APCRI Journal
Volume 27, Issue 1- 2025, Pg. No. 5-11
Peer Reviewed & Open Access Journal

Research Article

Elimination of Dog-mediated Human Rabies by 2030 from India: A Cross-sectional Online Survey to Assess the Awareness of Rabies Elimination Strategies among Members Affiliated with the Association for Prevention and Control of Rabies in India

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DOI: https://doi.org/10.24321/0973.5038.202506

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How to cite this article:
Narayana D H A, Poornima M K, Sudarshan M K. Elimination of Dog-mediated Human Rabies by 2030 from India: A Cross-sectional Online Survey to Assess the Awareness of Rabies Elimination Strategies among Members Affiliated with the Association for Prevention and Control of Rabies in India. APCRI J. 2025; 27(1): 5-11.

Date of Submission: 2025-04-15
Date of Acceptance: 2025-05-26

A B S T R A C T

Introduction: In December 2015, the World Health Organization gave a global call for the elimination of dog-mediated human rabies by 2030. In accordance with this, on 28th September, 2021 the Government of India launched the National Action Plan for Dog-Mediated Human Rabies Elimination from India by 2030.

Objective: To study the awareness of rabies elimination strategies among medical & veterinary professionals affiliated with the Association for Prevention and Control of Rabies in India regarding rabies prophylaxis, prevention of dog rabies, and elimination of dog-mediated human rabies by 2030 from India.

Methods: A pretested Google questionnaire consisting of 10 questions was sent via WhatsApp group of 267 members affiliated with APCRI, of whom 108 responded, yielding a response rate of 40.4% in June 2023.

Results: The median age of respondents was 48 years, the majority were males (66%) and medical professionals (74%). 88% responded that they were aware that intradermal rabies vaccination is as effective as intramuscular rabies vaccination, and 72% mentioned that rabies monoclonal antibodies are as good as rabies immunoglobulin. 82% responded that mass dog vaccination is an effective method for the elimination of rabies in dog populations. 82% mentioned that rabies vaccines should be supplied free of cost under the Universal Immunization Programme. However, only 32% of respondents were confident of India eliminating dog-mediated human rabies by 2030.

Conclusion: The awareness among members affiliated with APCRI regarding rabies prophylaxis and prevention of dog rabies is satisfactory but diverse with respect to the elimination of dog-mediated human rabies by 2030 from India.

Keywords: APCRI, Awareness, Elimination, India, Online survey, Rabies

Introduction

Rabies is a fatal but preventable viral zoonotic disease that continues to pose a significant public health challenge in India, which accounts for nearly 36% of global rabies deaths.[1] Dogs are responsible for up to 99% of human rabies transmissions worldwide.[2] Although rabies is entirely preventable through timely post-exposure prophylaxis (PEP) and dog vaccination, gaps in implementation, awareness, and access to resources remain persistent barriers in India.[3,4]

Recognizing the global burden of rabies, the World Health Organization (WHO), along with the Food and Agriculture Organization (FAO), World Organization for Animal Health (WOAH), and the Global Alliance for Rabies Control (GARC), launched the Zero by 30 initiative in 2015, aiming to end human deaths due to dog-mediated rabies by 2030.[5] In alignment with this, the Government of India launched the National Action Plan for Dog-mediated Rabies Elimination by 2030 from India (NAPRE) in 2021, outlining a comprehensive strategy based on mass dog vaccination, PEP availability, intersectoral coordination, and operational research.[6]

The Association for Prevention and Control of Rabies in India (APCRI), a national organization comprising members from both medical and veterinary fields, has played a pivotal role in rabies advocacy, research, and policy development.[7] Understanding the perspectives of these professionals is essential, as their knowledge and attitudes significantly influence rabies control efforts at ground level.

However, limited data exists on the consensus or divergence on the awareness of rabies elimination strategies among medical and veterinary professionals, who are the key stakeholders, particularly in the Indian context. Hence, an online survey was conducted with the objective of knowing awareness of rabies elimination strategies among medical and veterinary professionals affiliated with APCRI regarding key aspects of rabies prevention and control, including rabies prophylaxis, laboratory diagnosis of human rabies, mass dog vaccination, pet dog licensing, the Animal Birth Control (ABC) program, and elimination of dog-mediated human rabies from India by 2030.

Materials and Methods

A cross-sectional online survey was conducted using a structured, pretested questionnaire disseminated via WhatsApp groups of members affiliated with the Association for Prevention and Control of Rabies in India (APCRI). The sample size was calculated using the formula $n = Z^2pq/d^2$, where p is the expected proportion, q = (100 – p), and d is the absolute precision. Based on a previous study by Hardanahalli RS et al.,[4] the expected proportion (p) of physicians correctly managing positive skin sensitivity tests to ERIG was 66.9%. Using p = 66.9, q = 33.1, and d = 10, the sample size was calculated as $n = [(1.96)^2 \times 66.9 \times 33.1] / (10)^2 = (8506.8) / 100 = 85.06$, which was rounded up to 85. After adjusting for a 20% non-response rate, the final sample size was determined to be 102.

The questionnaire underwent a pretesting on 10 postgraduate students from medical and veterinary disciplines (APCRI non-members) who were not part of the study sample to ensure clarity, relevance, and effectiveness in capturing the intended information. The questionnaire was shared with 267 members affiliated with APCRI via the WhatsApp group in June 2023, which served as the primary communication platform. All members were invited to participate, although no prior individual notification was sent regarding the survey, of whom 108 responded, yielding a response rate of 40.4%. The questionnaire comprised of 10 questions covering rabies prophylaxis, the ABC program, mass dog vaccination, pet dog licensing, laboratory diagnosis of human rabies, and elimination of dog-mediated human rabies from India by 2030, ensuring a comprehensive assessment of awareness of participants.

The study involved recording of information without any linked identifiers, and any disclosure would not harm the interests of the observed person, which is as per National Ethical Guidelines for Bio-Medical and Health Research Involving Human Participants, Indian Council of Medical Research, 2017. Hence, the study is exempted from the review of the institutional ethics committee. (https://ethics.ncdirindia.org/asset/pdf/ICMR_National_Ethical_Guidelines.pdf)

Results

The present study included 108 members affiliated with APCRI who submitted the completed Google form. The median age was 48 years [interquartile range (IQR): 39-57 years]; 71 (66 %) were males, 37 (34 %) were females, 80 (74%) were medical professionals, and 28 (26%) were veterinarians.

The survey responses on medical, veterinary, laboratory, and NRCP program-related components are presented in Table-1

ISSN: 0973-5038
DOI: https://doi.org/10.24321/0973.5038.202506

Table 1.The survey responses on medical, veterinary, laboratory, and NRCP program components

Medical component				
Survey Questions	**Yes**	**No**	**Cannot say**	**Don't know**
Whether intradermal rabies vaccination (IDRV) is as effective as intramuscular rabies vaccination (IMRV)?	95 (88)	04 (04)	08 (07)	01 (01)
Whether rabies monoclonal antibodies (RMAb) are as good as rabies immunoglobulins (RIGs)?	78 (72)	04 (04)	21 (19)	05 (05)
Should the test dose (skin sensitivity test–SST) for equine rabies immunoglobulin (ERIG) be continued?	71 (66)	31 (29)	04 (03)	02(02)
If a pet dog is fully vaccinated, then there is no need for post-exposure prophylaxis (PEP) in the person bitten by that dog?	88 (81)	17 (16)	03 (03)	-
Veterinary Component				
Can animal birth control (ABC) program be effective in reducing the stray dog population in India?	85 (79)	14 (13)	09 (08)	-
Can mass dog vaccination (MDV) be effective in eliminating rabies in the dog population in India?	89 (82)	12 (11)	06 (06)	01 (01)
Should pet dog licensing be made mandatory and enforced with penalties in India?	101 (93)	03 (03)	02 (02)	02 (02)
Laboratory Component				
Should laboratory diagnosis be made compulsory in all suspected human rabies deaths?	77 (71)	21 (20)	08(07)	02 (02)
National Rabies Control Programme (NRCP) Component				
Should rabies vaccines be supplied by the Government of India under the universal immunization program (UIP) for both post–exposure and pre-exposure prophylaxis?	89 (82)	14 (13)	04 (04)	01(01)
Can dog-mediated human rabies be eliminated from India by 2030?	35 (32)	33 (31)	37 (34)	03 (03)

Note: Figures in parenthesis indicate percentage

Majority, 95 (88%), of the respondents gave a correct answer that IDRV is as effective as IMRV, and 4 (4%) mentioned that IDRV is not as effective as IMRV. Of the four who disagreed, 02 (50%) believed that "immunogenicity is less with IDRV," and 02 (50%) cited anatomical reasons such as "the presence of nerve endings is greater in muscle."

Regarding whether RMAbs are as good as RIGs, 78 (72%) gave the correct answer, and only 4 (4%) mentioned it's not. Among those who disagreed, 02 (50%) respondents noted, "Monoclonal may not work as efficiently on the Indian strain," while 02 (50%) others stated that "larger quantities are required to effectively counter the virus."

71 (66%) of the respondents mentioned that SST should be continued as mandated by DCGI & product insert, and 31 (29%) answered there is no need to do SST before administration of a full dose of ERIG. Among those opposing SST, 15 (48%) stated that "SST does not predict anaphylaxis," 10 (32%) mentioned "not a single case of anaphylaxis has been reported," and 6 (19%) highlighted that "WHO does not recommend skin testing."

Majority 88 (81%), mentioned that there is no need to provide PEP if a person is bitten by a fully vaccinated pet dog. This response does not align with the National Guidelines for Rabies Prophylaxis in India (2019), which clearly recommend that PEP should be administered

ISSN: 0973-5038
DOI: https://doi.org/10.24321/0973.5038.202506

irrespective of the vaccination status of the biting dog; so, 17 (16%) of the respondents answered correctly that PEP should be given even if a person is bitten by the vaccinated pet dog. Among those who answered correctly, 09 (53%) cited that "many immunized dogs show poor antibody response," and 08 (47%) mentioned issues like "vaccine potency and cold chain are questionable."

Majority 85 (79%) of the respondents answered that the Animal Birth Control (ABC) program will be effective in reducing the stray dog population in India, and 14 (13%) mentioned that the ABC program will not reduce the stray dog population in the country. Among those who mentioned No, 06 (42%) respondents cited poor implementation ("Poorly implemented without proper census of dogs"), 04 (29%) mentioned resource constraints and lack of commitment ("Ill-planned, poorly implemented, corruption"), and another 04 (29%) felt the program was ineffective ("ABC appears to be a futile exercise in India wasting public funds").

Regarding whether mass dog vaccination will be effective in eliminating rabies in the dog population in India, the majority, 89 (82%), answered yes, but 12 (11%) mentioned it will not be effective. Among those who disagreed, 05 (42%) respondents pointed to the large stray dog population ("Stray dog population is too large"), 04 (33%) cited issues of feasibility and coverage ("Effective coverage is impossible"), and 03 (25%) questioned its economic viability ("Not feasible and not viable practically").

Majority 101 (93%), answered that pet dog licensing should be made mandatory and enforced with penalties in India. No responses were submitted by those opposed.

Majority 77 (71%), answered that laboratory diagnosis should be done in all suspected human rabies deaths. However, 21 (20%) mentioned that it should not be made mandatory. Among those who opposed mandatory lab confirmation, 07 (33%) cited cost and complexity ("Cumbersome & expensive postmortem"), 08 (38%) felt clinical signs were sufficient ("Clinical signs are classical"), and 06 (29%) highlighted infrastructural issues ("Laboratory network is scarce").

Majority 89 (82%) answered that the Government of India should supply rabies vaccines to all states under the universal immunization program (UIP) for both post-exposure and pre-exposure prophylaxis, and 14 (13%) mentioned that it is not needed. Among the latter, 06 (43%) felt PrEP is not cost-effective ("Pre-exposure not economical or universally needed"), 05 (36%) noted that UIP is already burdened ("Already many vaccines under UIP"), and 03 (21%) saw it as a waste of resources ("Wastage of funds").

On the very important issue of the elimination of dog-mediated human rabies by 2030 from India, there was a difference in the awareness among the respondents. Only 35 (32%) mentioned that elimination is achievable, while 33 (31%) mentioned it is not possible, and 37 (34%) were unsure. Among those who doubted that it is not possible, 12 (36%) highlighted the uncontrolled stray dog population ("Too many dogs, not enough vaccines"), and 9 (28%) cited a lack of political will and administrative delays ("No political will or funding. Implementation is too slow"), 05 (15%) felt ABC is ineffective ("ABC is an eyewash"), 03 (09%) called the timeline unrealistic ("With current strategies, it is near impossible"), and 04 (12%) criticized poor intersectoral coordination ("Rabies is a One Health issue, but implementation is lacking").

Discussion

Rabies continues to be a significant public health challenge in India, contributing to a substantial proportion of global rabies deaths. Despite being a vaccine-preventable disease, gaps in vaccination coverage, dog population control, and public awareness hinder effective elimination efforts. The present study provided an insight into the perception of professionals involved in rabies control, including medical and veterinary experts, on various aspects of rabies management and elimination strategies.

One of the most effective ways to eliminate rabies is through widespread and sustained vaccination of dogs, as they are responsible for nearly 99% of rabies transmissions to humans. The success of rabies control programs relies on comprehensive dog vaccination campaigns, robust surveillance systems, and public education initiatives. The National Rabies Control Programme (NRCP), launched in 2013, has been instrumental in addressing these aspects through PEP, mass vaccination of dogs, and community awareness programs. However, challenges persist in terms of stray dog population control, vaccine accessibility, and compliance with vaccination protocols.

A majority (88%) of respondents correctly recognized that IDRV is as effective as IMRV, consistent with the findings demonstrating comparable rabies virus-neutralizing antibody responses between ID and IM administration.[8] However, a small proportion (4%) of the study respondents expressed concerns about IDRV's immunogenicity, citing lower antigen uptake and fewer nerve endings in the skin compared to muscle. These misconceptions highlight the need for continued awareness and training of medical professionals to promote wider acceptance of IDRV, which offers significant advantages in resource-limited settings due to its dose-sparing benefits.

Majority (72%) of respondents correctly acknowledged RMAb as good as RIGs, which is consistent with previous studies. The former established the non-inferiority of SII RMAb to HRIG in inducing rabies virus-neutralizing antibodies (RVNA), while the latter confirmed comparable antibody responses between Twinrab™ and HRIG, with no

ISSN: 0973-5038
DOI: https://doi.org/10.24321/0973.5038.202506

significant safety concerns.[9,10] However, a small proportion (4%) of our study respondents expressed doubts, citing concerns about RMAb efficacy against Indian rabies virus strains and the perceived need for larger quantities. These misconceptions highlight the necessity of awareness programs for medical professionals to enhance confidence in RMAb-based PEP, which offers a safe, effective, and accessible alternative to traditional RIG administration. As rabies is 100% fatal, early and complete PEP with RIG/ RmAbs in high-risk/category 3 exposures will prevent disease even after exposure to suspected or confirmed rabid animals. RIG and RmAbs are certainly lifesaving immune-biologicals in all category 3 rabies exposures.[11]

Majority (66%) of study respondents support continuing the skin sensitivity test (SST) for equine rabies immunoglobulin (ERIG) administration, aligning with the mandate by the Drug Controller General of India (DCGI) and product inserts. A study by Sudarshan M K et al. reported no serious adverse events associated with full-dose ERIG administration.[12] However, 29% of our study respondents opposed its continuation, citing reasons such as the test's inability to predict anaphylaxis, the absence of reported anaphylactic reactions in large patient cohorts, and the WHO updated guidelines recommending ERIG administration regardless of SST results. These findings highlight the ongoing debate over SST's necessity, suggesting that while it remains a regulatory requirement in India, there is a need to re-evaluate its clinical relevance in light of global best practices.

81% of study respondents believed that PEP is not required if a person is bitten by a fully vaccinated pet dog, while 16% expressed concerns regarding the potency of vaccines for dogs, cold chain maintenance, and inconsistent antibody response in some vaccinated dogs. According to the National Guidelines for Rabies Prophylaxis in India (2019), "irrespective of the vaccination status of the biting dog, PEP should be given." This difference underlines the urgent need for targeted training and sensitization programs for both medical and veterinary professionals on national rabies control protocols to ensure uniform and evidence-based practices.[13]

The present study found that 79% of respondents believe the Animal Birth Control (ABC) program can effectively reduce the stray dog population in India, while 13% disagreed, citing concerns about its implementation and impact. Evidence from a cross-sectional study in Kozhikode Municipal Corporation conducted over one month, during September 2022, using an input-output analysis method highlights the importance of systematic sterilization, emphasizing that at least 70% sterilization coverage is necessary to control stray dog populations and reduce rabies transmission.[14] However, a community survey of dog bites, anti-rabies treatment, rabies, and dog population management in Bangalore City[16] indicates that ABC program coverage remains insufficient, with only 10.4% of the stray dog population sterilized, far below the recommended threshold. Low public awareness and trust in the program further hinder its success.[15] Additionally, a performance audit of the ABC program in Bangalore by Sudarshan M K and team highlights the need for improved funding, community engagement, and monitoring to enhance its effectiveness.[16] While the ABC program holds promise as a long-term strategy, its success depends on scaling up sterilization efforts and integrating mass dog vaccination. In addition, strengthening infrastructure, increasing public awareness, and ensuring sustained governmental support are crucial for the program's effectiveness in controlling the stray dog population and mitigating rabies risks in India.

It was found in this study that 82% of respondents believed mass dog vaccination (MDV) is an effective strategy for eliminating rabies in India's dog population. Supporting this, a study[17] evaluated Bengaluru's MDV program and found that 71% of vaccinated stray dogs developed adequate immune responses, as confirmed by the rapid fluorescent focus inhibition test (RFFIT). The findings highlight the potential of MDV in achieving herd immunity among stray dogs, a crucial step toward rabies elimination. However, challenges such as low vaccination coverage, logistical constraints, and the need for sustained efforts remain. To maximize the impact of MDV, achieving high vaccination coverage, maintaining regular booster doses, and integrating it with Animal Birth Control (ABC) programs are essential. Strengthening surveillance, public awareness, and veterinary infrastructure will further enhance the effectiveness of MDV in reducing rabies transmission and achieving India's rabies elimination goals.[17]

A majority (93%) of study respondents supported mandatory pet dog licensing with penalties. Pet owners must be aware of their legal responsibilities, including licensing and liability for pet attacks. The study by Bhati and Jangid in the Jus Corpus Law Journal emphasizes that under Section 289 of the Indian Penal Code (IPC), pet owners can be held legally accountable if their negligence leads to harm. Courts in India have increasingly awarded compensation to victims of pet attacks, reinforcing the need for responsible ownership. Additionally, mandatory registration and pet insurance can help mitigate financial liabilities while improving public safety. Raising awareness about these legal obligations, along with stringent enforcement of pet licensing, can encourage responsible ownership, reduce pet-related injuries, and contribute to better public health and safety. Implementing these measures alongside effective stray dog management policies can further enhance efforts to control the spread of rabies and other zoonotic diseases.[18]

71% of study respondents supported mandatory laboratory diagnosis for all suspected human rabies deaths, while 20% opposed it, citing challenges such as high costs, the classical clinical presentation of rabies, limited laboratory

ISSN: 0973-5038
DOI: https://doi.org/10.24321/0973.5038.202506

infrastructure, and perceived lack of benefit. However, literature strongly supports the necessity of laboratory confirmation due to the limitations of clinical diagnosis, particularly in cases of paralytic rabies, which can mimic other neurological conditions. A review by Ashwini et al. highlights the critical role of advanced diagnostic techniques such as RT-PCR, direct fluorescent antibody tests, and next-generation sequencing in ensuring accurate case identification and surveillance.[19] Similarly, a report by the Ministry of Health and Family Welfare, Government of India, "Rabies General Aspects and Laboratory Diagnostic Techniques, 2023," emphasizes that standardized laboratory testing is crucial for accurate diagnosis, guiding post-exposure prophylaxis strategies, and strengthening rabies control efforts. Mandating laboratory confirmation for all suspected rabies deaths would enhance surveillance, prevent misdiagnosis, and support India's goal of rabies elimination by 2030.[20]

Presently, the lifesaving rabies vaccines and rabies immunoglobulins are procured by the state governments under the National Health Mission (NHM) and National Free Drug Initiative (NFDI), as health is a state chapter. But it is not happening satisfactorily, particularly in the northeastern states and others, for reasons related to procurement, supplies from producers, payments, etc., thus leading to frequent stockouts, and consequently, the poor are not receiving these lifesaving medicines in the government hospitals. To address this issue, the Government of India shall directly provide a free supply of rabies vaccines and rabies immunoglobulins (RIGs) to all states, as is done in the case of vaccines for routine vaccination under the Universal Immunization Programme (UIP).[21]

In the present study, only 32% of study respondents mentioned that elimination of dog-mediated human rabies by 2030 is possible, 31% mentioned that it is not possible, and 34% were unable to take a stance. The complexity of rabies elimination requires a multisectoral approach, as highlighted in a review article by Tiwari H.K., et al., A comprehensive intervention strategy must include mass vaccination and population control of free-roaming dogs, effective garbage management to reduce stray dog proliferation, and widespread educational initiatives targeting schoolchildren and the general public. Additionally, ensuring the accessibility of post-exposure prophylaxis and establishing robust surveillance systems for rabies detection are crucial to monitoring progress. Public-private partnerships play a vital role in promoting responsible pet ownership, incentivizing the adoption of stray dogs, and supporting large-scale intervention programs. Implementing a "One Health approach" through pilot projects in both urban and rural areas can generate empirical data to guide nationwide rabies eradication efforts. Without a coordinated and sustained effort from ecologists, social scientists, animal welfare organizations, educators, and administrative authorities, achieving a "Zero by 2030" target may remain a challenge. Strengthening existing programs with a holistic approach is essential for making rabies elimination a reality.[22]

Despite these comprehensive measures, several challenges remain. Limited awareness about rabies, misconceptions regarding PEP, and reluctance to seek timely medical care hinder effective disease prevention. Additionally, inadequate coordination between public health and veterinary sectors poses a barrier to achieving holistic rabies control. Addressing these gaps requires continuous efforts in capacity building, infrastructure development, and community engagement. Moving forward, sustained political commitment, increased funding, and innovative approaches such as oral rabies vaccination for stray dogs and enhanced digital surveillance systems will be crucial in accelerating progress towards rabies elimination. Strengthening intersectoral collaboration and fostering greater community participation will further enhance the impact of ongoing initiatives.

In addition to government initiatives, organizations such as the Association for Prevention and Control of Rabies in India (APCRI) play a pivotal role in advancing research, advocacy, and policy development.

Limitation

As participation in this survey and the responses were voluntary in nature, the results cannot be generalized and shall not be considered as the view of the association.

Conclusion

The awareness among members affiliated with APCRI regarding rabies prophylaxis and prevention of dog rabies is satisfactory but diverse in respect to the elimination of dog-mediated human rabies by 2030 from India. We recommend APCRI do advocacy with the National Center for Disease Control, Govt. of India, implementing the National Rabies Control Program to accelerate rabies elimination activities towards achieving the goal of "elimination of dog-mediated human rabies by 2030 from India.''

Conflict of Interest: None

Source of Funding: None

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process: None

Author's Contribution: AN and MKS- Contributed to the concept and study design; AN and PMK- Contributed to data analysis and interpretation of data; AN, PMK, and MKS- Contributed to the manuscript preparation and manuscript editing.

ISSN: 0973-5038
DOI: https://doi.org/10.24321/0973.5038.202506

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ISSN: 0973-5038

DOI: https://doi.org/10.24321/0973.5038.202506