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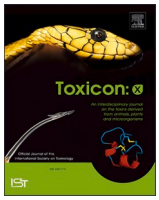

Barriers and enablers of community engagement practices for the prevention of snakebite envenoming in South Asia: A qualitative exploratory study

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ABSTRACT

Snakebite envenoming (SBE) is a grossly neglected tropical disease (NTD) that predominantly affects those living in rural settings in low-and-middle income countries. South Asia currently accounts for the highest global SBE-related mortality, and substantial morbidity rates. To alleviate the high burden in the region, community engagement (CE) is considered to be an integral component for optimizing SBE prevention and control. To better understand existing CE practices for SBE in the region, the experiences of SBE-CE actors concerning the barriers to, and enablers of CE practices were captured through semi-structured interviews. Fifteen key informants from India, Bangladesh and Nepal participated in the study. Important enablers included providing innovative, inclusive and continuous methods and materials, carefully planning of programs, performing monitoring and evaluation, SBE data availability, motivated and trained staff members, good organizational reputations, communication with other SBE-actors, collaborations, and the involvement of the government. Substantial barriers comprised a lack of SBE data, lack of innovative methods and materials for educational purposes, a shortage of human and physical resources, community resistance, untrained health care workers (HCWs), and ineffective traditional healing practices. In order to optimize and sustain SBE-CE practices, context-sensitive, multi-faceted approaches are needed that incorporate all these factors which influence its sustainable implementation.

1. Introduction

According to the former secretary general of the United Nations, Kofi Annan, snakebite envenoming is 'the most important tropical disease you have never heard of' (Williams et al., 2019). Snakebite envenoming (SBE) is a preventable, grossly neglected tropical disease (NTD) caused by venomous snakes that inject toxic secretions through bites or spraying venom in victims' eyes (Gutiérrez et al., 2017). SBE is known to disproportionately affect low-and-middle income countries, and in particular rural communities, those with a lower socio-economic status, those with a lower-level of education and those working in agriculture (Gutiérrez et al., 2017; Ooms et al., 2021; Van Oirschot et al., 2021). South Asia, according to current estimates, is one of the most affected regions of the world, as it accounts for 70% of all SBE mortality (Ralph et al., 2019). Moreover, 15% of the survivors suffer from long-term effects such as neurological, muscular and skeletal disabilities, psychological distress and organ failure (Gutiérrez et al., 2017; Ralph et al., 2019).

The main priorities of SBE intervention and control in South Asia include appropriate prevention measures, effective first-aid response improvements, rapid transport, and optimization of antivenom therapy and supportive care (Ralph et al., 2019). Optimizing prevention, first-aid responses and rapid transport requires substantial resources at the grassroots level (Gutiérrez et al., 2017). Because agricultural activities, false beliefs, mistaken attitudes and traditional healing practices prevail in local communities, which hamper appropriate health-seeking behavior, there is a need for relatively low-cost SBE preventive measures and evidence-based first aid-response in communities (Alirol et al., 2010; Ooms et al., 2021). As a result, community engagement (CE) has been recommended as the most important and simplest method to

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strengthen the prevention of SBE and SBE-related deaths in the context of South Asia (Kadam et al., 2021; World Health Organization, 2016; World Health Organization, 2016).

The importance of CE has been acknowledged by the WHO's global SBE control and prevention strategy which aims to halve morbidity and mortality rates by 2030 (Minghui et al., 2019; Williams et al., 2019). The WHO strategy targets four main domains including encouraging community engagement and empowerment, securing the availability of effective and safe antivenoms, strengthening of health systems and lastly, a call for partnerships and providing sufficient resources and allocating them equitably (Williams et al., 2019; World Health Organization, 2019). Community engagement of at-risk populations has the power to evoke both behavioral and environmental changes with the aim to optimize the well-being of the community and protect its individual members (CODE OF ETHICS FOR RESEARCH, 2016). Therefore, CE plays an essential role in the prevention and improvement of local responses for SBE (Ralph et al., 2019). Previous studies have reported the use of CE as successful prevention programs to combat the burden of neglected tropical disease (NTDs), including SBE, in communities (Moos et al., 2021; Oluwole et al., 2019). However, limited literature exists on the current status, experiences, and needs of SBE-CE practitioners in South Asia.

To better understand the experiences of SBE-CE practices, this study aimed to capture the barriers and enablers as experienced by CE actors working on SBE prevention in South Asia. In addition, this study translated these insights into recommendations for SBE stakeholders to optimize and sustain CE programs in this region.

2. Methodology

2.1. Study design

This study took on a qualitative exploratory research design as little is known about the barriers and enablers to the sustainable implementation of SBE-CE practices in South Asia. Semi-structured interviews were conducted among key informants to gain a deeper understanding of the barriers and enablers of SBE-CE practices. Given the exploratory focus of this study, a semi-structured interview format was chosen to allow the flexibility to move beyond the scope of prepared questions.

2.2. Study area and participants

The sample of informants in this study was collected during exploratory meetings with SBE experts from South Asia through Health Action International's (HAI) SBE network. India, Nepal and Bangladesh, as well as the sample of informants, were subsequently chosen for a more in-depth analysis based on judgments of informants of the exploratory meetings on the scale of intervention in those countries. The sampled participants had worked or were working in the field of SBE and CE at the time of the interviews and were treated as key informants. Further snowball sampling was used to identify additional participants in each of the countries. Key informants were only included if they were at least 18 years old and had a sufficient command of the English language. The sample was carefully selected to reflect a variety of regional SBE stakeholders who agreed to share their perspectives on CE efforts. The type of key informants and their professional careers ranged considerably between the three countries due to diverging SBE-CE programs and stakeholders per context.

2.3. Data collection tool

The interview guide was informed by a study of Garst et al. (2017) which focused on barriers and enablers to the sustainable implementation of international interventions for diabetes type II prevention. In the study of Garst et al. (2017), barriers and enablers were grouped in three categories in which they can occur: 1) the program itself, 2) the organization that offers the program, and 3) the community and context in which the program was introduced. Given the resemblance to the aim of our study, these three categories formed the basis of the conceptual framework (Fig. 1).

The interviews covered questions about topics within these categories to identify potential barriers and enablers, and included questions related to the effectiveness of the used methods and materials for community engagement, the role of the staff members and the resources of the organization, and the impact of other stakeholders like the government and partnerships on sustainable CE.

2.4. Data collection

Semi-structured interviews with key informants were conducted between March 24, 2022 and May 20, 2022 until topical saturation was reached. The interviews lasted between 42 and 76 min and were held via Zoom. The interviews were recorded, and the automatic transcription function of Zoom was used. Two interviews were conducted in written format as participants preferred this communication method. The interview guide was piloted with an SBE expert before the actual interviews; no alterations were necessary.

2.5. Data analysis

The automatic, verbatim transcripts were checked for errors and adjusted where necessary prior to analysis. Data was analyzed using the software program MAXQDA, using thematic analysis with content coding. Relevant segments of the transcripts were selected and coded with predetermined codes based on the conceptual framework of this study by the corresponding author (NJH) (see Annex I). Subsequently, the general themes were grouped in one of the three categories to synthesize the results. An overview was created of the various barriers and enablers per category while remaining sensitive to linkages between the data. The transcripts were read multiple times to allow for alterations in the coding process and to reach consensus on in which category the codes belonged.

2.6. Ethical considerations

For this study, there was no ethical approval necessary from an ethical review committee under the Dutch Law (Moos et al., 2021). Nonetheless, additional measures were taken to ensure ethical conduct in this research. Prior to participation, participants received a participant information sheet containing information on the study and its objectives. Individuals were asked to sign a written informed consent form and had to be at least 18 years in order to participate in the study. Data was de-identified and reported anonymously.

3. Results

3.1. Study sample

In total, 22 individuals were invited to participate; four did not respond and three accepted the invite but failed to make it to the interview, leading to a final sample size of fifteen participants. As limited attention to snakebite in community settings is given, the final sample size reflects a relatively large sample size particularly because convergence was reached in the responses. Six individuals lived in India, five were from Bangladesh, and four were from Nepal (Table 1). All participants were male. Participants' occupations included medical professionals, researchers, governmental officials, herpetologists, NGO staff and community health workers (CHWs). Almost every participant performed multiple SBE-CE activities, the majority being community education (n = 13), research (n = 9), and snake conservation (n = 8).

An account is given of the key informants' perspectives on the barriers and enablers of the sustainable implementation of SBE-CE

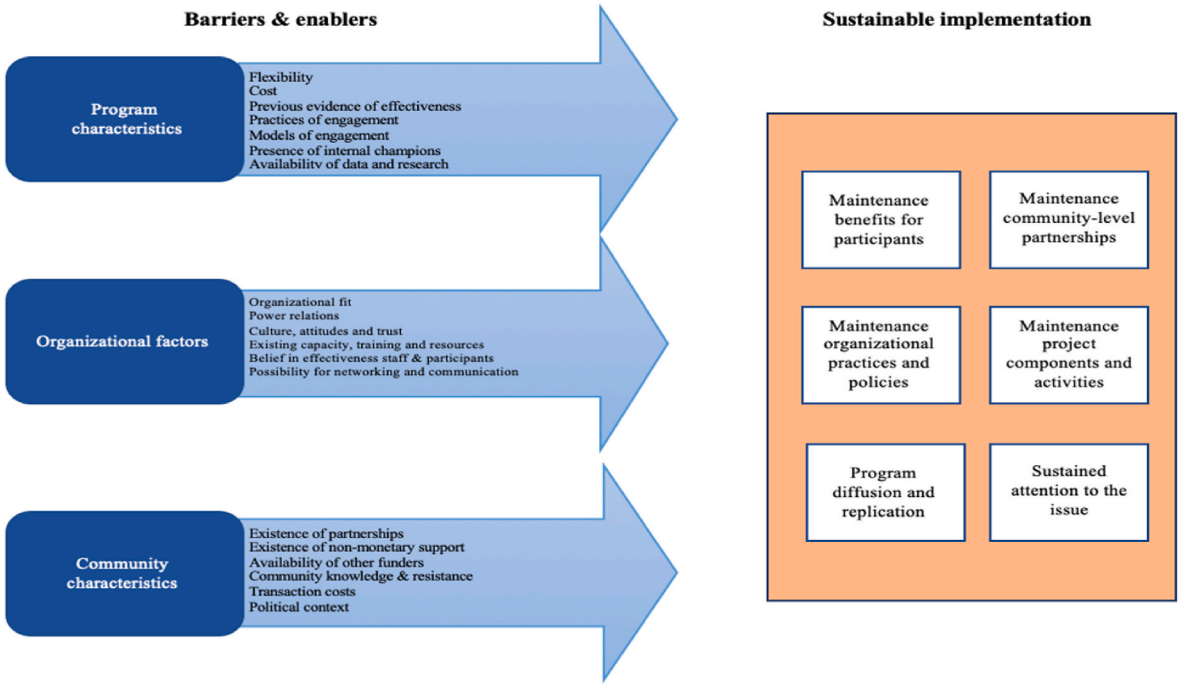

Fig. 1. Conceptual framework for the barriers and enablers to the sustainable implementation of SBE-CE practices in South Asia.

practices. An overview of these barriers and enablers is shown in Fig. 2. The results are categorized according to the adapted framework's components; the main categories were program factors, organizational factors, and community and context factors.

3.2. Program factors

3.2.1. Engaging with different target populations

Numerous participants stressed the enabling ability of children in SBE programs, as they quickly absorbed knowledge and bridged the gap between their parents and the program's staff. Illiterate individuals and elderly populations, on the other hand, were seen as the most difficult with whom to engage. The latter specifically often held deep-rooted religious and spiritual beliefs. One informant commented: *"There are myths in the community and when I try to tell them these are myths; they don't believe it. Mostly in the older populations, and if there are younger populations is it because older family members shared their beliefs with the younger ones." (P14)*.

Participants from India and Nepal reported the eagerness to learn about SBE amongst healthcare volunteers and nurses working in remote areas as part of established programs to strengthen health promotion. In addition, experiences from India and Bangladesh highlighted the importance of including local leaders and internal champions (SBE survivors) to effectively engage with communities. *"[An internal champion] is a goldmine of knowledge with the ability to positively influence a crowd of villagers." (P8)*.

Engaging with other powerful figures differed per context. Bollywood stars and cricket players in India, the Imam in Bangladesh, and celebrities in Nepal were seen as important influencers to be involved in SBE programs.

3.2.2. Methods used to engage with communities

In every context, various technologies, including social media, were highlighted as enabling methods to educate and communicate with communities efficiently. Three Indian participants reported the success of mobile apps and websites to educate communities and professionals, connect snake rescuers (who remove snakes) with communities, provide a hotline on social media for snake removal and relocation, offer a central database for educational materials and snakebite cases, and to generate epidemiological snakebite data which could be shared with government authorities. These methods were considered sustainable as they were continuous, easily accessible, interactive, and free of cost, once established. However, identified barriers included effective marketing of the app, user-friendliness, WIFI access in remote areas, and innovation. As one participant said about existing wildlife apps *"People don't look at user friendliness, in wildlife people don't do it professionally, they are in dire need of creativity". (P11)*.

Other enabling methods of engaging with communities focused on establishing a local SBE task force to educate communities and facilitate first-aid provision and rapid transportation. Two participants from Nepal reported a one-week program that trained snake handlers and interested community members to generate a sustainable network of qualified snake handlers and educators. Further, in Bangladesh, the health system offered free counseling and focus group discussions (FGDs) at the community level. The FGDs focus on various health topics, including on SBE, and are executed by CHWs. One participant explained: *"There is a department in our health system for the FGDs, that is the community clinic with community health care providers. The part of their work is arranging FGDs and a small part of that is on snakebite." (P1)*.

Interestingly, all participants highlighted the importance of offering continuous sessions as it takes time to change the beliefs and behaviors of communities regarding SBE. Moreover, various participants believed that a sustainable intervention required a feasible program replication roadmap, a realistic plan to scale up the program in other locations in which necessary resources and infrastructures were carefully evaluated beforehand.

A substantial barrier to almost every educational program was described by a participant from India, who stated that people have overcomplicated the program's information:

"HCWs and villagers do not benefit from details on snake identification, it is too specific and irrelevant for these populations." (P9).

3.2.3. Effectiveness of the educational materials used

The use of diverging materials was mentioned by participants for education and training purposes such as posters, videos, flyers, PowerPoint presentations, and snake replicas. For all of these materials, the

Table 1
Participant characteristics.

Participant number	Country	Gender	Profession	Job description
P1	Bangladesh	Male	Governmental official	Policy making Snakebite advocacy
P2	Bangladesh	Male	Governmental official Medical doctor	Policy making Medical treatment and care Research Snakebite advocacy
P3	Bangladesh	Male	Snake biologist	Research Snake conservation Community education
P4	Bangladesh	Male	Medical assistant	Medical treatment and care Community education Research
P5	Bangladesh	Male	Community health care worker	Counseling of snakebite victims Community education
P6	India	Male	NGO staff member	Community education Snakebite advocacy
P7	India	Male	NGO staff member	Community education Snake conservation
P8	India	Male	NGO staff member	Community education Research Snakebite advocacy
P9	India	Male	Snake biologist	Research Snake conservation Community education
P10	India	Male	Herpetologist	Research Snake conservation Community education
P11	India	Male	Snake biologist	Research Community education
P12	Nepal	Male	Medical doctor NGO staff member	Snake conservation Community education Medical treatment and care
P13	Nepal	Male	NGO staff member	Research Snake conservation Community education Snakebite advocacy
P14	Nepal	Male	Snake biologist	Snake conversation Community education
P15	Nepal	Male	Nature guide	Snake conservation Community education

facilitating role of regional language translations and simple content was emphasized in order to accommodate all community members. Moreover, several participants highlighted that educational and training materials work best if they are interactive, innovative, and updated regularly. One respondent from India mentioned: *"The education sessions need to be very interactive. We use supercool snakebite videos and some pictures, and we carry snakeskin for the children during our sessions which really helps us to execute the program very well." (P6*).

Furthermore, in India movies were seen as powerful materials, in Bangladesh advertisements on billboards and videos displayed in local health care units were more common, while local radio announcements were mentioned by Nepalese participants. Moreover, the potential of SBE songs was expressed by an Indian and Bangladeshi respondent.

To further enhance the effectiveness of the program's materials, participants mentioned sharing their contact information on the materials and providing printed materials to take home to allow for continuous access to the program. One participant explained: *"I am a photographer, so I show my photos on my phone and I use posters to show venomous snakes and people use that knowledge. My phone number for snake rescue is attached to these materials." (P14)* Likewise, the dissemination of the program's materials was facilitated by their presence on social media, in schools, bus stops, community centers, and local health facilities. Barriers in this theme were closely linked to the abovementioned enablers and included difficulties with translations and digitalizing materials.

3.2.4. Logistics of the program

Participants expressed difficulties with gathering community members for the program. These challenges were caused by work schedules of community members that differed per individual. The male community members of working age were often absent, leading to a skewed ratio within the programs favoring the sensitization of children, older adults and women. To mitigate this issue, participants discussed gathering individuals in places where social events regularly took place. One participant said: *"We do not try to gather people, but we go to places where they are already gathered. Especially around 4–6 in the evenings we have social gatherings because a lot of places in rural India are still open for human, social interactions." (P6*).

Unsurprisingly, programs were considered more likely to succeed if it was free of cost for communities. In Bangladesh, participants praised their programs for being free, whereas two Nepalese and Indian interviewees stated that communities demanded financial *incentives* as prerequisites to participate in their programs. One of the Nepalese interviewees explained: *"We often have to pay participants to come to the program because without having any payment and losing the whole day of work, people don't think it is worth it to come to our program. If we don't do this, it isn't sustainable." (P12*).

These demands were worsened by NGOs that paid communities to engage in their health-related initiatives, as this raised the expectations of community members. Moreover, community members were generally not aware that snake rescuers worked as volunteers, leading to community's preference for killing snakes rather than providing some assumed compensation to the snake rescuers for their services.

3.2.5. The availability of data to inform the program

Several interview participants referred to a scarcity of survey data on snakebites that impeded their ability to contextualize the snakebite problem in their work location. Participants elaborated that the majority of snakebite deaths were underestimated as they were not reported correctly in their country. In India and Nepal, participants expressed that important stakeholders did not want to act on the SBE issue as the scope of the problem was severely overlooked. *"There is no compulsion of the government to act as there is no data available." (P9*).

Because of this data deficiency, multiple participants felt uninformed on what program areas to focus and how to prioritize resource allocation. Also, one respondent from India characterized data as an

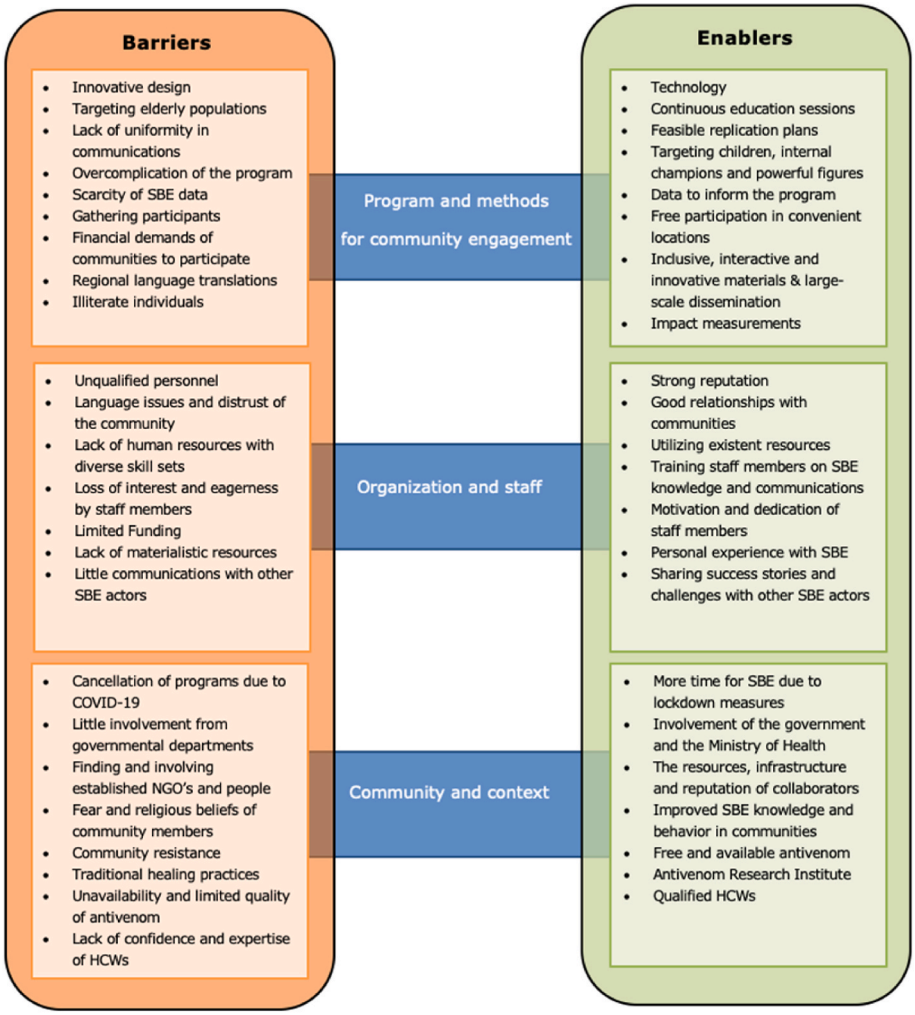

Fig. 2. Overview of the barriers and enablers of this study.

enabler as: *"Data increases relatability for community members, and staff members can appropriately handle counter questions using data." (P10*).

3.2.6. The ability to measure the program's impact

The ability to measure the impact of a program was acknowledged as an important enabler for sustainable program outcomes by the majority of the participants. Two Nepalese participants illustrated that pre-and-post questionnaires measuring the participants' knowledge before and after participating in their educational program, demonstrated that their methods were ineffective, and adaptations were needed. Conversely, another Indian participant shared this opinion of the usefulness of questionnaires; *"We could see a clear contrast how people have different knowledge when it comes to attending our programs. This is something we are trying to do in every state, it is very helpful." (P6)* In addition, alternative methods for measuring the impact of programs were recommended by respondents such as their social media interactions, the number of phone calls to snake relocation services, and mobile application activity.

One identified barrier to engage with communities was related to the presence of illiterate community members who could not fill out questionnaires independently. Moreover, one Indian participant said: *"We can't expect immediate results in SBE work, behavioral change happens slowly." (P9*).

3.3. Organizational factors

3.3.1. The reputation of the organization

Establishing an organization paved the way for attention from governments and funding opportunities according to several participants. Bangladesh and Nepal both have a Toxicology Association, an expert center dedicated to SBE. Developing a good reputation was a significant enabler for many participants as it established credibility, which helped to motivate community members and generated more requests for their programs. A participant from Bangladesh said: *"People from the area come here easily because of the quality of health care and the communication system of my community clinic." (P5*).

Moreover, the belief in the organization grew when, *"People are authentic and have the expertise" (P7)* explained an Indian participant. Snake rescuers were seen as 'heroes' by communities as snake rescues were usually performed in front of the communities. Likewise, a Nepalese participant posted his rescue videos on social media, proving his qualifications, which facilitated the trust of communities in his skills.

3.3.2. The relationship of the organization with the community

Familiarity of the organization to the community was seen as an important enabler. Three participants from India reported that community elections were held, in which villagers were elected to be trained by an organization on SBE, after which they returned to educate their communities. Likewise, CHWs were selected from the community itself in Bangladesh. Another important enabler related to continuity. An

Indian participant discussed: *"The corporates I worked with organized many fun activities with the community apart from the program. This ensured an ongoing relationship; [it is] very important to do this." (P10*).

Barriers to establishing desirable relationships, on the other hand, were also disclosed. Language barriers in Nepal and India led to an organization being seen as an outsider by some community members, or communication was simply not possible. Moreover, building a relationship took time, which was often a scarce commodity for participants.

3.3.3. Existing human resources of the organization

The existing human resources were reported as a substantial barrier to sustainable SBE-CE. Not many people were interested in working on SBE, soexpertise was in the hands of a limited number of people, and several individuals worked as volunteers and held paid employment as a means of support. This resulted in a lack of continuity and little program expansion possibilities as various participants claimed that it was impossible to run their project all year long. Nepalese snake handlers expressed their inability to respond to a high volume of rescue calls, which upset the communities.

Other barriers focused on the different type of employees that were needed to effectively run programs. An Indian participant described a need for designers and technicians to create sustainable and resource-saving campaigns. Others mentioned that they lacked community engagement specialists, educators to properly educate their staff members, and a diversified team*: "We need a diverse set of expertise - people with a diverging set of skills, this will make the work much stronger." (P10*).

To combat these human workforce shortages, several participants highlighted the importance of utilizing existing resources. In particular, participants discussed the facilitating role of physicians, field nurses and teachers to educate communities, as well as the potential to connect with individuals that already provide community sensitization programs on other health topics.

3.3.4. Training of staff members

For almost all participants, training of staff members was seen as a crucial factor to continue effective CE work. An Indian participant reported the significance of selecting and training volunteers carefully, prior to letting them do grassroots-level work. Other participants highlighted that communication skills training to effectively engage with villagers and to ensure that staff is well received within a certain community are important enablers; *"We cover all the information and then how to deliver that to the people. We learn how to talk to the local people effectively." (P5)* Moreover, one participant from Bangladesh praised having regular access to training sites to sustainably conduct training on a routine basis.

3.3.5. Attitude or motivation of staff members

As a significant proportion of the workforce on snakebite is on a voluntary basis, a number of informants reported similar enablers within the work ethos of staff members. The most noticeable enabler entailed committed and passionate staff members that dedicated their career to SBE death mitigation. One Indian participant said: "An interest and enthusiasm for the subject is the primary factor to sustain implementation of snakebite mitigation." (P8).

Another crucial enabler was personal experience with SBE, as this sparked interest and an understanding that mitigating snakebite is a key priority. Contrastingly, a challenge was that people lost interest. Snake rescuers specifically were not always interested in expanding their focus to snakebite death mitigation; *"They [snake handlers] don't get charm out of it, so we need to make our work kind of charming so rescuers feel like they're doing something good while doing snake bite death mitigation work"(P9*).

3.3.6. Existing physical resources of the organization

Funding was found to be the biggest barrier within the physical resources of the organization. The lack of funds, according to numerous informants, made it impossible to disseminate educational materials thoroughly, meet community needs, pay staff and volunteers regularly, conduct impact assessments and follow-up visits, continuate, scale up and replicate existing programs. To summarize: "Funding *determines the number of people we can hire, where we can go and if we can do it all year". (P13*).

Moreover, two Indian participants suggested that funders generally determined the work location rather than investing in the most affected areas. Participants from Bangladesh were the only individuals that received regular funding from the government to sustain their work on the ground. Another important barrier for physical resource allocation was that snake handlers did not own appropriate equipment to perform rescues.

3.3.7. Communication with other SBE actors

Barriers in communicating with other SBE organizations were encountered by several participants, leading to inability to exchange experiences. In general, participants expressed that actors were often not interested in sharing information because they were too busy, in India there were too many actors involved, or funding competition hampered conversations. As a consequence, an Indian participant said: *"Our action plan is not uniform, we need to simplify our whole process of snakebite death mitigation, it is too complex." (P9*).

Once communication was established, it became a enabler. In Nepal and India, snake rescuers were connected through an educational program and gained knowledge and skills from each other. Moreover, an Indian participant reported the importance of rotating within different organizations to connect and share information. *"I think people should be rotating into different institutions not stick to one institution for long you know and then probably the sharing will happen more." (P9*).

3.4. Community and context factors

3.4.1. Involvement of the government

The role of the government to acknowledge, prioritize and facilitate the work on SBE prevention, treatment and care was raised by all participants. The government of Bangladesh has taken up this role, according to participants, as they assigned two health departments to continuously work towards reducing SBE deaths and disabilities: The Non-Communicable Disease (NCD) Department and the CHW Department. Barriers resolved around the fact that Bangladeshi participants felt that the government determined the political SBE agenda without incorporating input of the affected rural communities.

Indian participants expressed that their government was willing to facilitate their work once convinced. Some state governments had facilitated free ambulance networks which were accessible to SBE victims. Also, the Wildlife department had facilitated the operation of some SBE apps in India. However, the sustainability of the work on SBE was still hampered by the lack of government engagement. According to informants, multiple governmental departments like wildlife, education, agriculture and health were not actively involved in the field*: "There needs to be participation from others as well, so right now it's individuals like self-motivated people who are trying to do something. But there are other players within the government that can play a role for sure." (P10*).

Moreover, informants believed there to be an unequal distribution of money to non-evidence-based programs, such as compensating SBE victim's families, as well as to more urban health problems such as rabies prevention programs. Participants felt that governments should concentrate on prevention in affected rural communities instead, for example by investing in SBE and antivenom research centers. Moreover, participants in India and Nepal explained that the Wildlife departments disproportionately focused on other animal attacks: *"The wildlife authority of India prefers to focus on crocodiles and leopard attacks, as they gain more publicity and political push to be incorporated in political agendas and elections, rather than snakebite which is much more a problem." (P10*).

3.4.2. Influence of collaborations

Collaborations provided a platform, with a solid brand and a strong infrastructure, which saved resources and generated desirable outcomes for several participants. Collaborations had provided funding, educational materials, SBE and research expertise, snake relocation equipment and help, adequate SBE-data and strong infrastructures and relationships with communities. In Bangladesh, NGOs occasionally joined FGDs. *"Sometimes we have them come to the office and they come to the sessions and they give their expertise information to the community." (P5*).

According to the participants, one of the biggest barriers was *"to find established organizations and people in every district and make them interested in snakebites." (P13)* Some participants believed it was not viable to conduct stand-alone SBE programs and stated that SBE actors needed to invest in collaborations with other health-related programs.

3.4.3. Knowledge and behavior of the community on SBE

Changing the perceptions of communities in relation to SBE was seen as one of the most important enablers. According to interviewees, communities that taught proper knowledge to the next generation(s) and that improved rapid transportation of SBE victims to hospitals saw a direct decrease in snakebite mortality rates, and a reduction in religious and traditional beliefs. One participant mentioned: *"If communities are aware and have knowledge about the conservation, then they will try to conserve the nature and try to harm snakes less, and they will teach the same things to the next generation. This reduces snakebite deaths." (P14*).

Nevertheless, plenty of barriers were reported as well. Removing negative religious and traditional beliefs amongst community members was proven to be extremely difficult. Despite the sacred status of snakes in several cultures, community members held deep-rooted beliefs that snakes are malevolent, aggressive animals and that snakebite is a punishment for bad behavior. Thus, the fear and mysticism of snakes may provoke violence and the death of the snake. An Indian participant said: *"We find that established community beliefs about snakes (thousands of negative myths) makes it difficult to counter these wrong beliefs." (P8*).

Several participants reported that community resistance negatively affected their program due to poor understanding of the SBE and inappropriate first-aid practices. Even though community members came to listen, in practice they did not always adopt the recommendations of the program, like using mosquito nets and not using tourniquets.

3.4.4. Presence of traditional healers

In every country, the presence and influence of traditional healers was reported as a massive barrier to health seeking behavior and successful treatment outcomes. Traditional healers were easily accessible, accepted goods over money, and gained the faith of communities as the vast majority of snakebites are 'dry' or non-venomous and thus, 'cured'. Once envenomed, patients only sought care at hospitals after consultation with a traditional healer causing long delays in evidence-based treatment. Such delay causes serious complications and sometimes death in hospital settings, fueling the preference of community members of sticking with traditional healers rather than seeking modern medical care. Consequently, several informants have tried to include traditional healers in their programs, but, of course, convincing them to use more scientific approaches was always going to be a challenge; We also included traditional healers who use different types of mantras to treat snakebite. But is has been hard to convince them that this is traditional and not recommended by healthcare workers." (P13).

3.4.5. Availability and quality of antivenom

The availability of antivenom in rural health facilities and remote areas was a huge issue in both India and Nepal, whereas in Bangladesh the NCD Health Department prioritized distributing antivenom to all parts of the country. Several participants expressed obstacles for community members to find rapid transportation to the hospital, as well as misunderstandings on where to go first for SBE treatment. Moreover, the quality of the antivenom was a major barrier in every context as antivenom produced in India was ineffective to counter the effects of envenomation caused by other common venomous snakes found in the region besides the big four. One Indian participant explained that: *"I have seen medical doctors from my state collectively agree upon using 25–30 vials* per *patient where it is supposed to be 2–3 vials, but the quality [of the antivenom] is different, and this leads to huge shortages." (P10)* As a result of these shortcomings, participants discussed that villagers lost faith in medical science and the information of their programs.

An enabler was that antivenom is free of charge in Nepal, Bangladesh and India. Moreover, Nepalese participants reported the availability of antivenom in rural army camps, whereas Bangladesh recently opened the first Venom Research Institute in Chittagong.

3.4.6. Capacity of local healthcare workers to treat snakebite

Various participants disclosed challenges to adequate medical SBE treatment in the public sector. HCWs often had limited knowledge on SBE and resources were scant. Unqualified personnel resulted in inability to perform intubation and loss of confidence of HCWs in all countries. More specifically, the fear of antivenom-induced anaphylactic shock amongst HCWs and the lack of ICU support was reported in Bangladesh. Furthermore, anger of victim's relatives in India and Nepal were barriers that fortified the underlying insecurities of HCWs. One participant explained: *"The hospitals should be ready, trained and qualified to treat and stabilize the patient. This is not happening now, so people run from hospital to hospital and lose faith in medical science and visit faith healers instead." (P1*).

On the contrary, HCWs were also seen as one of the biggest enablers as they were a huge driving force in every context. *"I think for facilitating the healthcare workers are the most important people, because they are the ones who are actually the biggest driving force, and if we can develop a big pool of them as good enablers in our country perspective, it would be fantastic." (P2*).

4. Discussion

This study aimed to provide an overview of the existing barriers and enablers to the sustainable implementation of CE practices tackling the burden of SBE in South Asia. Program enablers included providing consciously planned technological and continuous methods as well as inclusive and innovative materials, utilizing SBE data to inform the program, and conducting impact measurements. Barriers of the program entailed a scarcity of SBE data, issues with gathering participants for educative sessions, and difficulties with providing innovative methods and materials in different regional languages. In the organization, the facilitating role of motivated, trained staff members within organizations that hold strong reputations and communicate with other SBE actors, and utilizing existing resources were expressed. The most important organizational barriers included human resource shortages and unqualified staff members, limited funding, limited communication with other SBE actors and language barriers between the organization and the communities. For the community and context, the presence of collaborations, involvement of the government, and free and available antivenom were all enablers to sustainable SBE-CE work. Barriers at the community level were community resistance, unqualified healthcare workers, religious beliefs and traditional healers. To both tackle the aforementioned barriers while simultaneously sustaining enablers, this study proposes several top-down and bottom-up recommendations (see the Recommendation Box).

This study shows that the use of community-inclusive technology and innovation played a beneficial role for delivering CE methods and resources, which led to favorable and continuous program outcomes. The importance of social media, targeting different socio-economic groups and prolonged engagements in SBE-CE methods and materials, was also highlighted in empirical research in India, and a literature review in East Africa (Kadam et al., 2021; Moos et al., 2021). Furthermore,

these studies also stressed the importance of involving respected community figures and leaders to broker introductions, build relationships and disseminate their programs into the wide community, which is similar to our findings.

SBE-CE programs are also more likely to succeed once they were held during hours that did not compete with the work schedules of community members, in locations that were easily accessible, and where costs and resources were not a hindrance to participate. Issues with personal costs, timing and accessibility of CE programs were also highlighted in a literature review by Popay et al. (2007). The review examined barriers and enablers to the successful implementation of diverging international CE practices that addressed the social determinants of health or health inequalities. Similarly, a literature review of Moos et al. (2021), focusing on CE practices for NTDs in rural East Africa, reported that participation costs as well as time-competing activities of agricultural workers created barriers to SBE-CE programs. In addition, participatory approaches were described as enablers to SBE-CE practices (Moos et al., 2021). However, considering the descriptive nature of this literature review, the true implications of participatory approaches for SBE-CE remains unknown. As the extent to which CE was reached within the SBE programs was not addressed in this study, the effect of participatory approaches and facilitating community empowerment form an interesting topic for future research.

Secondly, this study demonstrates the vital importance of data. Availability of data is used to inform CE work on SBE, as well as to evaluate it through impact measurements. Several participants expressed a lack of SBE data in South Asia to inform their work in terms of understanding community SBE knowledge, relevant epidemiological data, and using data for advocacy. Likewise, a lack on SBE data was reported in multiple other studies within this context (Ediriweera et al., 2017; Hossain et al., 2016; Mohapatra et al., 2011). Future research thus needs to focus on generating adequate and frequent nation-wide community based SBE surveys and improve government health reporting systems to capture the incidence, morbidity, mortality and perceptions of communities on SBE. Moreover, this study highlights that SBE-CE actors need to develop methods to perform monitoring and evaluation (M&E) of their programs. Practical guidelines state that the M&E activities need to be planned just as carefully as the data collection phase, as they allow for timely adjustments during the program and knowledge about the effectiveness and efficiency of the program afterwards (Unesco, 2009). A similar guideline recommended the performance of formative, process, summative, outcome or impact evaluations, for community engagement work, using different methods, depending on the perspectives of several stakeholders (CODE OF ETHICS FOR RESEARCH, 2016). More specifically, empirical findings from SBE-CE work in India have suggested mixed-method studies to perform impact measurements for SBE-CE work (Kadam et al., 2021).

This study illustrates that, within SBE organizations, despite a huge shortage of human resources, staff members have the ability to generate numerous enablers. Motivated and trained staff members with a diverse set of skills and knowledge are key to establishing a strong reputation and longstanding relationships with communities, causing sustainable CE work. The undeniable facilitating role of staff members was also reported by a review focusing on CE practices for the delivery of healthcare services (De Weger et al., 2018). However, the significant lack of funding restricts the continuation and replication of the organization's activities. Financial issues for SBE work have been reported by several other studies (Moos et al., 2021; Sharma et al., 2013). Hence, future research and advocacy needs to focus on the reallocation of funds and attracting donor agencies to meet the need of SBE-CE actors.

This study also showed that deeply rooted perceptions, and inadequate knowledge and health-seeking behaviors of community members, result in resistance to CE programs. Identical community perceptions on SBE have been demonstrated in other studies conducted in South Asia, as villagers often held limited knowledge on SBE, performed harmful first-aid practices, and feared and killed snakes (Pandey et al., 2016; Ralph et al., 2019; Samuel et al., 2020). Moreover, several studies described the presence of unqualified HCWs and the unavailability and inadequacy of antivenom (Alirol et al., 2010; Moos et al., 2021; Potet et al., 2021), which are also substantial barriers found in this study. These barriers in turn, fuel communities desire to visit traditional healers, which are abundantly present in the South Asian context

5. Recommendations

5.1. Bottom-up

- Encourage the design and use of practical technology tools which are inclusive to local needs and support community participation and education
- Support the development of easy-to-use templates which can assist SBE CE actors in the design, planning, monitoring and evaluation of snakebite programs
- Work with NGO's, civil society and governments to develop best practice resources to support staff training on community snakebite programs
- Facilitate acquiring a diversified and motivated groups of staff members with a diverse set of skills
- Encourage the dissemination of snakebite education and awareness through existing community structures and meetings where possible
- Foster national, regional, and international collaborations which improve networking, learning and exchange among SBE CE actors

5.2. Top-down

- Ensure equitable and free access to quality antivenom and treatment commodities in local health facilities
- Strengthen the capacity of rural HCWs to diagnose, manage and treat snakebite patients through workshops, education sessions and by the training of trainers
- Train and sensitize appropriate first responders in snakebite prevention, first-aid, treatment and referral pathways including traditional healers, community health volunteers and local leaders
- Ensure a coordinated, integrated and uniform response by making policymakers and SBE-CE actors share the responsibility in close partnership for SBE prevention and control
- Support community members and civil society to conduct SBE surveys in affected communities on the incidence, morbidity, mortality and perceptions of community members
- Ensure the government prioritize snakebite by taking a leading role in the development of national snakebite strategies and plans in partnership with SBE CE actors and other stakeholders
- Ensure that adequate and sustainable funding is invested into community-based snakebite programs

(Hossain et al., 2016; Kadam et al., 2021; Rahman et al., 2010). Engaging with traditional healers has been proven essential yet difficult in this study, as well as in other SBE-CE efforts (Kadam et al., 2021; Moos et al., 2021). The work by Kadam et al. (2021) suggests that resources first need to be invested in other activities, given the difficulties with engaging traditional healers, which may be applicable for other SBE-CE actors in the field as well.

The need for governmental support to sustain the CE practices on SBEbecame evident in this study. The lack of support and prioritization of SBEby national governments has been highlighted extensively in the literature (Alirol et al., 2010; Gutiérrez et al., 2013; Ralph et al., 2019). This study shows that the government in Bangladesh has appointed two Health Departments to lead on national SBE efforts, hired CHWs and established a Venom Research Institute to try to mitigate the burden of SBE. In India and Nepal, several non-governmental SBE actors mainly perform isolated CE practices in different locations, without much central support from the government. Moreover, these independent actors fail to communicate with other SBE-actors, which may lead to inefficient use of resources and discontinuities of the program (Vermeir et al., 2015). These findings suggest a need for an integrated approach, involving different ministries (e.g. Ministry of Health, the Ministry of Wildlife, the Ministry of Education and the Ministry of Agriculture), as well as SBE-CE stakeholders, to facilitate a uniform and sustainable system of SBE prevention and control. Likewise, collaborations are reported as a significant enabler in this study. This vision supports the findings of Moos et al. (2021), who recommended cross-sectoral collaborations to establish 'quick-wins' in the field of community engagement and NTDs.

5.3. Strengths and limitations

This is the first study that has focused on uncovering the barriers and enablers to the sustainable implementation of CE practices for SBE in South Asia. An important strength of the study is that the sample of the interviews represented a variety of SBE actors and stakeholders in three countries of South Asia. Moreover, several topics were mentioned by multiple participants, illustrating consensus within the study sample. Naturally, this study also has some limitations. Linguistic barriers between the researcher and the target population decreased the total number of participants and may have led to some information being lost in translation. Secondly, language differences were specifically prevalent in those working on the grassroots-level, who directly engage with communities. Also, the number of SBE-actors working on CE efforts is generally limited in South Asia, and therefore, convenience and snowball sampling were used. These limitations may have caused volunteer and selection bias which may have influenced the quality of the study. Moreover, these forms of sampling have led to an unequal distribution of different stakeholders' groups in the final sample size.

6. Conclusion

This study offers an extensive overview of the perceived barriers and enablers of community engagement practices for SBE prevention and control in the context of South Asia. As every community has its own unique characteristics, this study does not aim to provide a generalizable overview. However, the findings of this study form a framework that depicts several program, organizational and contextual factors which are crucial for SBE and CE; a priority pillar of the WHO strategy for SBE prevention and control. Important enablers included providing innovative, inclusive and continuous methods and materials, carefully planning of programs, performing monitoring and evaluation, SBE data availability, motivated and trained staff members, strong organizational reputations, communication with other SBE-actors, collaborations, and the involvement of the government. Substantial barriers entailed a lack of SBE data, lack of facilitating innovative methods and materials, human and physical resources shortages, community resistance, untrained HCWs, and traditional healing practices. This overview will serve as a practical tool to inform policy makers, SBE-CE actors and other stakeholders on the underlying barriers and enablers of SBE-CE practices in diverging contexts. As optimizing and sustaining SBE-CE practices is of paramount importance, context-sensitive, multi-faceted approaches are needed that incorporate all factors that influence SBE community work.

Credit author Statement

N.J. Ten Have: Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing – original draft: Gaby I. Ooms: Conceptualization, Methodology, Supervision, Writing – review & editing: Benjamin Waldmann: Conceptualization, Methodology, Supervision, Writing – review & editing: Tim Reed: Writing – review & editing

Ethical statement

This research has been carried out in accordance with the Code of Ethics for Research in the Social and Behavioral Sciences Involving Human subjects.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

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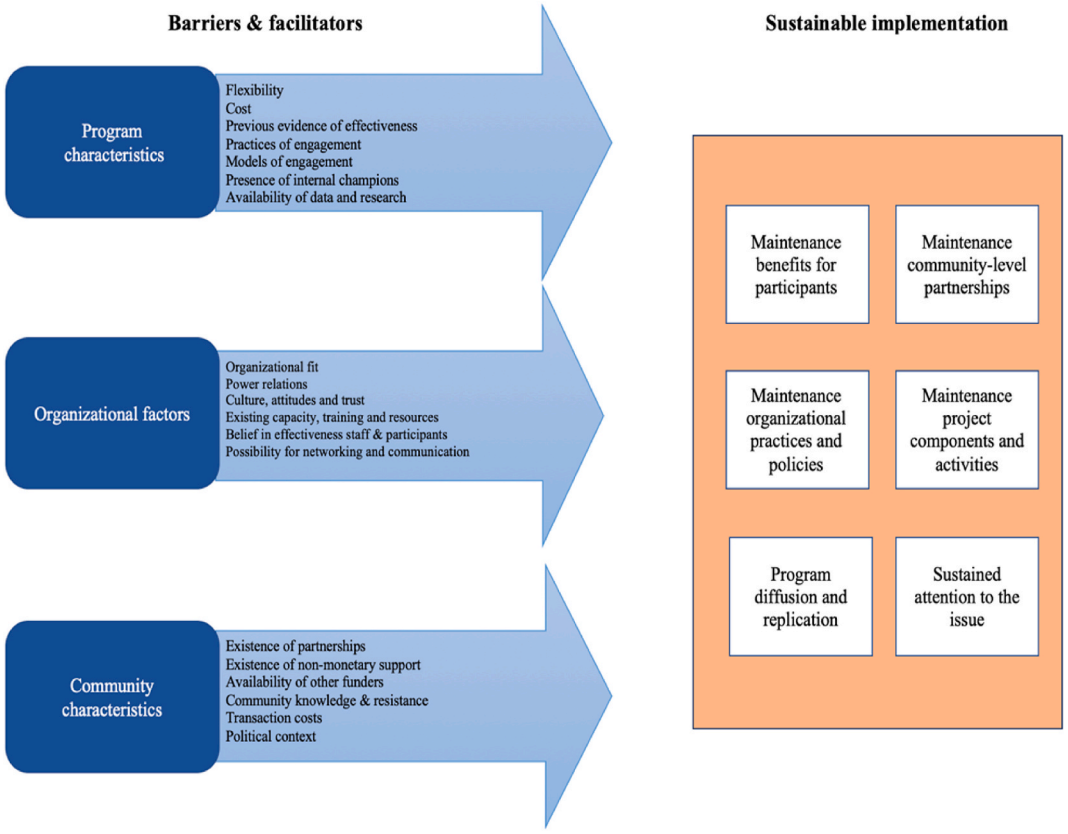
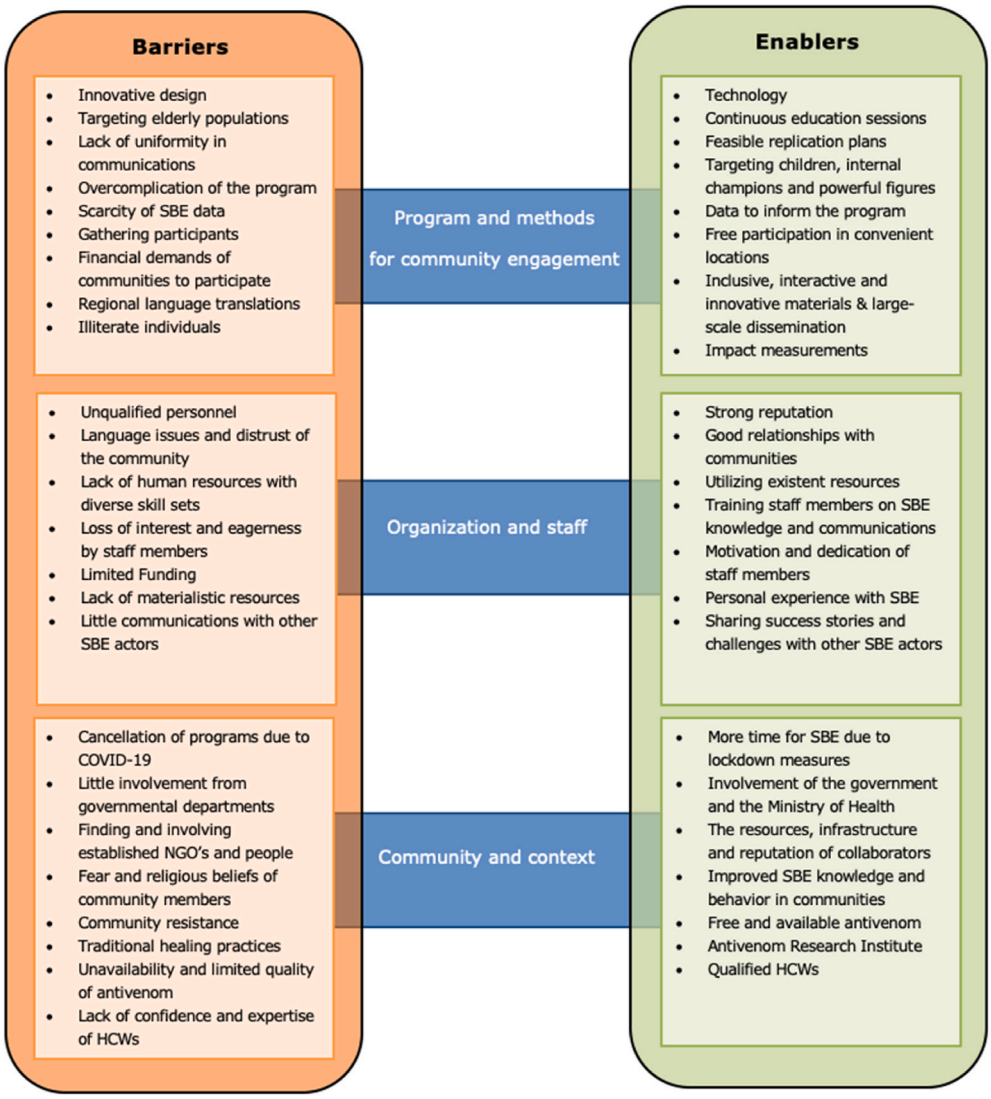
APPENDIX 1. CONCEPTUAL FRAMEWORK



APPENDIX II. OVERVIEW OF THE BARRIERS AND ENABLERS



References

Alirol, E., Sharma, S.K., Bawaskar, H.S., Kuch, U., Chappuis, F., 2010. Snake bite in South Asia: a review. PLoS Neglected Trop. Dis. 4 (1), e603. https://doi.org/10.1371/journal.pntd.0000603xz.

CODE OF ETHICS FOR RESEARCH IN THE SOCIAL AND BEHAVIOURAL SCIENCES INVOLVING HUMAN PARTICIPANTS, 2016. https://www.eur.nl/eshcc/media/67289.

De Weger, E., Van Vooren, N., Luijkx, K.G., Baan, C.A., Drewes, H.W., 2018. Achieving successful community engagement: a rapid realist review. BMC Health Serv. Res. 18 (1) https://doi.org/10.1186/s12913-018-3090-1.

Ediriweera, D.S., Kasturiratne, A., Pathmeswaran, A., Gunawardena, N.K., Jayamanne, S. F., Lalloo, D.G., De Silva, H.J., 2017. Health seeking behavior following snakebites in Sri Lanka: results of an island wide community based survey. PLoS Neglected Trop. Dis. 11 (11), e0006073 https://doi.org/10.1371/journal.pntd.0006073.

Garst, J., L'Heveder, R., Siminerio, L., Motala, A., Gabbay, R., Chaney, D., Cavan, D., 2017. Sustaining diabetes prevention and care interventions: a multiple case study of translational research projects. Diabetes Res. Clin. Pract. 130, 67–76. https://doi.org/10.1016/j.diabres.2017.04.025.

Gutiérrez, J.M., Calvete, J.J., Habib, A.G., Harrison, R.A., Williams, D.J., Warrell, D.A., 2017. Snakebite envenoming. Nat. Rev. Dis. Prim. 3 (1) https://doi.org/10.1038/nrdp.2017.63.

Gutiérrez, J.M., Warrell, D.A., Williams, D.J., Jensen, S., Brown, N., Calvete, J.J., Harrison, R.A., 2013. The need for full integration of snakebite envenoming within a global strategy to combat the neglected tropical diseases: the way forward. PLoS Neglected Trop. Dis. 7 (6), e2162 https://doi.org/10.1371/journal.pntd.0002162.

Hossain, J., Biswas, A., Rahman, F., Mashreky, S.R., Dalal, K., Rahman, A., 2016. Snakebite epidemiology in Bangladesh—a national community based health and injury survey. Health 8 (5), 479–486. https://doi.org/10.4236/health.2016.85051.

Kadam, P., Ainsworth, S., Sirur, F.M., Patel, D.C., Kuruvilla, J.J., Majumdar, D.B., 2021. Approaches for implementing society-led community interventions to mitigate snakebite envenoming burden: the SHE-India experience. PLoS Neglected Trop. Dis. 15 (2), e0009078 https://doi.org/10.1371/journal.pntd.0009078.

Minghui, R., Malecela, M.N., Cooke, E., Abela-Ridder, B., 2019. WHO's Snakebite Envenoming Strategy for prevention and control. Lancet Global Health 7 (7), e837–e838. https://doi.org/10.1016/s2214-109x(19)30225-6.

Mohapatra, B., Warrell, D.A., Suraweera, W., Bhatia, P., Dhingra, N., Jotkar, R.M., Rodriguez, P.S., Mishra, K., Whitaker, R., Jha, P., 2011. Snakebite mortality in India: a nationally representative mortality survey. PLoS Neglected Trop. Dis. 5 (4), e1018. https://doi.org/10.1371/journal.pntd.0001018.

Moos, B., Williams, D., Bolon, I., Mupfasoni, D., Abela-Ridder, B., Ruiz De Castaneda, R., 2021. A scoping review of current practices on community engagement in rural East Africa: recommendations for snakebite envenoming. Toxicon X 11, 100073. https://doi.org/10.1016/j.toxcx.2021.100073.

Oluwole, A., Dean, L., Lar, L., Salami, K., Okoko, O., Isiyaku, S., Dixon, R., Elhassan, E., Schmidt, E., Thomson, R., Theobald, S., Ozano, K., 2019. Optimising the performance of frontline implementers engaged in the NTD programme in Nigeria: lessons for strengthening community health systems for universal health coverage. Hum. Resour. Health 17 (1). https://doi.org/10.1186/s12960-019-0419-8.

Ooms, G.I., Van Oirschot, J., Waldmann, B., Okemo, D., Mantel-Teeuwisse, A.K., Van den Ham, H.A., Reed, T., 2021. The burden of snakebite in rural communities in Kenya: a household survey. Am. J. Trop. Med. Hyg. 105 (3), 828–836. https://doi.org/10.4269/ajtmh.21-0266.

Pandey, D.P., Subedi Pandey, G., Devkota, K., Goode, M., 2016. Public perceptions of snakes and snakebite management: implications for conservation and human health in southern Nepal. J. Ethnobiol. Ethnomed. 12 (1) https://doi.org/10.1186/s13002-016-0092-0.

Popay, J., Hornby, D., Milton, B., Whitehead, M., French, B., Kowarzik, U., Simpson, N., Povall, S., Lancashire, C., 2007. Community engagement in initiatives addressing the wider social determinants of health A rapid review of evidence on impact, experience and process. Semantic Scholar. https://www.semanticscholar.org/paper/Community-engagement-in-initiatives-addressing-the-Popay-Attree/5d0bec4af67616853d86bdc9d02f70d17852e06f.

Potet, J., Beran, D., Ray, N., Alcoba, G., Habib, A.G., Iliyasu, G., Waldmann, B., Ralph, R., Faiz, M.A., Monteiro, W.M., De Almeida Gonçalves Sachett, J., Di Fabio, J.L., Cortés, M.D.L.N., Brown, N.I., Williams, D.J., 2021. Access to antivenoms in the developing world: a multidisciplinary analysis. Toxicon X 12, 100086. https://doi.org/10.1016/j.toxcx.2021.100086.

Rahman, R., Faiz, M.A., Selim, S., Rahman, B., Basher, A., Jones, A., D'Este, C., Hossain, M., Islam, Z., Ahmed, H., Milton, A.H., 2010. Annual incidence of snake bite in rural Bangladesh. PLoS Neglected Trop. Dis. 4 (10), e860 https://doi.org/10.1371/journal.pntd.0000860.

Ralph, R., Sharma, S.K., Faiz, M.A., Ribeiro, I., Rijal, S., Chappuis, F., Kuch, U., 2019. The timing is right to end snakebite deaths in South Asia. BMJ. https://doi.org/10.1136/bmj.k5317 k5317.

Sharma, S.K., Alirol, E., Jha, N., Chappuis, F., Loutan, L., Bovier, P., 2013. Effectiveness of rapid transport of victims and community health education on snake bite fatalities in rural Nepal. Am. J. Trop. Med. Hyg. 89 (1), 145–150. https://doi.org/10.4269/ajtmh.12-0750.

Samuel, S.P., Chinnaraju, S., Williams, H.F., Pichamuthu, E., Subharao, M., Vaiyapuri, M., Arumugam, S., Vaiyapuri, R., Baksh, M.F., Patel, K., Trim, S.A., Duncombe, T.E., Vaiyapuri, S., 2020. Venomous snakebites: rapid action saves lives—a multifaceted community education programme increases awareness about snakes and snakebites among the rural population of Tamil Nadu, India. PLoS Neglected Trop. Dis. 14 (12), e0008911 https://doi.org/10.1371/journal.pntd.0008911.

UNESCO, 2009. On Target: a Guide for Monitoring and Evaluating Community-Based Projects. https://unesdoc.unesco.org/ark:/48223/pf0000186231.

Van Oirschot, J., Ooms, G.I., Okemo, D.J., Waldmann, B., Reed, T., 2021. An exploratory focus group study on experiences with snakebites: health-seeking behaviour and challenges in rural communities of Kenya. Trans. R. Soc. Trop. Med. Hyg. 115 (6), 613–618. https://doi.org/10.1093/trstmh/trab059.

Vermeir, P., Vandijck, D., Degroote, S., Peleman, R., Verhaeghe, R., Mortier, E., Hallaert, G., Van Daele, S., Buylaert, W., Vogelaers, D., 2015. Communication in healthcare: a narrative review of the literature and practical recommendations. Int. J. Clin. Pract. 69 (11), 1257–1267. https://doi.org/10.1111/ijcp.12686.

Williams, D.J., Faiz, M.A., Abela-Ridder, B., Ainsworth, S., Bulfone, T.C., Nickerson, A. D., Habib, A.G., Junghanss, T., Fan, H.W., Turner, M., Harrison, R.A., Warrell, D.A., 2019. Strategy for a globally coordinated response to a priority neglected tropical disease: snakebite envenoming. PLoS Neglected Trop. Dis. 13 (2), e0007059 https://doi.org/10.1371/journal.pntd.0007059.

World Health Organization, 2016. Guidelines for the Management of Snakebites. https://apps.who.int/iris/handle/10665/249547.

World Health Organization, 2019. Snakebite Envenoming: A Strategy for Prevention and Control. https://www.who.int/publications/i/item/9789241515641.