

Institution: University of Reading		
Unit of Assessment: 3 (Allied Health Professions, Dentistry, Nursing and Pharmacy)		
Title of case study: Evidence and action to address the burden of snakebite envenoming influences international policy and saves lives in Tamil Nadu.		
Period when the underpinning research was undertaken: Between November 2010 and April 2011		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Sakthivel Vaiyapuri	Associate Professor in Cardiovascular & Venom Pharmacology, Lecturer, Postdoctoral Research Assistant	Between March 2009 and present
Period when the claimed impact occurred: Between August 2016 and December 2020		
Is this case study continued from a case study submitted in 2014? No		
1. Summary of the impact		
<p>A University of Reading study has provided a rare account of the human costs of snakebite envenoming (SBE) in India, where approximately half of global SBE deaths occur. Dr Sakthi Vaiyapuri's 2013 paper has been cited by the World Health Organisation (WHO) as the only evidence on the socio-economic burden of SBE in India. This has supported policy development for global action to tackle SBE, including the 2019 publication of the WHO's SBE strategy for prevention and control. Vaiyapuri's finding that snakebite victims delay seeking treatment owing to lack of public awareness led him to develop and lead a public education campaign, which in 2019 reached an estimated 73,000,000 people via assemblies, leafleting, social media, television and newspaper articles. Consequently, two-thirds of SBE patients admitted to a major referral hospital in 2019 said that they were aware of the campaign, 95% arrived for treatment in under four hours in 2019 (compared with 60.5% in 2018) and SBE patient outcomes were improved.</p>		
2. Underpinning research		
<p>Estimating the global figures for disease, disability and deaths caused by SBE is problematic, primarily because SBE affects people living in poor, rural communities in which many do not have access to, or do not seek, appropriate healthcare. There is also a lack of systematic data collection. However, a 2017 study (Gutiérrez <i>et al.</i>) estimated that there are up to 138,000 deaths and 400,000 disabilities from SBE around the world each year. According to the World Health Organisation (WHO), this equates to a loss of 6- to 8,000,000 Disability Adjusted Life Years (DALYs) – a toll comparable to prostate cancer, cervical cancer, rheumatoid arthritis, and viral hepatitis. The Global Centre for Health Research Million Death Study estimated that approximately 58,000 deaths due to SBE occur annually in India, with states dominated by agricultural production, such as Tamil Nadu, the most heavily affected (Suraweera <i>et al.</i> 2020). The authors of the study concluded that global cases of SBE, including in India, are significantly underreported.</p>		
<p>Better estimates of SBE incidence and impacts on rural populations: In 2010, Vaiyapuri and colleagues performed a household survey (28,494 people) within 30 geographically representative rural villages in Tamil Nadu. This study indicated that the average annual incidence of SBE in Tamil Nadu was 2.4 times higher than previously estimated and demonstrated that the incidence of SBE was greater in small villages (with <100 houses) compared to medium (with 100 to 250 houses) and large villages (with >250 houses) [1]. The finding suggests that official statistics have previously underestimated the true scale of the problem: up to 50% of cases go unreported in remote rural areas where access to medical facilities and transport is highly limited. Victims either seek alternative treatments from local healers or die on the way to hospital [1]. As part of the same study, the team performed detailed interviews with 105 snakebite victims (or a family member) to identify the immediate and long-</p>		

term socio-economic ramifications of SBE on the rural population, based on SBE events between 2001 and 2010, as reported by study participants. Vaiyapuri and colleagues found evidence that **SBE has a multitude of consequences for the individuals affected and their families:**

- a) In terms of financial consequences, **none of the 105 victims who paid for their treatment were covered by medical insurance.** The one-off direct costs disclosed by participants in the 2010 study ranged between INR 1,000–INR 350,000, and long-term costs were up to INR 400,000 [1]. According to the Indian labour bureau, the average daily wage in India for agricultural occupations in 2007 to 2008 was INR 76 for a man and INR 54 for a woman, thus even INR 1,000 (approximately GBP 10) represented around half a month's salary and INR 350,000 represents over 12 years' salary for a typical agricultural worker.
- b) Impacts on the livelihoods of victims and their families were exacerbated by the **lack of loan availability from national banks to cover medical expenses.** Indeed, 17.8% of victims who paid for their treatment found it necessary to sell stored crops, 14% sold valuable items such as jewellery, 9.3% sold cattle, and 5.4% sold vehicles such as bicycles and motorcycles. Sadly, 3.1% found it necessary to remove their children from education and send them to work, and 3.9% had to sell land or property. **The significant threat to financial stability is likely to be the primary factor, in most cases, in whether individuals seek IMMEDIATE medical attention following a snakebite** [1].
- c) The study also identified a **high rate of long-term health conditions induced by SBE** among the rural population of Tamil Nadu. Notably, current snake antivenoms are not effective when administered to patients who are already exhibiting extensive muscle damage or other advanced clinical signs of SBE around the bite site. The implication is, therefore, that **DELAYED hospital attendance is associated with increased morbidity, permanent disability and mortality** [1].
- d) The research also identified that **64% of victims received no first aid.** Of the remaining 36%, almost all first aid was provided by untrained individuals, often taking the form of dangerous measures such as cutting the bite site with non-sterile sharp items and sucking blood, and practising ineffective, plant-based traditional treatments. In addition to financial cost, the study has established that the **lack of public awareness is another important factor that influences treatment-seeking behaviour** and thereby contributes to SBE-induced deaths, disabilities and the long-term socio-economic impacts [1].

Addressing the clinical challenges to the diagnosis and treatment of SBE in rural populations: In 2010, Vaiyapuri interviewed 25 clinicians working in rural clinics across Tamil Nadu to gauge their views on the challenges in treating and diagnosing snakebites. This study identified significant knowledge gaps and lack of training in standard protocols which presented challenges to the provision of appropriate primary treatment for SBE by healthcare professionals working in rural areas [2]. It is vital to address these gaps to enable rural healthcare workers to provide appropriate first aid and triage snakebite victims confidently, prior to sending patients to tertiary care facilities for further, more intensive treatment.

3. References to the research

The work outlined in this case study has provided important insights into a neglected tropical disease, which have been cited by the WHO as some of the only evidence on the scale of the socio-economic burden of SBE in India. Outputs from these studies have been published in international peer-reviewed journals, and the work has helped to underpin the competitive award of a Leverhulme Trust Senior Research Fellowship to Vaiyapuri, which started in October 2020.

1. **Vaiyapuri S, Vaiyapuri R, Ashokan R, Ramasamy K, Nattamaisundar K, Jeyaraj A, Chandran V, Gajjeraman P, Baksh MF, Gibbins JM, Hutchinson EG** (2013). 'Snakebite and its socio-economic impacts on the rural population of Tamil Nadu, India'. *PLoS One* 8(11): e80090. DOI: <https://doi.org/10.1371/journal.pone.0080090>
2. **Williams, H. F., Vaiyapuri, R., Gajjeraman, P., Hutchinson, G., Gibbins, J. M., Bicknell, A. B. and Vaiyapuri, S.** (2017). 'Challenges in diagnosing and treating snakebites in a rural population of Tamil Nadu, India: the views of clinicians'. *Toxicon*, 130: 44-46. DOI: <https://doi.org/10.1016/j.toxicon.2017.02.025>

4. Details of the impact

Vaiyapuri's two-pronged approach to preventing death and debilitation from SBE has shaped global policy on how to address SBE and, by engaging with rural communities who are most at risk, has raised public awareness of how to avoid snakebite and how to respond and seek rapid treatment if bitten, saving potentially thousands of lives.

Contributing to the evidence behind global SBE policy

The World Health Organisation's 2016 publication, *Guidelines for the management of snakebites* [E1], **cited Vaiyapuri et al. (2013) to highlight the long-term health complications caused by SBE.** While acknowledging that the data on the global burden of snakebite were incomplete, the WHO formally recognised snakebite as a 'high priority' neglected tropical disease in 2017. The WHO Director General's 2018 report *Global snakebite burden* [E2] **cited Vaiyapuri et al. (2013) again to demonstrate that the high costs of SBE treatment push poor people further into poverty and debt.** On the basis of this report, WHO's Executive Board recommended that the 71st World Health Assembly (WHA) adopt resolution EB142.R4 on addressing the burden of SBE. Subsequently, with a mandate from WHA member states to direct and coordinate global action on SBE, WHO developed, and published, *Snakebite Envenoming: A strategy for prevention and control* (2019) [E3]. **Vaiyapuri et al. (2013) is the only evidence cited from India of both the significant short-term treatment costs and long-term socio-economic costs of SBE in this strategy document.** This ambitious roadmap includes a GBP 120,000,000 programme to reduce snakebite-induced deaths/disabilities by half in 2030.

'Rapid action saves lives' campaign targets rural populations in Tamil Nadu

The clear need for community education on SBE, as demonstrated by Vaiyapuri's research, motivated Vaiyapuri to develop and lead a campaign to provide public health information to at-risk communities across the state of Tamil Nadu (an area the same size as England, but where approximately half of its 77,000,000 residents live in rural areas). The primary aim of the campaign was to dispel myths around snakes and snakebites, to provide clear, simple advice on how to respond to snakebites and, ultimately, to positively influence the treatment-seeking behaviour of victims and their relatives.

The team organised awareness assemblies in over 140 schools and colleges (with between 200 to 400 attendees at each event), and in over 100 rural villages (with between 100 to 300 attendees at each event, see Figure 1). These activities were supported by resources developed at the University of Reading including a comprehensive information leaflet (in Tamil and English), posters, and videos [E4]. The team also mounted a face-to-face leafleting campaign in hospitals, clinics, pharmacies, supermarkets, and bus stations across the region. In total, these activities provided **direct engagement with approximately 200,000 people between January and December 2019.** The campaign team itself also expanded from a core of 15 to over 100 volunteer members across the state (including healthcare professionals, charity workers, and education providers) over the same period.

To supplement face-to-face activities, Vaiyapuri created a Facebook page for people to access campaign resources and to discuss the issues raised [E4]. **The Facebook page was viewed over 2,800,000 times between March and May 2019** after two adverts, containing short information videos, targeted to the rural population in Tamil Nadu were produced. Additional short information videos posted on the Facebook page received over 150,000 views between August 2019 and March 2020. In collaboration with the producer of a popular TV series *Pulan Visaranai* (meaning 'crime investigation'), Vaiyapuri and other core team members co-developed a 25-minute documentary, titled 'Deadly Snakes', containing key messages from Vaiyapuri's research and the campaign. This programme was broadcast on the *Puthiya Thalaimurai* news channel at peak viewing times and was estimated to have been **watched on television by more than 4,000,000 people over four screenings in April and May 2019** [E5], with over 219,000 additional views of the documentary via social media over the same period. Furthermore, *Update News 360*, an online news channel developed a five-minute video based on the campaign's key messages, which was viewed over 330,000 times within one week of being uploaded to the channel's Facebook page, with over 7,000 shares. In addition, more than 60 articles highlighting the campaign appeared in local, state-wide and national newspapers between December 2018 and January 2020. These included **18 articles in prominent newspapers (Times of India, The**

Hindu, Dinamalar, Dina Thanthi and Dinakaran) that reached a combined readership of 65,600,000, according to average issue readership figures from the Indian Readership Survey, Q2 2019 [E6, E7].

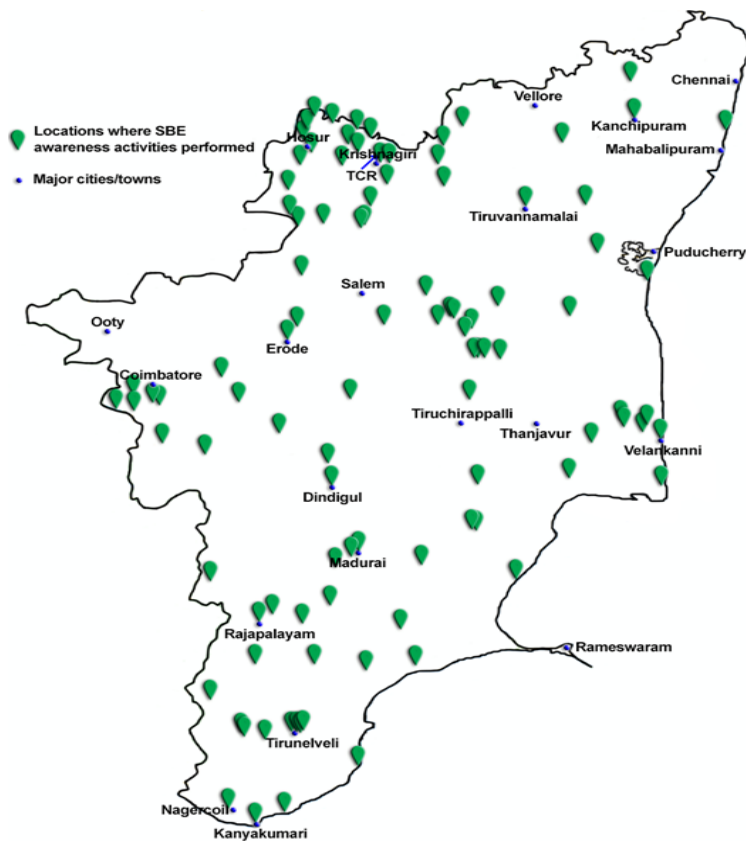


Figure 1: Map showing the distribution of campaign activities across the state of Tamil Nadu.

Evaluating the success of the campaign

i. Uptake and recall of key messages

Before their public awareness campaign, the team established that nearly 90% of students (n=2,004) believed that seeking prompt medical treatment was unnecessary, and 60% believed that traditional treatments were the best approach to treat snakebites. Similarly, only 10% of villagers surveyed prior to engagement (n=2,418) said that they would seek immediate medical attention and 95% believed that a tight tourniquet was the best approach to prevent venom from spreading following a bite. By contrast, when the survey was repeated at the end of engagement activities, **over 90% of student attendees and 95% of members of the wider community demonstrated good recall of the key messages: not to apply a tight tourniquet, not to cut and bleed or suck the bite site, not to waste time on traditional remedies, and to get to a hospital as quickly as possible.** Furthermore, the team returned to selected schools and villages after a period of 12 months to repeat the survey, which showed that over 90% of students (n=303) and 85% of villagers (n=413) remembered the information provided [E8].

Over 250 participants including general physicians, clinicians, nurses, surgeons and other healthcare professionals from Tamil Nadu attended a one-day symposium in December 2019, which was organised by the core team to address the clinical challenges in handling SBE patients (surgical procedures to treat SBE-induced muscle damage, complications associated with non-venomous snakebites, and novel strategies for the diagnosis and treatment of SBE). 95% of participants said that the knowledge that they gained would improve the ways in which they handle snakebite victims and had changed their views about SBE. Further written feedback indicated demand for hands-on training. As a result, in September 2020, Vaiyapuri and colleagues ran an online survey, which has provided clarity on the training needs of rural clinicians. They have also instigated a collaboration with Health Action International as well as a former advisor on snakebites to the Tamil Nadu government, now principal of Trichy SRM Medical College in Tamil Nadu, with the aim of developing training materials for clinicians, e.g. on appropriate first aid measures for SBE.

ii. Changes in treatment-seeking behaviour

TCR Multispeciality Hospital is a leading SBE referral centre in the north of Tamil Nadu, with patients from the surrounding six districts of Krishnagiri, Dharmapuri, Salem, Tirupathur, Thiruvannamalai and Vellore able to reach the hospital within two to three hours. Therefore, between 1 and 20 January 2019, all community education activities were focussed within these districts to enable the team to record the treatment-seeking behaviour of the hospital's SBE patients over 2019 (see Figure 1). Following informed consent, data was collected from 291 patients who were admitted to TCR with suspected snakebites between 20 January and 31 December 2019. This was compared with SBE admissions records from 2018 (n= 223). **Significant differences were observed in arrival times at the hospital between the 2018 and 2019 data** with 276 (95%) arriving in under four hours in 2019, compared to the corresponding figure of 135 (60.5%) in 2018. Remarkably, 283 (97.3%) of SBE patients arrived at TCR in 2019 without seeking traditional treatment, in contrast to 142 (63.7%) in 2018. These data are further supported by the observation that 173 **(59.5%) of SBE patients admitted to TCR in 2019 reported that they were aware of Vaiyapuri's campaign, all of whom arrived at TCR within four hours of receiving a bite** [E8]. Furthermore, all SBE patients who were admitted to TCR in 2019 within four hours of being bitten were discharged within seven days (45% of these within three days). By comparison, all SBE patients who arrived at TCR in 2019 more than four hours after being bitten had hospital stays of over one week, and 47% stayed over one month due to the severity of their injuries.

Summary: Vaiyapuri's studies have addressed a significant knowledge gap on the socio-economic burden of SBE in India. This evidence was cited by the WHO as they developed a mandate for global action to tackle SBE. The multi-faceted community education programme developed by Vaiyapuri and his team tackled some of the barriers to treatment seeking behaviour identified by his research. Through direct engagement and social media, the team reached approximately 8% of the total rural population of the state of Tamil Nadu in 2019 and, over the same time period, this reach was extended significantly through broadcast and newspaper coverage (approximately 70m total views). As a result, a greater proportion of people who had been bitten by snakes arrived at hospital faster compared to the previous year. This was endorsed by Health Action International, whose project manager for snakebites said: "Dr Vaiyapuri's public education campaign has demonstrated the effectiveness of using targeted education tools to engage target communities resulting in a positive change in behaviours for snakebite treatment and care," [E9]. Consequently, a greater number of patients were discharged sooner, with fewer complications and lower treatment costs, leading to better long-term outcomes for families living in poverty.

5. Sources to corroborate the impact

- [E1] [Guidelines for the management of snakebites, 2nd edition](#) WHO 2016
- [E2] World Health Assembly, 71. (2018). [Global snakebite burden: report by the Director-General](#). World Health Organization.
- [E3] [Snakebite Envenoming – A strategy for prevention and control](#), WHO 2019 (see pages 5 and 27)
- [E4] Campaign information leaflet, available via the [Venomous snakebites: rapid action saves lives Facebook page](#)
- [E5] Email from the producer of *Pulan Visaranai* TV series confirming viewing figures for the [Deadly Snakes documentary](#), which is available to watch via YouTube
- [E6] [Indian Readership Survey Q2 2019](#), Media Research Users Council.
- [E7] List of 18 newspaper articles published between December 2018 and January 2020 whose readership is monitored by the IRS.
- [E8] Samuel S. P., Chinnaraju S., Williams H. F., Pichamuthu E., Subharao M., Vaiyapuri M., et al. (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 Tropical Diseases* **14** (12): e0008911. <https://doi.org/10.1371/journal.pntd.0008911>
- [E9] Testimonial from project manager at Health Action International