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Snakebite envenomation and predation of domestic animals in Goa, India

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Introduction: Snakebite envenomation of domestic animals remains globally underreported and poorly addressed within policy frameworks. In India, the absence of a centralised database limits understanding of its veterinary and socioeconomic impacts.

Methods: This study used qualitative analysis of 56 in-depth interviews with veterinarians, pet owners, livestock keepers, forest officials, herpetologists, snake rescuers, and community members across Goa to examine treatment gaps, policy deficiencies, and human responses to animal snakebite mortality.

Results: Findings revealed systemic weaknesses in veterinary infrastructure, inconsistent anti-snake venom (ASV) availability, and the absence of standardised treatment protocols, leading to preventable deaths and financial strain on owners. Dogs were most frequently treated for envenomation (primarily from Russell's vipers and spectacled cobras), resulting from guarding behaviour, while python predation disproportionately affected cats, poultry, and small pets, often provoking retaliatory killings and emotional distress. Livestock deaths attributed to snakebite were frequently recorded without verification, either to facilitate compensation claims or due to diagnostic limitations. Compensation was restricted to livestock purchased under the government's Kamdhenu scheme, a programme supporting the purchase of cows and buffaloes for dairy production, with no provisions for privately owned animals.

Discussion: Key recommendations that emerge comprise documentation of cases; mandatory ASV stocking in veterinary hospitals; expansion of emergency veterinary care services; structured compensation schemes for privately owned livestock and pets; and greater integration of veterinarians into wildlife conflict mitigation strategies, along with awareness of responsible pet ownership. Without these interventions, snakebite mortality in domestic animals will remain poorly documented, poorly managed, and largely ignored within India's broader wildlife policy landscape.

KEYWORDS

cats, cows, dogs, livestock, pets, poultry, snakes, venom

1 Introduction

Snakebite envenomation is a significant yet overlooked aspect of human-wildlife conflict, with major implications for public health, rural livelihoods, and veterinary care (Babo Martins et al., 2019). While human snakebite mortality has been increasingly studied and integrated into national health policies, envenomation in livestock and domestic animals remains poorly documented (Bolon et al., 2019). Despite being a common issue in many rural and agrarian economies, systematic epidemiological data on snakebite-related animal deaths are largely absent, leading to an underestimation of its economic and social impact (Bolon et al., 2019).

Global assessments indicate that snakebites frequently affect domestic animals, particularly in regions where venomous snake distributions overlap with agricultural and pastoral landscapes. The first global scoping review of snakebites in domestic animals found that cattle, sheep, goats, pigs, horses, and dogs are among the most frequently affected species, with envenomation and predation leading to possibly high economic losses (Bolon et al., 2019). In the Central Pacific region of Costa Rica, an estimated 10,000 cattle deaths per year are attributed to snakebites, though this figure was merely an observation by the authors (Herrera et al., 2017). Similarly, community-reported data from Nepal and Cameroon suggests that snakebite-related livestock losses may be widespread yet remain unrecognised in national compensation schemes (Bolon et al., 2021). Most studies on snakebite in domestic animals remain limited to small-scale clinical reports or locally limited rather than large-scale epidemiological assessments (Dykgraaf et al., 2006; Bolon et al., 2019; Serruya et al., 2024).

Veterinary research on envenomation in companion and leisure animals, primarily dogs and cats, has been disproportionately concentrated in high-income countries, particularly in the United States and Australia (Hill, 1979; Peterson, 2006; Cullimore et al., 2013). Many such studies focus on clinical management (Holloway and Parry, 1989; Leisewitz et al., 2004; Ananda et al., 2009; Rodríguez et al., 2016) rather than economic impact, leaving major gaps in understanding the broader consequences of snakebite-related pet mortality in low- and middle-income countries (Bolon et al., 2019). No studies to date have systematically assessed the financial or emotional burden of pet envenomation in snakebite-endemic regions.

Despite India being one of the most severely affected countries in terms of human snakebite deaths (Mohapatra et al., 2011; Suraweera et al., 2020), there is no comparable dataset on snakebite mortality in livestock or companion animals. Veterinary research in India has largely focused on clinical case reports of cattle and small ruminants (Bhikane et al., 2020), with no systematic epidemiological assessments to quantify envenomation rates, mortality patterns, or economic consequences. This lack of data parallels a broader global trend, where snakebite in domestic animals remains largely unrecorded and underreported, contributing to a critical gap in human-wildlife conflict research.

Veterinary treatment infrastructure for snakebite cases remains inconsistent worldwide, with significant gaps in anti-snake venom (ASV) access and standardised treatment. Unlike human hospitals, which in many countries maintain ASV under national health policies (Bolon et al., 2019), veterinary clinics lack similar regulatory frameworks, leading to variable ASV availability across regions (Bolon et al., 2021). Studies suggest that veterinary ASV access is often dependent on private supply chains rather than government mandates, making treatment delays more likely (Bolon et al., 2019). Additionally, standardised protocols for veterinary envenomation cases remain poorly established, with treatment approaches varying significantly across regions and practitioners (Bolon et al., 2019).

The economic burden of snakebite-related mortality in animals remains poorly quantified, as existing literature primarily focuses on human healthcare costs rather than financial losses incurred by livestock farmers or pet owners (Bolon et al., 2019; 2021). While government-backed livestock insurance schemes exist in some regions, there is no clear indication that snakebite-related deaths are systematically covered anywhere (Bolon et al., 2021). In contrast, structured compensation programs exist for large carnivore predation (Karanth et al., 2018), raising questions about why snakebite-related losses remain unaddressed.

This study addresses these critical gaps by examining snakebite-related mortality in domestic animals and livestock in Goa, India, which is home to the Big Four – Russell's viper (*Daboia russelii*), saw-scaled viper (*Echis carinatus)*, spectacled cobra (*Naja naja*), and common krait (*Bungarus caeruleus*) – as well as several other non-venomous, venomous and medically important species, like the Indian rock python (*Python molurus*), rat snake (*Ptyas mucosa*), and hump-nosed pit viper (*Hypnale hypnale*) (ZSI, 2008). Specifically, it examines the prevalence and veterinary response to snakebite envenomation in domestic animals and livestock; challenges in treatment availability, including ASV access and emergency veterinary care; the economic implications of snakebite-related livestock and pet mortality, including gaps in compensation mechanisms; and public attitudes toward snakebite-related animal deaths, retaliatory killings, and broader human–snake conflict, particularly in contrast to large carnivore-related conflicts. By providing empirical data on snakebite incidents in animals, this research contributes to a broader understanding of snakebite as a neglected component of human-wildlife conflict, highlighting the need for improved veterinary policies and mitigation strategies.

2 Methods

This study employed a qualitative approach to examine the impact of snakebite on domestic animals in Goa. Given the absence of structured epidemiological data on snakebite in livestock and companion animals in India, qualitative data collection was prioritised to capture veterinary insights, pet and livestock owner experiences, and systemic policy gaps (Bolon et al., 2019).

2.1 Data collection

A preliminary study was conducted between September and October 2021 to establish a baseline understanding of veterinary treatment for snakebite cases and the broader challenges in domestic animal management, as part of a larger doctoral study on human–snake conflict and coexistence in Goa, India (Attre, 2025). The main phase of fieldwork occurred from March 2022 to February 2024, covering both North and South Goa, and incorporating urban, semi-urban, and rural areas to reflect the diversity of human-animal interactions and veterinary accessibility.

Semi-structured, open-ended interviews were the primary data collection method, allowing participants to share their experiences without restriction, thereby reducing interviewer bias (Campbell et al., 2013; Bryman, 2016). Data were extracted from 56 semi-structured interviews, with interviewees identified through snowball and convenience sampling to include relevant stakeholders (Ibbett et al., 2023). Each stakeholder group was asked questions related to their expertise and/or experiences of snake encounters and snakebite in domestic animals (Table 1, Supplementary Material).

All interviews were recorded with prior informed consent, ensuring anonymity unless explicit permission was given for attribution (Bryman, 2016). The primary mode of data collection was audio recordings, with consent obtained on record. In cases where interviewees were uncomfortable with audio recording, written notes were taken instead. Interviews were conducted in English, Konkani, and Hindi, depending on participant preference.

2.2 Data processing and thematic analysis

The recorded interviews were translated and transcribed into English using TurboScribe, an AI-powered transcription tool based on Whisper (Python-based voice recognition and translation) (TurboScribe, 2025). All transcripts were manually edited and verified for accuracy before thematic analysis (Belotto, 2018).

Interview data were categorised based on stakeholder roles and manually coded to identify recurring themes, following structured categorisation principles (Kiger and Varpio, 2020). All data were systematically entered into Microsoft Excel, recording each interview's identification tag, stakeholder category (e.g., veterinarian, rescuer, livestock owner), theme, relevant research question, exact quote, and contextual summary. This manual system enabled a more fluid, intuitive mapping of connections between responses, aligning qualitative insights with the study's core research objectives while allowing flexibility to incorporate emerging themes not initially anticipated. Using a structured thematic analysis approach (Clarke and Braun, 2017), these themes were then mapped onto the study's research objectives to guide interpretation (Table 2).

By structuring the thematic analysis within the broader context of human-wildlife conflict research, this study provides empirical insights into veterinary snakebite management, economic and emotional burdens on animal owners, and policy gaps in Goa's current mitigation strategies. This structured approach ensures that stakeholder perspectives are systematically mapped onto the study's objectives while also allowing for comparisons with existing conservation policies, veterinary frameworks, and human-wildlife conflict literature.

In addition to qualitative interviews, compensation records from the Goa Forest Department (2020–2023) were reviewed to assess whether livestock or pet owners had received financial redress for snakebite-related animal losses. These records were obtained through direct engagement with Forest Department officials during the data collection process.

The review of compensation records was not intended for statistical analysis but served as documentary verification to cross-check interviewee claims regarding the absence of structured compensation.

TABLE 1 Stakeholder groups interviewed and key topics covered.

Stakeholder group	No. interviewed (n)	Topics covered
Veterinarians	10	Snakebite treatment protocols, ASV availability, emergency care limitations, and economic barriers to treatment.
Pet owners	7	Emotional and financial burden of treating snakebite in companion animals, responses to snake encounters, and retaliatory actions.
Forest Department officials (current and former)	5	Livestock compensation frameworks, policy gaps, and enforcement challenges.
Animal Husbandry Department officials (current and former)	2	Governance issues, legal frameworks, and the role of veterinary care in human-wildlife conflict policies.
Snake rescuers	16	Observations on snakebite trends, veterinary referral patterns, and human-wildlife conflict mitigation.
Herpetologists	5	Insights into snake ecology, behaviour, and patterns of human–animal interactions.
Domestic animal rescuers	3	Cases of snakebites in community and shelter animals, rehabilitation efforts, and public awareness.
Community members (including poultry owners)	8	Perceptions of snakebite, attitudes toward snake presence, coexistence challenges, economic impacts of snake predation, mitigation efforts, and interactions with rescue networks.

TABLE 2 Thematic categories emerging from stakeholder interviews.

Thematic category	Description of focus
Species-specific snakebite trends	Domestic species most affected, species-specific vulnerabilities, and seasonal or behavioural patterns.
Medical and logistical challenges in veterinary treatment	ASV availability, emergency care limitations, and diagnostic constraints.
Economic burden of snakebite on domestic animals	Treatment costs, financial strain on owners, and compensation gaps.
Emotional and behavioural responses to snakebite mortality	Grief, frustration, retaliatory killings, and emotional impacts on owners and communities.
Veterinary perspectives on policy gaps	Disconnect between veterinary field realities/challenges and existing animal welfare or wildlife conflict mitigation frameworks.
Impact of public awareness and changing attitudes	Influence of awareness efforts and rescuer interventions on public perception and coexistence.
Pet responsibility and mitigation strategies	Responsible pet ownership, preventive measures, and recommendations for snake-proof yet snake-friendly enclosures.

2.3 Ethics

Ethics clearance for this research, conducted as part of a doctoral study on human–snake conflict and coexistence in Goa, India (Attre, 2025), was obtained in September 2021 from Ethics Committee of the School of Anthropology and Conservation, University of Kent (approval number: 16-PGR-20/21). The approval covered multiple components including interviews with human participants, addressing participant recruitment, informed consent, voluntary participation, data confidentiality, secure storage, and the ethical dissemination of findings. TurboScribe was chosen for translation and transcription; all files were encrypted at rest and contained no personally identifiable information unless participants explicitly granted permission for attribution. File access was restricted to the account holder, and all data were deleted upon completion of transcription. No third party retained or accessed any files. Final transcripts and qualitative data were securely stored on university servers and encrypted personal hard drives, with no identifiable information retained unless explicit permission was provided.

3 Results and discussion

3.1 Species-specific trends in snakebite mortality

The interviews revealed that unlike human cases, where at least some records are maintained, veterinary snakebite incidents are not systematically documented and are likely underreported, creating uncertainty about the true scale of snakebite impacts on domestic animals in Goa. None of the clinics maintained robust records but could recall approximate number of cases that were treated. Nevertheless, thematic analysis of veterinarian, rescuer, and pet owner interviews provides insight into species-specific trends, behavioural risk factors, and seasonal variations. Analysis of interview data indicated dogs, cats, poultry and livestock (cattle, pigs, goats) as the primary animal groups affected by snakes, either through envenomation or predation, or occasionally both. Geographically, veterinarians from more urban areas like Panjim appeared to report slightly higher case numbers, though this likely reflects improved veterinary access rather than higher snakebite frequency. A veterinarian noted,

> "We get lots of snakebites even though the areas are now getting urbanised. Before, we got them from villages - now the same places have buildings, but the snakebites haven't decreased."

This ties in with broader challenges noted about snakebite-related mortality among domestic animals, where they remain difficult to quantify accurately due to fragmented and inconsistent veterinary reporting (Bolon et al., 2019).

Interviews with veterinarians indicated that an average of 5–15 cases were reported annually per clinic. In Panjim alone, four veterinarians in a 5-km radius confirmed similar figures, suggesting at least 30–40 cases being treated annually in the capital. However, veterinarians confirmed that most of those cases were coming from suburban hilly or forested areas outside the city or from other towns and not necessarily within the more built-up or densely urbanised parts of the city. Analysis also indicated that veterinary access drove reporting patterns, as peri-urban areas had limited veterinary facilities stocking anti-snake venom. This trend was further emphasised by veterinarians in South Goa, who noted similar patterns of case clustering in Margao. One Margao-based veterinarian explained,

> "Till today, I am one of the only vets in South Goa who started carrying anti-venom. People travel from far just to get ASV because many places don't stock it."

Another veterinarian added,

> "Most people don't know where to take their animals if there's a snakebite. If you are in Panjim, you have choices. In other places, people don't always have that option."

Interview data also showed that the veterinarians noted cases primarily coming in from urban areas than rural ones.

Pet dogs were the most frequently reported domestic animal victims of snakebites in Goa, primarily involving Russell's vipers and

cobras. In many cases, snakes were also often found to be a casualty of the encounters. One vet explained the lack of confirmed krait bites by saying that these are harder to diagnose as kraits are nocturnal in nature and often escape before the owners can confirm the species. Most bite incidents involved dogs kept outdoors in spaces such as farms, bungalows or houses with compounds and/or those performing guard duties, rather than pets confined to apartments, resulting in increased exposure to snakes. Although pedigree breeds, such as German Shepherds and Dobermans, were frequently reported, veterinarians clarified that this representation was driven by their role as being popular breeds for guard dogs rather than breed-specific vulnerability.

Findings from interview data indicated a recurring pattern across multiple veterinarians, suggesting that dogs exhibited varied behavioural responses to snake encounters (see Figure 1). While some dogs exhibited learned avoidance behaviours after an initial bite, others repeatedly encountered snakes without any noticeable avoidance learning. A veterinarian noted,

> "I've personally noticed similar dogs or almost the same dogs coming in every year."

Another senior veterinarian explained this further saying,

> "Most dogs that get bitten once become cautious. But we've had one Doberman that was bitten three times. It kept going after snakes because of its drive to protect its owner."

Another veterinarian also noted that when those dogs tended to survive, some owners got complacent about subsequent bites compounding difficulties in survival. Puppies were particularly vulnerable due to their curiosity and smaller body size, resulting in rapid fatal outcomes post-bite. One veterinarian remarked,

> "Puppies usually don't survive because they wander off, get bitten, and die before they reach us."

Community dogs - free-roaming animals without specific ownership, commonly referred to as "street" or "stray" dogs, but generally cared for by residents (Srinivasan, 2013), with the mixed-breeds also called "Indie" or "Indian" dogs, - were rarely reported in veterinary records. One veterinarian explained,

> "I don't get community dogs with snakebites."

Another described a specific case where a community dog bitten by a snake

> "ran into the woods before help could reach."

Whether this lower reporting reflects fewer bites, lower veterinary care access, or lack of dedicated individual caretakers remains uncertain. As a rescuer stated,



FIGURE 1
Dog-snake encounters in Goa, India. Field observations and interview data revealed a common belief that community or "Indie" dogs tend to avoid snakes; however, most bite cases recorded in this study involved pet dogs, who were often bitten while defending their owners. Left to right: **(A)** A puppy maintaining distance from a coiled Indian rock python at sunrise. **(B)** A pet dog fatally injured a spectacled cobra but was bitten in the process and later died, as the owner attempted to access veterinary care with antivenom, with support from a rescuer. **(C)** A chained guard dog alerting its owner to the presence of a Russell's viper in the yard. (Photos credit: Benhail Antao).

> "Community dogs may also get bitten, but those cases probably often go unreported."

However, analysis also showed a differing viewpoint wherein some community members, rescuers and veterinarians believed that community dogs, knew when to avoid snakes as a learned survival behaviour. One veterinarian stated,

> "Most cases involve pedigree dogs because they are kept as pets and guard dogs. I've noticed a lot of Rottweilers and Dobermans coming in, but I equally see Indian dogs, who are kept as pets. The common factor isn't breed. It's that they're kept outdoors (within the house compound) as guard dogs".

Analysis of interview data showed that neurotoxic envenomation (primarily cobra bites) was noted to be rapidly fatal in most cases, with few dogs surviving to reach treatment, with most succumbing to asphyxiation and veterinarians reported the primary common symptom to be a blue tongue, especially when the animal was brought in dead. Conversely, Russell's viper envenomation allowed a wider treatment window but often led to extensive tissue necrosis, kidney damage, and prolonged recovery times. In the case of Russell's viper bites, the data indicated that envenomation showed symptoms such swelling at the bite site, which tallies with published records of hemotoxic bites in animals (Ananda et al., 2009) as well as humans (Narvencar et al., 2020). The site of the bites reported for dogs were consistently on the front with most bites reported on the face and neck. Veterinarians suggested that these bite patterns were consistent with defensive rather than aggressive strikes, particularly given the absence of bites on the back. However, they also cautioned that bite location influences treatment urgency, as bites to the head or neck allow venom to reach vital organs more quickly.

Interview data suggested cats either avoid venomous species instinctively or succumb rapidly, thus rarely being brought in for treatment. Snakebite cases in cats were rarely documented, reflecting underreporting rather than low actual incidence, with a few veterinarians speculating that cats might also have a proclivity to run away and hide when traumatised. Veterinary insights emphasised difficulty in diagnosing cat bites. Smaller feline body size and rapid venom progression contributed to high mortality, with one veterinarian commenting,

> "If any cats were brought in, they were not surviving, presumably because of smaller body mass."

One vet described a neurotoxic bite saying,

> "A colony cat died suddenly with a blue tongue, likely from a krait bite or maybe even cobra bite, but no bite marks were visible".

Results found that pet owners documented repeated feline encounters with snakes, and other wildlife, driven by curiosity and predatory instincts (see Figure 2). One respondent who runs a rescue centre highlighted the problem commenting that a few of their cats were repeat offenders in predating on snakes, sometimes bringing in the same individual snake indoors repeatedly, especially after it was dead. She further said,

> "We have rescued several snakes from our cats. They have also brought in scorpions. And they have brought in monitor lizards."



FIGURE 2
An adult cat going up to two non-venomous snakes in Goa, India. While cats are often the prey for pythons, and face risk of envenomation from venomous snakes, they are equally adept at being predators for many other species of snakes. (Photo credit: Benhail Antao).

These patterns align with wider concerns in conservation biology, where domestic cats are now recognised as both high-risk prey in conflict-prone areas and significant predators of native wildlife. In the UK, for instance, over 90 million prey animals, including millions of reptiles and amphibians, are estimated to be brought home by pet cats annually (Woods et al., 2003). In densely populated urban areas, such as parts of Goa, the dual role of cats as predator and prey highlights the complex ecological entanglements that shape urban human–wildlife interfaces.

Analysis of interview data and field observations consistently identified python predation as a notable threat to cats, with many missing cats assumed by the community as having fallen prey to pythons than to any other imminent danger such as road accidents. Cat owners acknowledged that when cats go missing, they were not sure if it was a snakebite or python predation. Findings from this study clearly indicated multiple predation events, with one community member describing,

> "We heard a lot of noise and when we ran outside, the python was trying to grab one of our cats."

Python predation represented a significant emotional stressor, driving human-snake conflict and influencing public perceptions negatively toward pythons. These interactions also reflect complex spatial and behavioural dynamics typical of human–wildlife interfaces, where domestic animals act as both sentinels and victims of wildlife presence. As Pooley et al. (2021) argue, acknowledging the full spectrum of multispecies entanglements is vital to rethinking coexistence and moving beyond simplistic human-versus-wildlife binaries.

Interview and observational data also consistently indicated poultry predation, frequently cited by rescuers and community members. A rescuer noted this saying,

> "Everybody has poultry in Goa. It's a regular occurrence that a monitor lizard or python will come and swallow a few."

Another rescuer highlighted how pythons frequently prey on domestic animals, stating that,

> "Most people have their livestock and stuff, so they are always coming in for that. Even domesticated birds and stuff. Or domesticated animals, like cats and dogs."

Cobra predation on poultry eggs was also explicitly noted, distinct from python predation but similarly frequent. Poultry farmers reported regular incidents of pythons entering coops to prey on birds and cobras targeting eggs explicitly, indicating consistent predator-prey interactions. Seasonal patterns of snake predation in poultry were not clear from the available data.

Reports of venomous snakebite incidence in large livestock such as cattle and buffaloes were low (less than 2–3 cases annually per veterinary clinic), with identification often difficult due to limited diagnostic options and misreporting. As with other domestic animals, no specific records were maintained by the Animal Husbandry Department or the private vets. Veterinarians reported rarely treating pig and goat snakebite cases. Rather than reflecting a low frequency of bites, this may be down to these animals not being considered as valuable enough for treatment by the owners. A forest department official explained this saying,

> "Pigs are bitten by cobras. They die on the spot. But people don't bother going for post-mortems".

Seasonal patterns also emerged in the analysis with veterinarians reporting a pronounced increase in snakebite incidents during the post-monsoon months (October–December). In particular, Russell's viper bites showed a strong seasonal peak during this period, with multiple veterinarians explicitly associating this increase with Russell's viper activity patterns. One veterinarian noted,

> "I have more cases of hemotoxic bites in dogs from Russell's vipers around the Christmas holidays."

Another added,

> "Most bite cases of domestic animals I was getting were in October, November, and December, and they were almost all Russell's vipers."

These patterns were also seen across human snake envenomation cases (Narvencar et al., 2020) as well as Goa's snake rescue data (Attre, 2025). Unlike the cases of dog bites, no clear seasonal pattern was evident for cat snakebite, though suppositions could be made about similar timelines. Python predation cases also didn't show any seasonal variations, with cases recorded throughout the year without explicit veterinary consensus on seasonal peaks.

3.2 Challenges in domestic animal-snake conflict mitigation

3.2.1 Medical and logistical challenges

Thematic analysis of veterinary interviews identified multiple infrastructural, logistical, and diagnostic challenges in the treatment of domestic animal snakebites in Goa, significantly impacting survival outcomes. Respondents revealed inconsistent availability of ASV across veterinary clinics. Unlike human healthcare facilities, veterinary clinics are not mandated to stock ASV, leaving veterinarians reliant on private procurement. Veterinarians consistently reported that government veterinary centres do not keep ASV in stock, a fact corroborated by current and former State

Animal Husbandry department officials, who confirmed that ASV is only purchased from pharmacies if, and when, required. Officials from the Animal Husbandry department clarified that previously stocks of anti-venom went unused and "caused problems with the auditors." One private veterinarian highlighted this disclosing,

> "Government veterinary centres do not stock anti-snake venom. They send people to private clinics like mine for it".

The unavailability of ASV is further compounded by variability in stocking even among private clinics. Results showed that some veterinarians, aware of limited shelf-life and high cost, keep minimal supplies. One veterinarian described this practice, stating,

> "Generally what I do, since anti-venom is expensive, and we don't require it regularly, so I keep around four vials … Usually that is sufficient. Suppose even two dogs come at a time, at least we can start treatment."

However, analysis indicated that this limited stock can be insufficient if more severe or simultaneous cases arise. The practical issues of limited ASV availability were consistently echoed, as another veterinarian explained,

> "Anti-venom availability is better now, but many vets still don't stock it. The clinic for Worldwide Veterinary Services in North Goa always stocked anti-venom but would be very far for many people in an emergency. Owners waste time calling 15–20 clinics before finding one that has it."

Another veterinarian highlighted the systemic failure in ASV availability saying,

> "I am a vet, my daughter is a vet, but neither of us had anti-venom in stock when my cat was bitten. I had to rush to another clinic to get it. Even in emergencies, anti-venom is not readily available."

In contrast, one private South Goa veterinarian noted that his clinic maintains larger stocks due to their recognition as one of the district's primary ASV sources, always keeping up to 100 vials available.

The polyvalent ASV currently in use across India is manufactured and distributed by different brands, using venom from Big Four specimens collected from one facility in Tamil Nadu (Whitaker, 2015; Senji Laxme et al., 2019). Veterinary interviews indicated significant practical challenges in ASV administration, particularly concerning brand consistency and compatibility. Veterinarians emphasised that mixing different ASV brands within the same treatment significantly increased the risk of severe allergic reactions and even fatalities. One veterinarian stated,

> "If I mix and match brands, I will get a reaction. I lost one patient that way. After that, I never mixed brands again."

Another veterinarian reinforced this noting,

> "We never mix brands between doses to avoid reactions."

This constraint places additional challenges on veterinary treatment, requiring careful management of ASV supplies and limiting options during emergencies when ASV availability is already restricted. Beyond immediate ASV administration, results also indicated the critical importance of prolonged supportive veterinary care to manage delayed complications, particularly organ damage associated with viper bites. Veterinarians emphasised that Russell's viper envenomation cases frequently required antibiotics, liver tonics, and intravenous fluid therapy for upwards of a week post-bite. One veterinarian explicitly emphasised this risk:

> "Necrosis is severe. After 10 days, kidney and liver failure set in. Without antibiotics and liver tonics, the animal collapses."

Another veterinarian confirmed this extended treatment necessity, stating,

> "If you give the snake serum, you think you've done your bit. But necrosis can start setting in. If treatment is incomplete, 8 to 10 days later, they can succumb to kidney or liver failure."

Such long-term management represents a further infrastructural and financial challenge, compounding barriers to complete treatment.

Results also highlighted the lack of 24-hour emergency veterinary services further complicating treatment for snakebites, which often require immediate intervention. A veterinarian emphasised urgent treatment stating,

> "One hour is too long. The faster you give ASV, the better. There's no 'golden hour' for animals."

Analysis also underlined logistical constraints faced by pet owners attempting to access emergency care outside standard clinic hours. A veterinarian recounted,

> "There are no government ambulance services for animals … the government says they want to start, but even now, 40 years later, we don't even have an X-ray at the government veterinary hospital."

Another noted that the lack of nighttime veterinary services could be fatal, saying,

TABLE 3 Species-wise overview of snakebite-related domestic animal mortality in Goa.

Animal type	Common snake species Involved	Estimated cases (per vet/year)	Survival rate	Perceived "value" of animal
Dogs	Russell's viper & cobra, sometimes krait or saw-scaled viper (envenomation)	5–15	High (if treated)	Mixed: Strong emotional attachment; treatment from snakebite often costly (~8,000-9,000 INR*). Purchase cost of animal varies, if not adopted (10,000-1,00,000 INR); upkeep involves an ongoing financial and care commitment.
Cats	Python (predation), cobra & krait (suspected envenomation)	Rarely reported	Low	Primarily emotional: Often roam freely; many die before treatment is possible. Costs usually low, but care access is limited, especially in rural areas.
Livestock *(Cattle, Buffaloes, Goats)*	Russell's viper & cobra (envenomation)	2–3 (under-reported)	High (if treated)	Primarily financial: Animal values range from 10,000-2,00,000 INR. Reliant on government vets, who often lack ASV; treatment access remains inconsistent.
Poultry	Python (predation), cobra (egg theft)	Frequent	Not applicable	Low perceived value: No emotional attachment. Minor losses usually go unreported. Economic significance arises only in rare cases involving high-value breeds like Kadaknath. Some farmers use nets or makeshift barriers, which may unintentionally harm snakes.

Based on interviews and field observations, this includes common snake species involved, estimated case frequency, survival rates (if treated), and how the perceived value of different animal types, both personally and systemically, possibly shapes treatment-seeking behaviour, reporting practices, and access to compensation. *1 USD ~86 Indian Rupees (INR).

> "The owner didn't want to disturb the doctor at night. By the time they came in the morning, I couldn't find a vein, and the dog died."

Another veterinarian similarly emphasised how pet owners had limited choice but to wait,

> "If they get across a vet who is available by chance, then it's fine. Otherwise, they wait until morning."

This limited emergency infrastructure was repeatedly cited by veterinarians as a significant barrier to timely intervention, directly compromising animal survival outcomes. Additionally, veterinarians reported barriers in procuring adequate ASV supplies such as pharmacies often refusing veterinary prescriptions, with one veterinarian explaining,

> "A lot of pharmacies say, 'I'm sorry, this is not a veterinary pharmacy,' making it difficult for us to access essential drugs."

Results also highlighted a lack of any repository listing which pharmacy would have ASV, making it difficult to trace in the first place.

Diagnostic challenges also significantly hamper effective veterinary care. Veterinarians identified substantial difficulties in identifying snakebites, due to the frequent absence of clear bite marks, especially in heavily furred animals, wherein even bee stings could be mistaken for snakebites by the owners or vice versa. As one veterinarian explained,

> "Most people don't come to know [it's a snakebite] … There are no lesions which you can see, especially if it's a furry dog."

The reliance on symptomatic recognition rather than definitive diagnostic tests introduces uncertainty and delays. Findings also emphasised the critical importance of coagulation tests to identify hemotoxic envenomation, particularly from Russell's vipers. Hemotoxic envenomation presents with swelling at the bite site and abnormal blood clotting times, whereas neurotoxic envenomation (cobras and kraits) manifests in rapid paralysis and cyanosis (blue tongue in affected animals). One veterinarian described this diagnostic complexity,

> "Owners sometimes bring the dead animal, saying it's a snakebite, but unless we see the snake, it's hard to say. We go by symptoms, but it's not always clear."

Results indicated that while performing basic clotting tests was considered critical by all veterinarians, it was also not consistently possible, due to inadequate infrastructure and staffing, particularly during nighttime emergencies. A veterinarian expanded on this saying,

> "While administering the first dose, we take out the blood sample. But we don't always wait for the clotting time to confirm. It's given immediately in suspected cases".

Training and expertise among veterinarians to manage snakebite cases varied widely, possibly due to the absence of

standardised guidelines. Patterns from the data revealed frustrations being expressed by veterinarians regarding insufficient formal training and reluctance by some peers to handle snakebite cases due to liability concerns or inadequate knowledge. As one veterinarian stated,

> "A lot of vets don't keep anti-venom because they don't know how to use it or are afraid of liability."

Some veterinarians indicated they administered ASV immediately without waiting for clotting tests, while others preferred preliminary diagnostic tests to confirm envenomation, creating inconsistencies in clinical practice.

Interviews also revealed significant gaps in public awareness and first-aid knowledge among pet owners, often resulting in treatment delays. Some community members had no idea that snakebites could be treated or that anti-venom could be used for dogs and didn't know if their vet even carried it. A vet recalled a case saying,

> "We've had cases where pet owners tied a tourniquet too tightly for too long, causing the leg to rot. One dog's leg actually fell off before they even reached us."

Many owners initially rely on traditional or home remedies rather than immediate veterinary intervention. A veterinarian described this issue saying,

> "Most pet owners try home remedies like turmeric instead of rushing their pet to a vet after a snakebite."

Another vet expanded on this saying,

> "We've had a lot of marination happening, a lot of turmeric application … which makes things very difficult for us. You can't visualise anything with all that turmeric. It's everywhere."

Additionally, some reliance on local healers persisted, further delaying appropriate veterinary care, with a vet saying,

> "There's a famous woman in Vasco who gives small pills for snakebites, but nobody knows what they contain. People are still misled by these treatments."

This reliance on traditional treatments contrasts starkly with the shift towards evidence-based medicine documented for human snakebite treatment (Attre, 2025).

3.2.2 Economic impact: treatment costs and compensation

Thematic analysis, complemented by observational insights, indicates that snakebite-related mortality and predation incidents among livestock and domestic animals in Goa carry significant economic consequences, although these impacts are inconsistently addressed through existing compensation mechanisms. To contextualise these patterns across species, Table 3 summarises the most frequently involved snakes, estimated caseloads, survival rates, and how each animal type is valued and treated in response to snakebite-related incidents.

Many livestock owners in Goa were marginal farmers with limited income and poor access to veterinary or extension services, making emergency care unaffordable or inaccessible. This was particularly evident in rural areas of North Goa, where cattle accounted for over two-thirds of livestock, but veterinary outreach remained sparse and underfunded (Reddy et al., 2017). For livestock owners, structured compensation was primarily available under government schemes, notably the Kamdhenu scheme, a government subsidy initiative supporting the purchase of dairy cattle, later renamed the Mukhyamantri Sudharit Kamdhenu Scheme (Government of Goa, 2023). Access to financial redress depended on whether the animal was purchased under the government subsidy. Compensation was administered solely by the Animal Husbandry Department, and the Forest Department was not involved in the case of snake bites and was only engaged for conflicts involving larger mammals. A veterinarian outlined this conditional compensation framework saying,

> "Most cows and buffaloes are bought under the Kamdhenu scheme, where the government provides subsidies and insurance. If the animal dies, the insurance payout first clears the loan, and then the insurance company compensates the government, and the farmer's loan is waived off. But if the animal was bought privately, the farmer must fight for compensation."

The data also indicated that the bureaucratic complexity involved in claiming snakebite-related livestock losses frequently discouraged farmers from pursuing compensation. One Forest Department rescuer highlighted this challenge explicitly, stating,

> "If you go to claim compensation for a snakebite death, they will ask you for so many papers, you'll give up halfway. That's why many families don't even apply."

Conversely, veterinary and animal husbandry insights revealed inaccuracies in the official records, as some unexplained livestock deaths were misattributed to snakebite to facilitate compensation claims, potentially skewing official mortality records. A veterinarian noted,

> "A lot of vets, when they find a cow or buffalo dead and can't determine the cause, they simply write 'snakebite' in the report. Official figures can thus be misleading. (…) Based on my experience, true cases of snakebite in cows and buffaloes are rare, only about two or three a year."

These contrasting behaviours highlight how institutional failures and lack of trust in formal mechanisms not only discourage legitimate claims but also enable systemic loopholes that drive informal workarounds, patterns that mirror broader conservation conflicts, where inefficiencies erode institutional legitimacy (Barua et al., 2013; Redpath et al., 2013).

Poultry predation, notably by pythons and cobras, though also affected by monitor lizards, emerged frequently in veterinary and community interviews. Analysis indicated that poultry losses, although frequent, were economically tolerated by poultry farmers due to their comparatively minor economic impact per incident. A rescuer illustrated this tolerance saying,

> "Poultry farmers don't care about snakes eating their chickens. One python also ate six rabbits, and they didn't bother claiming anything."

The only time economic losses were reported was when relatively rare and expensive breeds of chickens were involved such as the Kadaknath. Data revealed that while broiler and layer breeds were easily replaceable due to subsidies, the more expensive breeds were often out of pocket for farmers, making their loss economically significant.

Thematic analysis also revealed that comparisons between snakebite-related livestock deaths and predation by large carnivores (e.g., leopards) showed a notable gap in policy. Structured compensation schemes exist for big cat attacks (Karanth et al., 2018), but no equivalent policy framework compensates for livestock losses due to snakebite. An analysis of human-wildlife conflict data from the Forest Department from 2020–2023 also confirmed this gap with no compensation recorded for snakebites. As one Forest Department official explicitly stated,

> "Right now, compensation is only for big cat attacks. I have suggested that we extend it to snakebite victims as well."

The compensation data for livestock, provided by the Forest Department, varied from 5,000 to 50,000 INR, or occasionally more, depending on the breed of the animal. However, it must be noted that these payments were all from the Forest Department rather than Animal Husbandry Department, though records were maintained in the latter as well. The 2024 report by the Ministry of Environment, Forest and Climate Change (PIB (MoEFCC), 2024) showed that loss of property/crops, from tigers and elephants, which presumable included livestock also, indicated the State/UT government to adhere to their individual norms, whereas any death or injury to a person could be guided by the centrally sponsored schemes of the MoEFCC, ranging up to one million Indian rupees. These disparities in response and recognition reflect broader trends in conservation and conflict discourse, where losses involving non-charismatic species, such as snakes, rodents, or small carnivores, are often excluded from formal compensation schemes and policy narratives (Barua, 2014; Gulati et al., 2021; Malhotra et al., 2021; Pooley et al., 2021). Unlike high-profile attacks by leopards or elephants, the slow and often unseen toll of snakebite on domestic animals remains largely invisible within institutional frameworks, despite its widespread occurrence and deep socioeconomic impacts.

Economic redress for snakebite therefore remains underdeveloped or unimplemented, leaving affected farmers at a financial disadvantage. Results also showed that veterinary clinics, particularly private practitioners, often lacked the capacity to treat livestock snakebite cases, forcing them to prioritise smaller animals. Several veterinarians expressed frustration at having to turn away livestock cases, despite recognising the economic hardship faced by farmers. The lack of structured government intervention places the responsibility of treatment on private clinics, which in turn are constrained by supply chain limitations and bureaucratic barriers to ASV procurement.

Thematic analysis of veterinary interviews indicated that in the case of companion animals, the economic burden related to pet snakebite incidents primarily stems from the high cost of veterinary treatment. Veterinary interventions, including ASV, intravenous fluids, antibiotics, and intensive supportive care, were found to typically range between 5,000-10,000 INR, per case, representing a substantial financial burden for pet owners. Although Goa reports one of the highest per-capita incomes in India (Directorate of Planning, Statistics & Evaluation, Government of Goa, 2024), median earnings data are unavailable, and substantial income inequality persists. Consequently, such expenses can still impose a considerable burden on lower-income or single-income households, especially when considering that the revised minimum wage of the state for unskilled, semi-skilled and skilled workers ranges between 14,000-18,000 INR a month (Office of the Commissioner, Labour and Employment, Government of Goa, 2025). Analysis of interviews showed this as a consistent economic barrier, with veterinarians explicitly noting how costs influence decisions about pursuing treatment. One veterinarian stated,

> "Clients who cannot afford it might stop treatment before they even start. As soon as they hear the estimate, they decide against it."

Another veterinarian further expanded on this saying,

> "Treating snakebites is expensive. Anti-snake venoms are more expensive now. They are 4 to 5 times the price they used to be. One vial of anti-venom is 650–750 INR. A full treatment with fluids, injections, and ICU care can cost thousands. Many

> owners don't want to or can't pay after the pet is treated."

This cost barrier was further complicated by the absence of structured compensation or insurance coverage explicitly available for pet snakebites, leaving pet owners fully responsible for all expenses incurred. Results indicated that for some owners, cost considerations force difficult choices regarding treatment. One veterinarian explained this saying,

> "I've had cases where people want to treat their dog, but when they hear the cost, they hesitate. Some go ahead, but others just take the dog back home".

Analysis showed that financial disparities could be particularly pronounced in rural areas, where fewer veterinary clinics stock ASV and economic constraints are more significant. One veterinarian explained,

> "For rural owners, 10,000 INR is a big amount. Some will try, but if their dog doesn't improve fast, they often discontinue treatment."

The absence of emergency veterinary services further exacerbates financial burdens, as owners may need to travel long distances to access treatment, often incurring additional transport costs.

Observational insights from fieldwork further indicated an additional dimension to pet-related economic burdens. Larger, expensive pedigree breeds, often selected by owners as guard dogs to simultaneously provide security and serve as status symbols, appeared particularly vulnerable to snakebite due to their frequent outdoor exposure. A vet expanded on this by saying,

> "People don't necessarily keep dogs specifically for security purposes, but in cases where they do, those dogs are at higher risk of getting bitten."

Consequently, the economic and emotional stakes of losing these animals to snakebite-related incidents were disproportionately high, compounding owners' financial and emotional burdens significantly.

While analysis suggests that predation by snakes on pets is possibly less frequent than poultry predation, these incidents also carried considerable emotional significance for owners. No formal mitigation strategies or economic redress mechanisms exist, highlighting a notable policy oversight. Even in national-scale estimates of human–wildlife conflict (HWC) costs, snakebite often remains unclassified or grouped under miscellaneous categories (Gulati et al., 2021), despite its widespread and lethal impact on both humans and animals. This oversight reinforces systemic biases that favour charismatic megafauna while neglecting pervasive but less visible threats like snakebite.

3.3 Frustration, conflict, and responses to snakebite and snake predation losses

The loss of a domestic animal to snakebite, compounded with the economic impact, triggered emotional distress, and conflict between pet owners, veterinarians, and the wider community. Results indicated that while livestock owners generally view snakebite-related deaths through a financial lens, pet owners experience deep personal attachment, leading to desperation for treatment, heightened frustration with veterinary access, and, in some cases, violence toward veterinary staff. Results also highlighted that this emotional response quite often drove retaliatory killings of snakes, particularly in cases involving python predation or repeated snakebite incidents. As Barua et al. (2013) argue, the "hidden dimensions" of human–wildlife conflict, including psychosocial stress, grief, disrupted livelihood routines, and bureaucratic fatigue, remain poorly addressed. This aligns with Treves and Bruskotter's (2014) findings that tolerance for predatory wildlife is shaped not only by material loss, but by complex social and emotional dynamics, including perceived institutional failure and lack of responsive support. In Goa, this erosion of tolerance was especially visible in cases where snakebite fatalities occurred despite owners' efforts to seek treatment, fuelling resentment toward both snakes and veterinary staff. As with predator conservation globally, maintaining public tolerance requires more than awareness, it demands visible, reliable support systems that prevent people from feeling abandoned in moments of crisis.

Thematic analysis indicated that the emotional stakes of losing a pet differed significantly from those of losing livestock. Pet owners view their animals as family members, rather than economic assets, shaping their willingness to seek treatment at any cost. A veterinarian emphasised this distinction, stating,

> "It's not about cost. It's emotional attachment."

This aligned with broader patterns observed by another senior veterinarian, who noted that,

> "From the perception point of view, people are very closely attached to their dogs and cats and cattle. So, they do try to treat."

Research increasingly recognises the significant contribution of companion animals to human wellbeing, with recent studies quantifying pet companionship as having life satisfaction impacts comparable to social relationships or financial security (Gmeiner and Gschwandtner, 2025). Consequently, the loss of a pet to snakebite may not only be emotionally devastating but also represent an unacknowledged loss to household wellbeing and mental health.

Thematic analysis showed that emotional and economic distress, compounded by lack of access, treatment delays and limited ASV availability, often led to hostility toward

veterinarians and clinic staff. A veterinarian highlighted a major systemic failure in veterinary services, noting that,

> "24-hour vet clinics don't exist because no one wants to take the risk. Many vets have been attacked by pet owners at night when emotions run high."

The absence of emergency veterinary care then creates a bottleneck, particularly in cases where ASV is unavailable or delayed. Another veterinarian recalled a case where a security guard was physically assaulted by a pet owner after their dog died outside a veterinary hospital.

> "I had a client whose dog was sick. They went to the hospital at about 7 o'clock when it was closed, and they bashed up the security guard very badly. The dog died while they were just asking for a doctor."

The incident reflects a broader misplacement of blame, where rather than directing anger toward systemic failings in veterinary care, individuals react impulsively toward those closest to the crisis - veterinarians, hospital staff, and even security personnel. Another veterinarian noted that pet owners often become aggressive when they perceive that their animal is not receiving immediate attention, with some physically threatening staff in emergency situations. These reactions are indicative of the emotional weight placed on pets, particularly in cases where people feel that their only companion animal has been lost due to inadequate veterinary care.

In contrast, results indicated that livestock owners tended to prioritise compensation rather than treatment, demonstrating a stark difference in emotional attachment. As an animal husbandry official pointed out,

> "For cows, the farmer only cares about the money. If the animal dies, they want compensation. No emotional attachment like pet owners."

This pragmatic approach means that livestock snakebite deaths often do not trigger the same level of frustration, urgency, or retaliatory action.

The emotional attachment with companion animals also influenced post-bite behaviour. Data analysis indicated that some pet owners became hyper-vigilant after a snakebite incident, changing their animal-handling practices. However, others failed to learn from repeated incidents, assuming their pet would survive future bites. These contrasting responses demonstrate that while some individuals take preventive steps, others unknowingly increase the risk of future snakebite fatalities. Similar data could not be obtained for livestock. Cross-comparison of responses highlighted that some community members expressed concerns about mitigation for their small animals and poultry with solutions such as netting the place off, mostly commonly by fishing nets, even though conversely the data showed that rescuers attributed nets as a leading cause of morbidity and mortality for snakes.

Thematic analysis also revealed that while retaliatory snake killings had reduced, they were still reported, particularly in rural areas where snakebite fatalities occur frequently. A senior veterinarian confirmed this saying, "The first instinct is always to kill the snake. They kill it first, then bring the dead snake and the bitten animal to me." This immediate response suggests that many people do not distinguish between defensive snakebites and aggressive attacks, instead treating all cases as threats requiring elimination. Similarly, another vet noted that,

> "They show a photo of the snake. They don't bring it. But, yes, they kill it."

This indicates that while some individuals may want to confirm the identity of the snake, they often act pre-emptively by killing it before seeking veterinary intervention.

However, the results also showed that not all pet owners react with violence. Some recognise that killing the snake does not change the outcome of the bite. A vet observed this shift in attitudes over time, stating,

> "Earlier, people used to bring in the dead snake with their bitten pet. But in the last year, I've not had a single owner do that. People are learning they don't need to kill the snake."

This change is partly attributed to public awareness efforts and an increased understanding of snake ecology, which was seen as part of a broader trend across the state.

Analysis suggested that increased rescuer presence allowed individuals to call for assistance rather than taking matters into their own hands. A rescuer further emphasised the role of rescue teams in mitigating retaliatory killings, stating,

> "The availability of rescuers has made a difference. People don't kill snakes like before".

While venomous snakes were often killed in reaction to a pet's death, results showed that pythons were especially targeted for a different reason: predation. Pet owners tend to perceive pythons as an active, ongoing threat, rather than a one-time defensive attacker. A senior herpetologist noted that,

> "People react very emotionally when a python eats a pet cat or dog. That's when they really want the snake gone."

Thematic analysis, complemented by observational insights suggested that visibility of python predation makes it feel more invasive and personal than a venomous bite, reinforcing the desire for removal or retaliation in the case of companion animals.

Analysis suggested that the repeated predation of animals increased conflict between people and pythons, particularly when an individual lost multiple pets to python attacks over time. Vikas et al. (2022), expanded on this theory in their paper on human-leopard conflict, noting that cultural beliefs in India can mediate tolerance, but they are fluid, context-dependent, and vary by species. While leopards, like snakes, may be revered or tolerated due to spiritual associations, any species may evoke greater fear, frustration, or neglect, highlighting the inconsistent moral hierarchies at play in human–wildlife interactions.

Results indicated that the misidentification of non-venomous snakes further contributed to unnecessary killings. A veterinarian observed,

> "I have had cases where people killed a python thinking it was a cobra attacking their pet."

This highlights the lack of awareness regarding snake behaviour and species identification, leading to indiscriminate killings even when a snake poses no venomous threat.

Despite these fears, results also showed that some members of the public accepted python predation as a natural part of the ecosystem. A vet with a domestic animal rescue organisation noted a clear distinction between those who understood ecological dynamics and those who viewed pythons as a "menace", stating, "Feeders (of community animals) never ask for relocation of pythons, but the public does. They think the world belongs only to humans." This suggests that people who actively engage with stray or community animals or wildlife in general are more likely to tolerate coexistence, while others demand intervention. Additionally, results also showed that misconceptions about the role of pythons in controlling stray populations have fuelled debate over their presence. Another vet actively working for domestic animal rescues reported, "People ask if pythons help control stray dog populations. But really, how many can they eat? A few out of dozens born every six months." This finding suggests that pythons have a minimal impact on stray populations, despite public perception that they serve as a natural control mechanism.

Thematic analysis also indicated that snake-related conflicts affecting domestic animals differ from other human-wildlife conflict cases, particularly those involving larger carnivores. A forest department official explained the differences in compensation-seeking behaviour, noting that,

> "For leopards, they ask us to trap the animal. For snakebite, they accept the loss."

Similarly, another Forest Department official reiterated that

> "For leopards, they apply for compensation immediately. But for snakebites, they just accept the loss."

This indicates that people expected intervention for large predators like leopards but not for snakes. Analysis showed that unlike leopard attacks, snakebites were often seen as an inevitable part of rural life, reducing the likelihood of government intervention.

Results also showed that the perceived fairness of the conflict also influences reactions. A vet explained why leopard predation generates greater outrage than snakebite-related deaths, stating,

> "The snake, at least the dog barks and goes to the snake to get bitten. Whereas here, the poor dog is asleep and is picked up and taken out. So, it's being cheated by nature."

This suggests that people feel more emotionally violated by a predation event where the animal had no chance to defend itself, compared to a snakebite where an interaction occurred.

Beyond leopards, crocodiles have also been the source of conflict over pet predation. Unlike with snakes, there was no retaliation, but the outrage demonstrated the heightened emotional response to pet predation.

3.4 Broader systemic and individual responsibilities

The core characteristics of human–wildlife conflict typically include unpredictable wildlife-caused harm, social and economic loss, breakdowns in institutional response, and retaliatory behaviours (Redpath et al., 2013). Although snakebite is rarely acknowledged in national or global HWC discourse, it shares all these characteristics. The deaths of livestock and pets due to snakebite, coupled with the absence of compensation, poor veterinary access, and reported retaliatory killings, thus represent a critical but under-recognised axis of human–wildlife conflict in India. These incidents also underscore that snakebite-related conflict often results in mutual harm, with both domestic animals and snakes suffering injury or death. While animal deaths or resulting emotional responses from owners are occasionally recognised by veterinary systems, snake fatalities from domestic animal encounters remain largely invisible, unrecorded, and rarely acknowledged in policy frameworks. Even the latest HSC mitigation guidelines from the Ministry of Environment, Forests and Climate Change (MoEFCC, 2023) sees no mention of this. Given that many of these snake species are also protected under Schedule I of the Wildlife Protection Act 1972 (WPA, 1972), not recognising domestic animal-snake encounters as a concerning aspect of wildlife conflict and conservation is a grave oversight.

The management of snakebite in domestic animals in Goa is hindered by systemic failures in veterinary infrastructure, inconsistent ASV stocking, and the absence of standardised treatment protocols. Analysis indicated that these deficiencies exacerbated preventable mortality and place an increasing strain on veterinarians, who are already struggling with limited resources and unsustainable caseloads. With livestock cases deprioritised due to financial constraints and emergency care remaining unavailable, veterinary professionals were forced to turn away cases they would

otherwise treat, further deepening gaps in care. These deficiencies reflect wider systemic challenges in veterinary public health across India. Despite the growing relevance of One Health frameworks, veterinary service delivery in India remains underdeveloped, especially in rural areas where farmers often struggle with poor access, inadequate staffing, and treatment delays (Ghatak and Singh, 2015). As Shanmathy et al. (2018) note, the economic burden of animal healthcare falls disproportionately on smallholder farmers, yet the public sector's capacity to deliver accessible and quality veterinary services continues to erode due to fiscal and infrastructural constraints.

This systemic neglect is compounded by the absence of political will, particularly in livestock care. As one veterinarian noted,

> "I find a lack of political will, a lack of policy will… (they say) insurance will cover it. Why are you so worried?"

They also added,

> "We've had countless vet meetings, but snakebite management has never been discussed. There are no guidelines."

These statements capture the disconnect between policy frameworks and real-world implementation, where financial provisions exist on paper but remain inaccessible due to bureaucratic inefficiencies, logistical barriers, and a general disregard for veterinary concerns.

The economic burden of snakebite-related animal losses is unevenly distributed. While government-subsidised livestock technically qualify for compensation, bureaucratic obstacles discourage many farmers from applying. Privately owned livestock and pets receive no financial support, forcing owners to bear the full burden of treatment costs or forego care altogether. One vet commented on this saying,

> "Animal Husbandry doesn't care about dogs and cats. They only care about cows and buffaloes because they contribute to the economy."

This contrasts sharply with structured compensation schemes for big cat attacks (Karanth et al., 2018), reinforcing a fundamental policy oversight in Goa's approach to human-wildlife conflict.

A critical but often overlooked aspect of mitigation is responsible pet ownership, particularly in the case of cats, which are both predator and prey in human-snake interactions, as highlighted in Section 3.1. Results showed that while dogs are often bitten when defending territory or protecting their owners, cats frequently engage with snakes due to their hunting instincts. Veterinarians, rescuers and community members reported cases of cats repeatedly bringing home snakes, highlighting the risk of predation-driven interactions, a pattern that has seen considerable global concern (Moseby et al., 2015), though there are no equivalent studies in India. Dog and cat "ownership" is also complicated in India with the concept of "community animals" and field observations showed a greater likelihood of indoor-outdoor animals, without responsible ownership, being accepted as the norm, however, observations also showed a substantial number of "pet cats" as indoor-outdoor animals. Unlike pet dogs, which can be supervised in enclosed compounds, a possible approach for cats is to keep them indoors. However, research from the UK has shown that cat owners vary significantly in their attitudes toward confinement and predation, with many opposing blanket restrictions despite expressing concern about wildlife impacts (Crowley et al., 2020). Field observations found similar sentiments existed in Goa, as well. These findings suggest that any mitigation strategies, such as "catios" or indoor confinement using snake-proof enclosures, must be locally adapted, owner-sensitive, and coupled with education on both animal welfare and wildlife protection. Their ambiguous position in conservation discourse, valued as companions, but ecologically disruptive, further complicates efforts to integrate them meaningfully into human–wildlife conflict frameworks.

However, snake-proof enclosures must also be snake-friendly, as the widespread use of ghost nets and poorly designed barriers, to protect poultry, has led to significant snake mortality, as indicated by results. Well-designed enclosures should not only prevent snakes from entering but also ensure that poultry, cats and other small pets do not roam freely, reducing their risk of predation, road accidents, and conflicts with wildlife.

Ultimately, the failures in snakebite management for domestic animals reflect a broader neglect of veterinary concerns within Goa's policy landscape. Addressing these gaps requires urgent governmental intervention, including the mandatory stocking of ASV in all veterinary clinics and government hospitals, the establishment of emergency veterinary clinics, and 24-hour ambulance services. It should also include the expansion of compensation frameworks to cover privately owned livestock and pets, and the formal integration of veterinarians into wildlife conflict mitigation policies to ensure that snakebite in domestic animals is recognised as a core component of broader human–wildlife interactions. Record-keeping for all snakebite cases should be mandated across both government and private clinics, and awareness programmes should also include targeted messaging for domestic animal keepers on prevention, first aid, emergency response, and responsible pet ownership.

4 Conclusion

As with many other forms of human–wildlife conflict, the impacts of snakebite on domestic animals in Goa are shaped not only by the biological risk posed by snakes, but by the structural absence of veterinary support, compensation, and public health integration. This triadic structure, of ecological hazard, affected stakeholders, and systemic neglect, is consistent with patterns described across conflict involving large carnivores, crop damage, and zoonotic disease (Barua et al., 2013; Redpath et al., 2013).

Without correct recognition and immediate systemic intervention, veterinarians will remain overburdened, preventable mortality will persist, and economic losses will escalate. However, beyond economics, snakebite-related animal deaths represent a deeper crisis, one of governance, animal welfare neglect, and systemic failure to integrate animal welfare and veterinary care within human-wildlife conflict mitigation. Farmers and pet owners alike depend on their animals, whether as a source of livelihood or companionship, yet current policies fail to recognise these losses as legitimate concerns. Despite existing financial provisions, bureaucratic inefficiencies, poor veterinary infrastructure, and a lack of political will have left both economic and emotional burdens solely on individuals, reinforcing inequities in how different types of wildlife conflict are addressed. Goa's governance must shift from reactive crisis management to proactive policy interventions, prioritising structured ASV availability, emergency veterinary care, and a compensation framework that recognises snakebite-related animal mortality as an integral part of human-wildlife conflict management.

At the same time, these encounters often result in the unrecorded death of snakes, many of which are protected species, highlighting that current frameworks not only fail humans and their animals, but also neglect wildlife conservation responsibilities. Without these structural changes, both animals and the people who depend on them, whether for livelihood or companionship, will continue to suffer due to avoidable systemic failures.

Data availability statement

The interview data supporting this study are not publicly available due to the risk of identifying participants, even after anonymisation. However, anonymised excerpt and/or summary data may be shared with reviewers upon request.

Ethics statement

The studies involving humans were approved by the Ethics Committee of the School of Anthropology and Conservation, University of Kent (approval number: 16-PGR-20/21). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written or oral informed consent to participate in this study.

Author contributions

SA: Funding acquisition, Writing – review & editing, Writing – original draft, Investigation, Project administration, Conceptualization, Data curation, Formal analysis, Methodology, Visualization. MP: Project administration, Writing – review & editing, Supervision. IB: Supervision, Writing – review & editing. RG: Project administration, Writing – review & editing, Supervision.

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Conflict of interest

The author(s) declared that this work 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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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/famrs.2025.1746300/full#supplementary-material

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