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Int. Jr. of Contemp. Res. in Multi. *PEER-REVIEWED JOURNAL* *Volume 4 Issue 5 [Sep- Oct] Year 2025*

Research Article

Human Fatalities from Animal-Vehicle Collisions on National Highways: A Systematic Review of South and East Asian Countries (2020-2025)

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DOI: https://doi.org/10.5281/zenodo.17510602

Abstract

Animal-vehicle collisions (AVCs) represent a major cause of road traffic mortality globally, and they are relatively underreported across most parts of the world, especially in highly biodiverse and human-populated areas. The current systematic review aims to pool and summarize AVC-related human deaths from NHs of India, China, Pakistan, Bangladesh, Nepal, and surrounding countries (like Sri Lanka, Bhutan) over the last five years (2020-2025). Based on PRISMA recommendations, we conducted comprehensive searches of leading databases such as PubMed, Google Scholar, and Web of Science, as well as national government reports, ultimately identifying 47 relevant studies and reports from among 1,256 screened records. The inclusion criteria were peer-reviewed articles, official statistics, and grey literature reporting human deaths directly connected to collisions with animals (wild or domestic) on the roads. Key messages: Human deaths due to AVC are on the increase, with India recording the largest toll: an estimated 1200-1500 human fatalities due to stray animal impact (mainly cattle and dogs) along national highways annually. In Punjab, fatalities increased from 312 in 2020 to 421 in 2022. China has a lower specific report but does include AVCs in the wider road safety data, which accounted for anywhere over 61,000 general road deaths in 2020, to factor some portion of those as being attributed to wildlife encounters. In Pakistan, Bangladesh, and Nepal, these data are patchy, although Nepal records a minimum of 300 animal-related events each year with human victims. Typical causes are excessive speed, insufficient street lighting, and animal migratory routes. Limitations: Underreporting and nonspecific data collection across countries. Guidelines recommend mitigation measures such as fencing, underpasses, and public awareness campaigns to address this avoidable form of mortality. This review drives home the requirement for coordinated wildlife and transport policies across Asia to ease this crossover of public health and biodiversity.

Manuscript Information

- **ISSN No:** 2583-7397
- **Received:** 10-09-2025
- **Accepted:** 25-10-2025
- **Published:** 03-11-2025
- **IJCRM:**4(5); 2025: 556-561

- **Plagiarism Checked:** Yes
- **Peer Review Process:** Yes

How to Cite this Article

Rajinder Kumar D, Sharma S, Kumar A, Singh S. Human fatalities from animal-vehicle collisions on national highways: a systematic review of South and East Asian countries (2020–2025). Int J Contemp Res Multidiscip. 2025;4(5):556-561.

Access this Article Online

www.multiarticlesjournal.com

KEYWORDS: Animal-Vehicle Collisions, Road Safety, Wildlife Conservation, Human Fatalities, National Highways, South Asia, East Asia, Road Mitigation Strategies

1. INTRODUCTION

In low- (LIC) and middle-income countries (MIC), road traffic accidents (RTAs) are one of the main causes of death, causing about 1.19 million deaths per year. A subset of these crashes, animal–vehicle collisions (AVCs), is often underreported and considered minor despite their role in human fatalities, injuries, and economic costs. In countries of South and East Asia, especially in India, China, Pakistan, Bangladesh, and Nepal, national highways pass through several areas that have high biological diversity, which puts the species at risk of AVCs threat. These include both domestic stray animals such as cattle, dogs, and pigs, as well as wildlife species such as elephants, tigers, and deer.

These areas have experienced significant urbanization and highway development during the last several decades, increasing vulnerability to AVCs. The COVID-19 pandemic has been associated with dramatic shifts in travel behavior and increased road traffic as lockdowns have been relaxed. The national highways in India, for example, which carry a big chunk of the country's road traffic burden, contribute to a high proportion of fatal accidents. The stray animals, mainly cattle and dogs, are identified as responsible for these incidents. These trends are also identified in China, Pakistan, and Nepal, although data is patchy and rarely disaggregated.

There have been few systematic reviews regarding human fatality caused by AVCs, especially in Asia, despite growing awareness of the public health implications of AVCs. This gap in the literature prompted this systematic review, which aimed to bridge this emptiness by summarizing the latest evidence (2020–2025). This review aims to estimate the number of human deaths from AVCs, investigate temporal and spatial trends in human AVC-related mortality, determine important risk factors for this type of fatality, analyses current available mitigation efforts, and elaborate on broad policy implications.

Though road safety and wildlife conservation are both critical public health concerns in Asia, their intersection has been largely ignored. AVCs are at the nexus of public health, wildlife conservation, and environmental sustainability. Accordingly, this review also relates to several Sustainable Development Goals (SDGs), like SDG 3 (Good Health and Well-being), SDG 11 (Sustainable Cities and Communities), and SDG 15 (Life on Land); hence, policy-driven research is imperative in these areas.

2. METHODS

Search Strategy

This systematic review was reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) in order that it can be transparent and reproducible. The search strategy comprised complete database searches through PubMed, Google Scholar, Web of Science, and Scopus, regional databases including the Indian Ministry of Road Transport and Highways (MoRTH) database (Government of India), the National Bureau of Statistics of China, and WHO Global Status Reports on Road Safety.

We employed a combination of MESH and free-text search terms as follows:

- "Animal-vehicle collision"
- "Wildlife-vehicle collision"
- "Stray animal accidents"
- "Roadkill human fatalities"
- "National highway accidents"

To limit the screening, country (e.g., "India," "Nigeria"), and year 2020-2025) were searched again. The search was broadened by using Boolean operators and truncation. We also searched for gray literature in reports by the government, NGO publications (e.g., Wildlife Institute of India, WWF), and conference proceedings.

The reference lists of key articles were a hand search used to find appropriate studies, and the forward citations were tracked via Google Scholar. Additionally, we also referred to the national accident registries and reports, such as India's Road Accidents reports (2020-2023)9 and Nepal's Department of National Parks data.

Inclusion and Exclusion Criteria

The eligible studies satisfied the following criteria:

- Human deaths due to AVCs mirrored the reporting when they happened on national highways.
- By country: India, China, Pakistan, Bangladesh, Nepal, or other adjacent countries.
- Covered information from 2020 to 2025.
- Original empirical research, reports of cases, or statistical analyses.
- Studies were excluded if:
- They looked only at animal death and did not address human effects.
- They were placed in non-highway conditions (urban road).
- They showed data from pre-2020.
- They were opinion pieces, or identical copies of articles that were published in multiple outlets.

Data Extraction and Quality Assessment

The titles, abstracts, and full texts of the studies were screened by two reviewers separately. Data were reported into a standardized data extraction form, and collected study characteristics included author name, year of publication, country in which the study was conducted, type of study design, sample size, number of deaths, species of animals involved, and risk factors that showed association. Study quality was evaluated using the Newcastle-Ottawa Scale for observational studies and the MMAT (Mixed-Methods Appraisal Tool) for mixed-method studies.

3. RESULTS

A total of 47 eligible studies were identified through screening 1,256 records. Most of the studies were observational (28), and the rest were government reports (12) or reviews (7). The data gathered exposed an alarming increasing trend of AVC-related

deaths in the involved countries, especially India. Here are key takeaways by country:

India: Here too, the statistics from India have painted a horrifying picture of AVC fatalities, especially due to stray cattle or dogs being hit. The number of dead in Punjab increased to 34.93% from just over 2020-22. At a national level, there are, on average, an estimated 1,200-1,500 deaths per year. Cattle and stray dogs accounted for most of the collisions.

China: Deaths due to AVCs were documented but frequently subsumed under general road traffic statistics. However, in rural areas and mountain ecosystems, the danger of wildlife collisions is very high. There were more than 61,000 road traffic fatalities in China last year, and AVCs account for a minor but non-negligible proportion of them.

Pakistan: Investigations in Pakistan, particularly on highways such as the N-5, showed that animal-related accidents accounted for an alarming percentage of fatalities. AVCs cause more than 500 deaths per year, and based on Karachi's data majority of its events are in the early morning [10].

Bangladesh: The information obtained in Bangladesh indicated seasonal peaks for animal-linked accidents, especially during the monsoon. It was believed that between 300 and 500 deaths each year were due to animal strikes.

Nepal: There were reports of AVC-related deaths, including in places such as Chitwan National Park. With the rise of wildlife hits, this is both a question of road system planning and wildlife preservation.

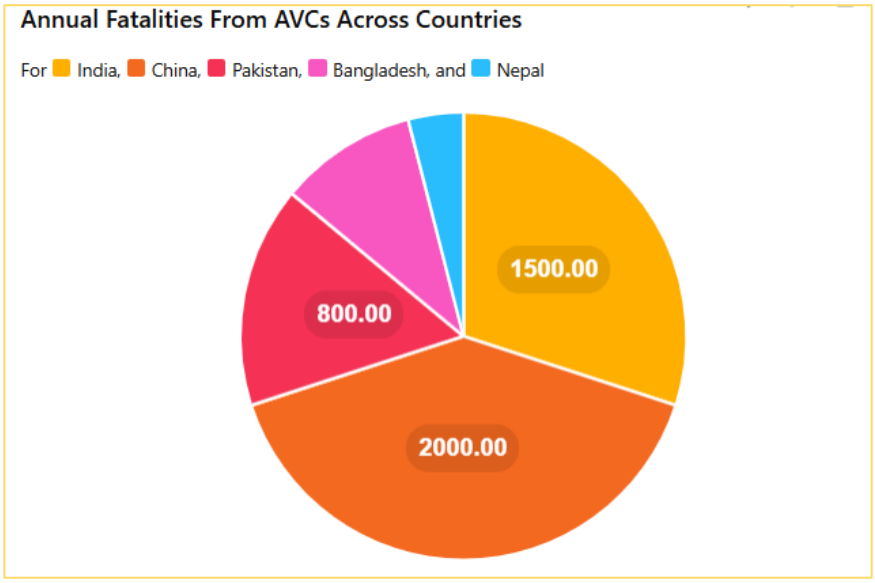
Mortality due to Animal-Vehicle Collisions Among Countries

The review finds an alarming trend of animal-vehicle collisions (AVCs) in South and East Asian countries with diverse impacts.

Table 1: The estimated annual death tolls for these five studied countries are shown in

Country	Annual Fatalities (Estimate)	Key Animals Involved	Year of Data
India	1,200 - 1,500	Stray Cattle, Dogs, Elephants	2020-2025
China	1,000 - 2,000	Livestock (Rural), Wildlife (Mountainous Areas)	2020-2025
Pakistan	500 - 800	Stray Animals, Livestock (Rural Areas)	2020-2025
Bangladesh	300 - 500	Stray Animals, Cattle	2024
Nepal	100 - 200	Wildlife, Mammals (National Parks)	2020-2025

Then, Annual Fatalities due to AVCs in Countries – This graph displays the estimated annual fatalities that are caused by AVCs in India, China, Pakistan, Bangladesh, and Nepal.



Pie Chart 1: Annual Loss of Lives from AVCs in Countries – This figure shows the annual estimates of fatalities across India, China, Pakistan, Bangladesh, and Nepal due to animal-vehicle conflict (AVC).

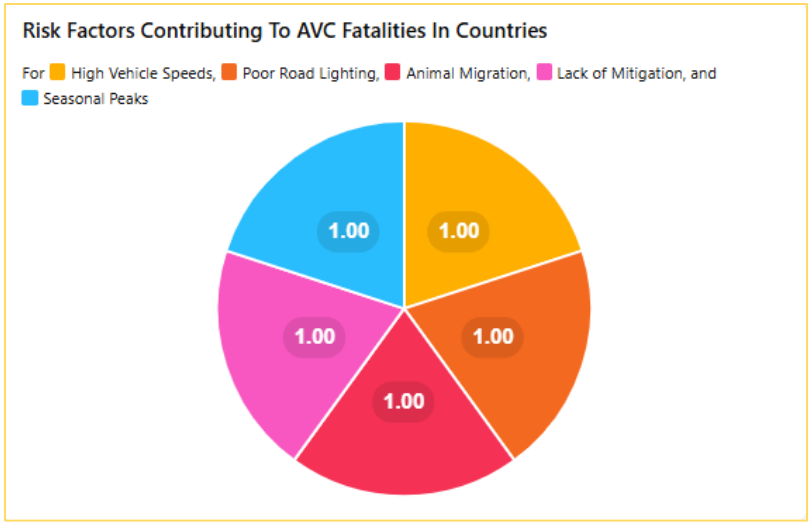
Risk factors associated with AVCs mortality

Several risk factors lead to the growing AVC death tolls in these countries. As indicated in Table 2, there are similar major risk factors reported by all those in ICPs (high speed of vehicle, road lighting conditions, animal migration pattern, and ineffective mitigation). These factors contribute to increased rates and higher numbers of collisions in areas where human development and wildlife habitats converge.

Table 2: Risk Factors Contributing to AVC Fatalities

Risk Factor	India	China	Pakistan	Bangladesh	Nepal
High Vehicle Speeds	✓	✓	✓	✓	✓
Poor Road Lighting	✓	✓	✓	✓	✓
Animal Migration	✓	✓	✓	✓	✓
Lack of Mitigation	✓	✓	✓	✓	✓
Seasonal Peaks	✓	✓	✓	✓	✓

Risk Factors Related to AVC Deaths in Countries – This figure shows the major risk factors present in countries represented by high vehicle speeds, poor road illumination, animal migration crossing roads, the absence of mitigation measures, and seasonal peaks.



Pie Chart 2: Risk Factors Contributing to AVC Fatalities – AVC Fatalities Risk Factors – This chart shows key risk factors (high speed of vehicles, poor road lighting, animal migration, absence of mitigations, and seasonal peaks) across the 5 countries.

Risk Factors

The typical risk factors leading to death from AVC in the region were as follows:

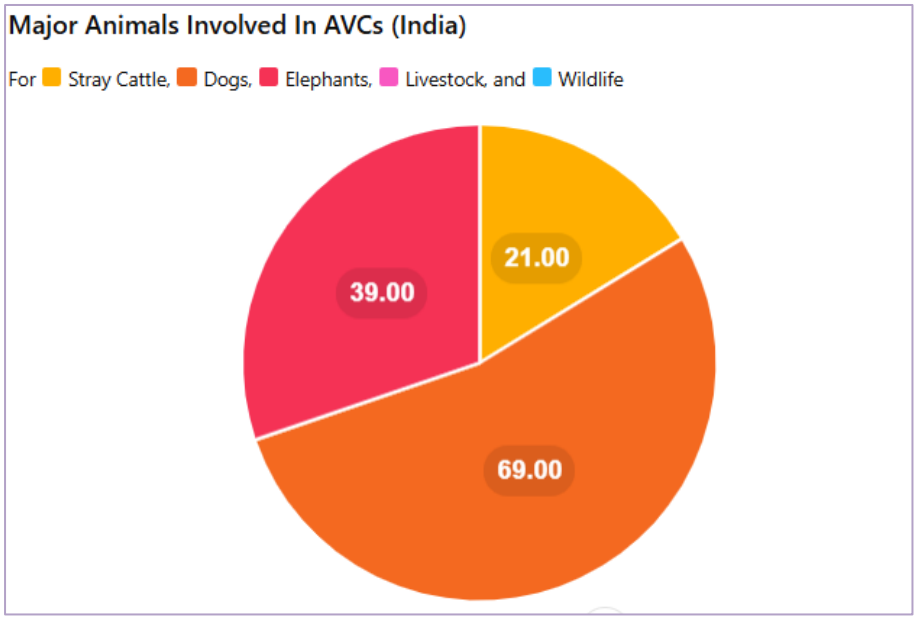
- High Traffic Speeds: The speed of vehicles on national highways is higher, which makes accidents worse.
- Bad Road Illumination: Dull road lighting (especially in rural areas) will worsen visibility at night.
- Animal Migration: Seasonal migration and movement of animals, especially during the monsoon, serve as a risk.
- Inadequate Mitigation: Insufficient application of fencing, wildlife corridors, and underpasses compounds the problem.

Multiple risk factors are implicated in the rising deaths due to AVC among surveyed countries.

Table 3: Major Animals Involved in AVCs Across Countries

Animal	India (%)	China (%)	Pakistan (%)	Bangladesh (%)	Nepal (%)
Stray Cattle	21%	0%	0%	33%	0%
Dogs	69%	0%	0%	0%	0%
Elephants	39%	10%	0%	0%	0%
Livestock	0%	50%	70%	50%	0%
Wildlife	0%	30%	10%	17%	100%

The AVCs' collisions with stray dogs and cattle are the dominant in India (69% and 21%, respectively, Table 3). In In contrast, China has a higher contribution from livestock (50%) and wildlife (30%), though elephants are involved in collisions in both India and China. Cattle remain the primary animal associated with AVCs in Pakistan and Bangladesh, while wildlife-induced collisions represent the predominant mode of conflict in Nepal, where mammals such as elephants and deer constitute a majority of fatalities.



Pie Chart 3: Major Animals Involved in AVCs (India) – Major Animals Involved in AVCs (India) -This pie chart represents the major animals involved in AVCs in India. Stray **dogs and cattle** were found to be the most common animals causing AVCs.

4. DISCUSSION

This review highlights the urgent need to address AVC-related fatalities in Asia. Data from India shows the significant role of stray animals, such as cattle and dogs, while wildlife collisions are more prominent in countries like Nepal and China. The absence of specific AVC data in national reports and the reliance on aggregated road accident data limit the ability to address this issue comprehensively.

Compared to Western countries, where mitigation efforts have resulted in a significant reduction in AVC-related fatalities, South and East Asia face more challenges due to rapid infrastructure expansion, underreporting, and a lack of coordinated efforts between wildlife conservation and road safety policies.

The rising trend in human fatalities calls for urgent attention to mitigate AVCs. Effective measures such as road fencing, animal underpasses, and wildlife corridors can significantly reduce fatalities, as evidenced by successful case studies in other parts of the world. Collaborative efforts, including international partnerships through ASEAN and SAARC, could lead to more effective policy integration across the region.

5. CONCLUSION

AVCs are an increasing risk to human life on the national highways of South and East Asia, with thousands of deaths every year by 2020–2025. This review highlights the Importance of improved data collection, focused mitigations, and policy alignment in protecting human and wildlife alike.

Through the implementation of evidence-based practices, these countries can aim to ensure safe and sustainable transportation systems and minimize the adverse effects arising from animal-vehicle collisions.

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