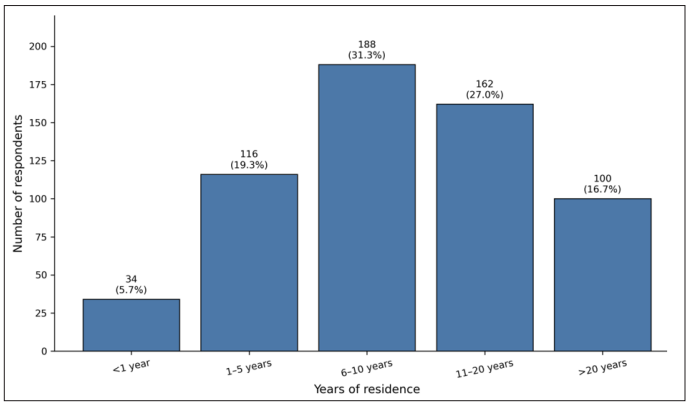


Figure 2: Distribution of Years of Residence in the Current Community

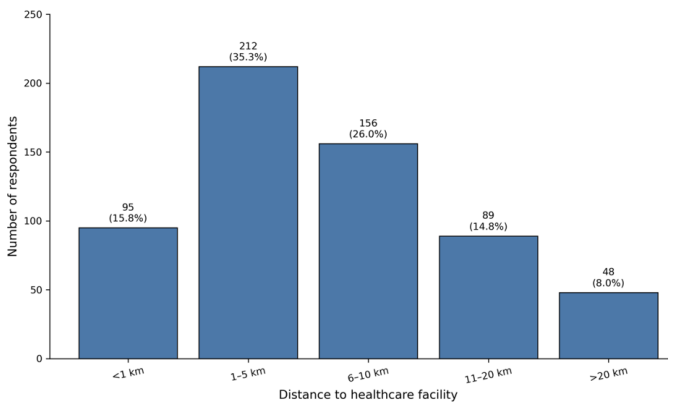


Figure 3: Distribution of Distance to the Nearest Healthcare Facility

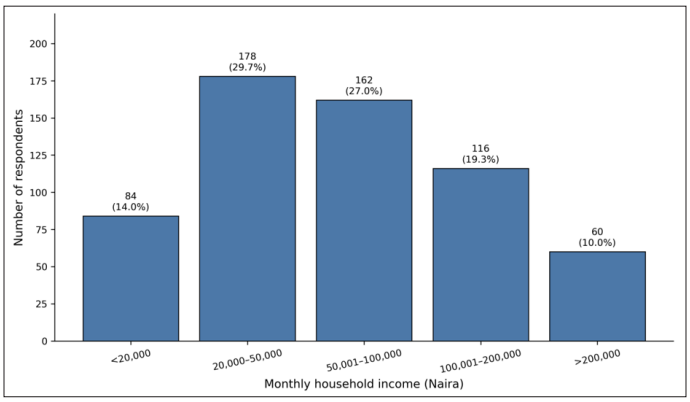


Figure 4: Distribution of Monthly Household Income

Discussion

The study examined knowledge, experiences, first-aid practices, and healthcare-seeking behaviour regarding scorpion stings among residents of rural and urban communities in Imo State, Nigeria. The findings highlight the potential importance of community awareness, environmental exposure, socioeconomic circumstances, and access to healthcare in preventing complications associated with scorpion stings. Scorpion envenomation is an important public health concern in tropical and subtropical regions, although its severity varies with scorpion species, venom characteristics, and individual vulnerability [2,3,7].

Regarding knowledge, 29.7% of respondents scored between 6 and 7, while 26.0% scored between 4 and 5. This distribution suggests that many respondents may have intermediate knowledge, although the actual adequacy of their understanding depends on the knowledge questions and scoring thresholds used. Comparable concerns have been reported in Morocco, where found deficiencies in healthcare workers' knowledge of scorpion identification and management [12]. Similarly, identified the need to strengthen knowledge and clinical preparedness among healthcare trainees in India [13]. These findings support community-based education focusing on scorpion habitats, sting prevention, recognition of danger signs, and appropriate first aid.

Reported the death of a two-year-old child following a scorpion sting in Osogbo, southwestern Nigeria [9]. The child developed severe clinical complications and died despite treatment. Although this case does not establish the frequency of fatal stings nationally, it illustrates the potential seriousness of envenomation, particularly among young children. Writing from the Nigerian clinical context, also highlighted the challenge of managing pain associated with scorpion stings [10]. More recently, documented severe oesophageal complications associated with ingestion of herbal preparations used following scorpion stings in southeastern Nigeria [11]. This evidence underscores the need to discourage potentially harmful remedies and promote timely professional assessment.

Residential history showed that 31.3% of respondents had lived in their communities for 6–10 years, while 27.0% had resided there for 11–20 years. Although prolonged residence may increase familiarity with local environmental conditions, it does not necessarily indicate adequate knowledge of scorpion prevention. Scorpion exposure is influenced by interactions between human activities, housing, land use, and environmental conditions [3,7]. Consequently, preventive education should address household and occupational exposure rather than assume that long-term residents understand the risks.

Healthcare accessibility was another important consideration. Approximately 35.3% of respondents lived 1–5 km from the nearest healthcare facility, while 22.8% lived more than 10 km away. Such distances may increase transport expenses and delay treatment, particularly where affordable transport is limited. In Namibia, identified distance, financial constraints, and transportation difficulties as barriers to timely care following snake and scorpion bites [14]. However, the distances reported in the present illustrative dataset cannot independently establish whether treatment was delayed; this relationship must be assessed using the actual healthcare-seeking results.

Household income may also influence decisions about seeking care. The largest income category was ₦20,000–₦50,000 monthly, representing 29.7% of respondents, while 14.0% reported incomes below ₦20,000. These figures suggest potential financial vulnerability, although household size and actual treatment costs would be needed to determine affordability. The Nigerian case series by documented socioeconomic difficulties contributing to treatment default among patients with complications following traditional remedies [11]. This reinforces the importance of accessible health services and appropriate referral systems.

Overall, the findings highlight the importance of integrated community education, preventive practices, and timely healthcare-seeking following scorpion stings. Targeted awareness programmes should involve community leaders, healthcare workers, and local organisations in both rural and urban areas.

Conclusion

The study highlights the importance of assessing community knowledge, scorpion-sting experiences, first-aid practices, and healthcare-seeking behaviour among rural and urban residents of Imo State, Nigeria. Improving public awareness, promoting appropriate first-aid measures, and addressing barriers to accessing healthcare are essential for reducing the potential health consequences of scorpion stings. Community-based health education, improved access to healthcare facilities, and timely medical assessment are recommended to strengthen prevention and management practices.

Data Availability Statement

All data supporting the findings of this study are available within the paper.

Ethical Approval/Considerations

The study was approved by the Imo State University Ethical Committee on Neglected Tropical Diseases with approval number IMSU/ETH/ONCHO/NTDs/1.2031. Permission to conduct the study was also obtained from the respective community leaders. Written informed consent was obtained from adult participants.

Author Contributions

IJI: Conceptualization, Investigation, Methodology, Writing – original draft, Writing – review and editing. UOP: Conceptualization, Investigation, Methodology, Writing –original draft, Writing – review and editing. NMC: Project administration, Methodology, Data Curation, Writing – review and editing. UGM: Investigation, Methodology, Data Curation, Writing – review and editing. NGU: Supervision, Methodology, Data Curation, writing review and editing. MN: Supervision, Writing – review and editing. OMO: Supervision, Methodology, Data Curation, Writing – review and editing. ACC: Supervision, Methodology, Data Curation, Writing – review and editing. OEO: Supervision, Methodology, Data Curation, writing review and editing.

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Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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