One health intervention for the control and elimination of scrub typhus, anthrax, and brucellosis in Southeast Asia: a systematic review

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Summary

The "One Health" (OH) approach, introduced in 2004, integrates human, animal, and environmental health to address emerging and re-emerging diseases. This study evaluates OH strategies used by southeast Asian countries for brucellosis, anthrax, and scrub typhus. We systematically searched Medline, EMBASE, ProQuest, and EBSCO-CINHL up to May 11, 2023, screened 711 articles, and included ten studies (five on brucellosis, four on anthrax, and two on scrub typhus). Key strategies identified included intersectoral collaboration, vaccination initiatives, and comprehensive surveillance systems for both humans and animals. Additional efforts were noted in improving health infrastructure and implementing preventive measures. The review underscores that although some progress has been made, a more integrated OH approach is crucial for effective prevention and management of zoonotic diseases in southeast Asia, highlighting the need for enhanced collaboration and coordinated efforts across sectors.

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Introduction

An emerging or a re-emerging disease is defined as a disease that (i) has appeared recently or evolved in a population, or (ii) has existed previously and has shown notable changes in incidence, geographic distribution, range of vectors and host species.[1] According to the WHO, 60% of the known infectious diseases and around 75% of emerging infectious diseases (EIDs) are of zoonotic origin.[2] The WHO South-East Asian (SEA) region, comprising of 11 member states and home of over a quarter of world's population[3] is considered as a hotspot for several emerging and re-emerging zoonotic diseases, including Nipah virus, arbovirus diseases, Ebola, influenza of zoonotic origins, plague, the recent COVID-19, etc. The region is highly susceptible to these emerging and re-emerging zoonotic diseases due to a combination of factors such as population growth, high population density, rapid urbanisation, and migration. Collectively these factors foster conditions that promote disease spread.[4,5] The region's reliance on tourism and strong connectivity further increases transmission risks not only within the region, but to other parts of Asia and the rest of the globe. Environmental stress from deforestation, driven by rapidly growing palm oil production and agricultural expansion, heightens human-animal interactions, fostering zoonotic diseases. Climate change and altered weather patterns are boosting vector populations and pathogen evolution that enhances the transmission of vector-borne infections. Such determinants are further influenced by political, cultural, and socioeconomical diversities.[6] Moreover, increased wildlife consumption and trade exacerbate these risks, making it even more challenging to track and control these diseases and highlights the urgent need for proactive public health measures. Climatic extremes, such as floods and droughts, exacerbated by climate change and pollution, have significantly contributed to the spread of pandemics and infectious diseases. Pollution-driven desertification, increased reliance on bushmeat, and poor sanitation in relief camps further heighten zoonotic transmission risks, highlighting the critical link between environmental degradation and public health crises.[7]

The current disease outbreaks and pandemics have revealed the gaps, as well as unveiled the epidemiological complexity and connexion among humans, animals,

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plants, and the environment, emphasising the need for a collaborative and worldwide framework providing integrated solutions with a systemic approach, termed as "One Health" (OH). It is an integrated, unifying approach that aims to provide a more comprehensive assessment of health challenges, thereby facilitating the development of appropriate prevention and management strategies and inclusive evidence-based policies to develop sustainable health systems and ecosystems.[8] To mitigate the challenges of the traditional approach to zoonoses, that primarily focuses on human and animal health separately, the OH approach emphasizes on addressing interactions at the human-animal-environment interface.

Understanding how the OH concept approaches to address the issues related to major zoonotic diseases by improving disease surveillance and prevent transmission is crucial. It unravels the points of interactions among humans, animals, and the environment through a syndemic lens, aiding to effective prevention and management strategies. Several studies have demonstrated the effectiveness of the OH approach in addressing diseases such as scrub typhus, brucellosis, and anthrax, which are prioritised on the region's One Health zoonotic disease list.[9–13] This approach encompasses inter-sectoral collaboration, human and animal vaccination, establishment of surveillance system, upliftment of human and animal health infrastructure, assessment of knowledge and perception and development of guidelines as a tool for disease management and prevention.[14–18] Although, individual studies have explored various aspects of these diseases, there is still a knowledge gap in understanding them in detail and coherently through the lens of the OH approach. This systematic review aims to provide an overview of diverse One Health approaches employed against three significant zoonotic diseases: brucellosis, anthrax, and scrub typhus. These diseases are among the top 10 prioritised One Health zoonotic diseases in many countries of the SEA region.[19–21] Anthrax presents a significant public health burden, often exacerbated by inadequate livestock vaccination coverage and close human-animal interactions. The frequent regional reports of the disease underscore a critical gap in understanding, emphasising the urgent need for targeted research and effective intervention strategies to mitigate its impact.[22,23] Scrub typhus is a major cause of non-malarial fever in south and southeast Asia, with about one million cases and one billion people at risk annually, yet it remains underrecognised due to challenges in diagnosis and differentiation from other febrile illnesses, leading to uncertainty about its burden even in established regions.[24,25] Additionally, focusing on brucellosis is crucial due to its endemic nature in southeast Asia and its significant economic and health impacts.[10,26]

By examining various strategies and interventions, this review seeks to highlight effective practices, challenges, and opportunities for enhancing OH initiatives in addressing these critical public health concerns. This underscores the importance of OH in promoting improved intervention strategies across the region, ultimately contributing to better health outcomes for humans, animals, and the environment.

Methods

Concept of this review

The research question was framed according to the population, concept, and context (PCC) strategy. In this review, we focused on various steps taken in SEA countries based on the OH approach for the control and elimination of anthrax, brucellosis, and scrub typhus and examined the implemented strategies or activities.

Population

South-East Asian region was defined using two criteria: (i) in accordance with the WHO classification, encompassing 11 nations (Bangladesh, Bhutan, Democratic People's Republic of Korea, India, Indonesia, Maldives, Myanmar, Nepal, Sri Lanka, Thailand, Timor-Leste); and (ii) all the 20 countries from the SEA region, included in the MeSH term "Asia, Southeastern" [MeSH]. It ensured a complete representation of the SEA context by incorporating studies.

Process of study selection

The detailed method of this review was registered in PROSPERO (Regd. No: CRD42023471312). After conducting the literature search on May 11, 2023, we identified 711 articles. Next, 14 duplicate articles were detected in two-steps via EndNote (v20) and online screening software, Rayyan.[27] Primary screening was conducted independently by two reviewers (SG and SK), from which 24 aligned with this review's objective. These 24 articles underwent full text examination using MAXQDA (Analytics Pro, 2022) and 10 of them were found eligible (Fig. 1). Additionally, the reference lists of identified reports and articles were hand-searched for additional information.

Assessment of methodological quality

We utilised specific Joanna Briggs Institute (JBI) checklists tailored for each study type: cross-sectional studies, qualitative studies and expert opinions.[28] Any disagreement that arose between the reviewers were resolved through discussion. The JBI Critical Appraisal checklists for analytical cross-sectional studies, qualitative studies and textual evidence have been attached in the Supplementary Table S1.

Data charting process

According to the objectives of the study and the PCC framework, broad themes and subthemes were created in excel, those were transferred in MAXQDA. While

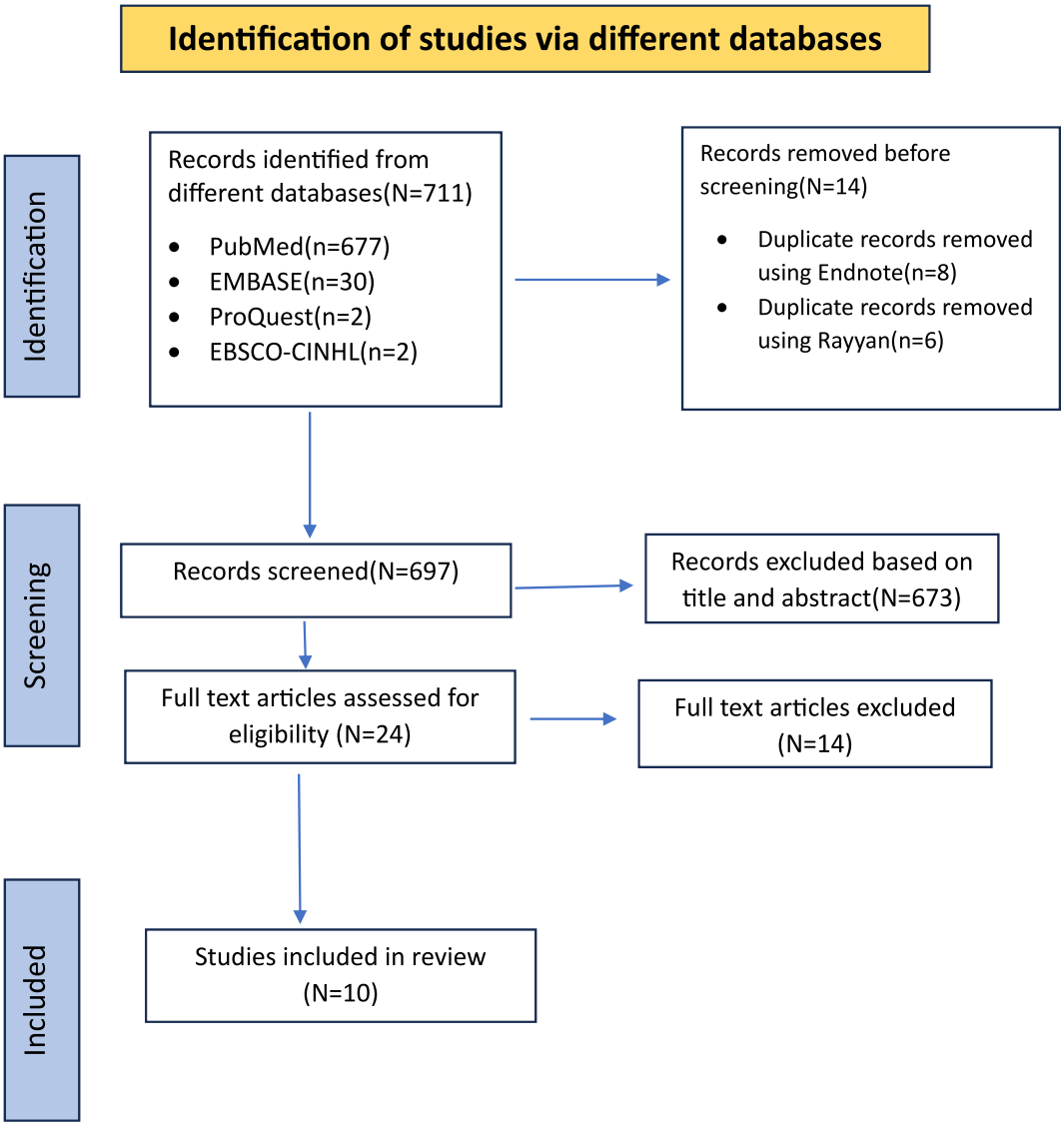

Fig. 1: **Flow diagram of study selection process.**

going through the full texts, the data were extracted based on them. If any new category or sub-category was found, it was further incorporated to the coding tree.

Synthesis of results

Two reviewers summarised the results, and disagreement was resolved ensuring consensus. Subsequently, the extracted data were organised into distinct categories serving the primary purpose. After conducting a thematic content analysis, the resultant themes were derived and summarised individually. The themes covered health-seeking behaviour of the participants, international collaboration within the OH framework, national safety initiatives, assessment of knowledge and perception, government treatment guidelines, and measures for surveillance, screening, and diagnosis. Meta-analysis was not conducted as the included studies were descriptive in nature.

Results

Among the ten studies, those served the purpose of this systematic review, seven were from India, one each from Nepal and Cambodia and one described the interventions, not limited to one national border, rather two neighbouring countries, Laos and Cambodia. There were seven, five and two studies providing insights on the inhibition of brucellosis, anthrax and scrub typhus transmission in the community, respectively.

We classified the OH interventions into six broad categories. The most implemented were inter-sectoral collaboration and disease surveillance for both humans and animals, each mentioned in five studies. Three studies focused on assessing community and healthcare workers' knowledge of zoonotic disease transmission and prevention, followed by practices to control these diseases. Less attention was given to improving infrastructure, developing locally appropriate guidelines, addressing health-seeking behaviour, and fostering national and international collaboration to tackle zoonoses at the human-animal interface, with only one study covering each of these aspects.

National interventions

Inter-sectoral collaborations

Through the OH concept, the interconnectedness between human and animal health is extensively noted at national level. The Indian Council of Medical Research (ICMR) and the Indian Council of Agricultural Research (ICAR) jointly established the "Centre for One Health" at Nagpur (India) in 2019 as a satellite centre under the National Institute of Virology.[29] However, inadequate collaboration between public health, animal health, and agricultural departments at the sub-district level poses a significant challenge. Studies have noted this issue as a barrier to effective intersectoral action *(11)*. To address anthrax transmission at the village level, the *Gaon Kalyan Samiti* (village representatives) could be used to overcome this challenge.[30,31] In Haryana, experts from the health, animal husbandry, and wildlife departments worked together to prioritise zoonotic diseases. They used the Health Zoonotic Disease Prioritization tool and the Analytical Hierarchy Process to develop targeted disease control strategies.[32]

Preventive measures

The preventive measures for brucellosis included milk pasteurisation, the test-and-segregation approach for brucellosis-positive animals, and assessing the suitability of the test-and-cull approach.[30] Vaccination of female calves (aged <1 years) against Brucella strain-19 was also highlighted. Furthermore, biannual vaccination of the healthy livestock within a vicinity of five kilometre of anthrax outbreak site (ring vaccination) was also reported. Along with it, an integrated reporting system and vaccine procurement including cold chain storage and adding a mobile unit for attending house calls were highlighted.[31]

Social security

The National Livestock Mission emphasises the need for enhanced protection of non-vaccinated animals in India. As a compensatory measure, provision of a livestock insurance covered financial loss; barring consumption of dead cattle meat.[31]

Disease surveillance

Human survey

Patients from Bangladesh, Nepal, Bhutan, and India, suffering from acute febrile illnesses, consistently diagnosed for scrub typhus.[16] Serological surveys conducted among different eastern and north-eastern states of India, where the seroprevalence of scrub typhus was estimated as low as 21.3% in Gorakhpur in the state of Uttar Pradesh, to a maximum of 62.7% in the state of Assam.[33] Prevalence of brucella infection varied between 29.6% and 47.6% from the states of Haryana and Punjab, respectively.[32]

Animal survey

Risk mapping was assessed for Cambodian goats through estimating prevalence of zoonotic and high-impact diseases employing OH framework.[34] In Laos and Cambodia, strategic bi-monthly sampling using ELISA kits, combined with the Rose Bengal Test was implemented to estimate the prevalence among the cattle.[35] Inclusive analysis of incidence, prevalence, case reports, and seroprevalence data from Haryana and neighbouring regions of India provides insights into spread of zoonoses in north Indian region.[36]

A compiled line listing for vaccination of the cattle for foot and mouth disease, and brucellosis is conducted by the livestock inspectors (LIs) in India, based on which an annual indent request is prepared by the respective veterinary officer.[31] Additionally, primary animal health workers conduct household visits, and private veterinarians—who serve as the primary healthcare providers in 87.4% of cases—play a crucial role in delivering animal care services.[16]

Assessment of knowledge and practices

Health literacy is intimately associated with primordial prevention, health-seeking behaviour and occupational health. A community-based qualitative assessment from India indicated limited dead animal burial with prior notification to the LIs.[11] To extend this community evaluation, Yasobant and colleagues introduced a zoonotic awareness score, calculated through a normalized scoring system.[16] Assessment for veterinary students revealed excellent level of knowledge on occupational health (94.6%), its importance in interdisciplinary sectors. They expressed high preference towards its institutionalisation (95.2%) as well.[36]

International collaborations

In 2019, with support from the Mahidol Oxford Tropical Medicine Research Unit (MORU), an abattoir-based surveillance network was instituted in two neighbouring countries, Laos and Cambodia. This initiative aimed to strengthen veterinary surveillance capacity through capacity building of field officers and laboratory personnels. The network focused on estimating seroprevalence of selected zoonoses, including brucellosis. For

communication purpose, popular social media platforms (WhatsApp and Telegram) were utilised.[35]

Health seeking behaviour

Perception to healthy state and pursuing a healthier life is a behavioural factor for an individual, as well as to a community. In Indian scenario, the primary contact point in public health system is often the community health workers, and for the cattle and other animals, LIs and veterinarians are equally responsible. Evidently, both groups demonstrate competence and have cultural acceptance, ensuring their ability to provide comprehensive services.[16]

Guideline

Adhering to the recommendations from national and state health ministry, area-specific guidelines were documented to diagnose scrub typhus from the eastern Indian state West Bengal, and the guidelines have been adopted by hospitals since 2004.[33] Another manual was developed for sample collection from the abattoir-based animals, located in Laos and Cambodia (Table 1).[34]

Discussion

The OH concept, tracing its origins to the 1800s, recognises the intricate linkages between human and animal health.[37] During the 19th century the term "zoonoses" (*zoon*: animals, and *noson*: disease) was coined by Rudolf Virchow,[38] but the more appropriate term to address animal to human transmission is "anthropozoonosis".[39] Initially observed in the 19th century, it gained formal recognition by introducing the term "One Health" at a meeting of the Wildlife Conservation Society in 2004 after the Severe Acute Respiratory Syndrome (SARS) and the avian influenza H5N1 outbreak in 2003.[40] This approach is an integrated effort across human, animal, and environmental health sectors to confront infectious zoonotic diseases at different level of prevention, by limiting their source and transmission, and management. Despite practiced separately, increasing awareness, propelled by pivotal figures and events, has elevated the OH concept to a central role in both public health and veterinary communities.

Surveillance of human and cattle plays a pivotal role in monitoring the prevalence and distribution of anthrax, brucellosis, and scrub typhus, in both human and animal

Level of interventions	Activities	Outcome
Interventions at the national level	1. **Intersectoral collaboration:** Collaborative research activities from human and animal health research institutes. 2. **Preventive measure:** a. Milk pasteurisation, b. Implementing test-and-segregation, test-and-cull method, c. Vaccination drive for the cattle 3. **Social security:** Insurance coverage and financial compensation against death of the cattle	• Formation of "Centre for One Health" • Vaccination against brucellosis of the female calves aged <1 year • Ring vaccination for anthrax outbreak • Barring consumption of dead cattle meat.
Surveillance of the zoonotic diseases among human and animals	1. **Surveillance among human:** Serological surveillance for acute febrile diseases and brucella infection among human population. 2. **Surveillance among animals:** a. Estimating seroprevalence of the zoonotic diseases among cattle and goats. b. Household visit and line-listing for vaccination (brucellosis) of the eligible cattle.	• Sero-positivity for scrub typhus in India: Varied between 21.3% and 62.7%. • Sero-positivity for Brucellosis in India: Varied between 29.6% and 47.6%.
Assessment of knowledge and practices	1. Development of an awareness scoring system to assess community's knowledge on zoonotic diseases. 2. Assessing veterinary students' knowledge on occupational health	
International collaboration	• Universities and foreign funders joined hands to establish an abattoir-based surveillance network in two neighbouring countries, Laos and Cambodia.	Establishing an abattoir-based surveillance network in Laos and Cambodia.
Health seeking behaviour	• Livestock inspectors and veterinarians were the primary point of contact in case of animal health emergency. Positive feedback was recorded in terms of providing comprehensive services and socio-cultural acceptance.	
Guidelines	1. Building up manuals for sample collection, training for the laboratory and the ground staff 2. Preparing area-specific guideline, adhering to existing national and state level recommendations.	• Developing an area-specific guideline in the State of West Bengal, India. • Developing manuals for capacity building of the laboratory and field staff in Laos and Cambodia.

Table 1: **Summary of the study findings.**

populations.[13,41–43] A robust OH surveillance system periodically collects and analyses information on disease epidemiology, identifies high-risk areas, ensures early detection of outbreaks and identify their transmission pathways. Based on the surveillance reports, prevention and control strategies are developed or modified at various level. A task force is often established for inter-disciplinary coordination, ensuring a comprehensive approach to disease management. Furthermore, capacity-building of healthcare professionals, veterinarians, local administrative bodies and environmental scientists is another component of such a strategy. Overall, a national initiative provides a framework for integrating efforts across sectors to safeguard public health and prevent the spread of infectious diseases.

OH activities, targeting the different prevention levels of the zoonotic diseases, help forming proactive strategies to combat disease spread. Milk pasteurisation stands out as a fundamental preventive measure, particularly for diseases, like brucellosis, transmitted through contaminated dairy products.[44] Additionally, the implementation of a "test and segregation" or "test-and-cull" approach for brucellosis infected animals can help prevent the spread of the disease within livestock populations.[45] Though, contradictory opinions like, adequacy of common milk boiling practice instead of pasteurisation; questionable practicality and availability of segregation spaces in test-and-segregation approach for brucellosis-positive animals; and cultural and religious non-acceptance for the test-and-cull approach have been documented causing hindrance to optimal outcome.[31]

The effectiveness of vaccination programmes for zoonotic diseases is underscored, since minimal number of diseases are preventable through vaccines, and these are restricted for the cattle only.[46] However, challenges involving the cost and non-availability of vaccines, inaccessible remote areas persist in several Asian countries,[41] highlighting the need for a sustainable strategy for logistic management. Also, tackling disease transmission from free-grazing animals, sharing communal water ponds, overcrowded shelters, unrestricted visits in smallholder backyard farms is another area that is to be approached recognising the actual root-cause.[30]

Be it for human health or animal health, a universal document describes the consistent method of prevention to management of a disease, generally known as an operational guideline or a standard operating procedure.[47] The existing Operational Guidelines for Livestock Health & Disease Control Scheme[48] provides insights on reduced risk to animal and human health along with overall increase in livestock productivity by reducing disease burden. Another document of Food and Agriculture Organization of the United Nation on Guidelines for livestock vaccination campaigns promotes the importance of vaccination, disease prevention, and control.[14] Apart from spreading health literacy, and awareness to preventive measures guidelines also take care of the handling and treatment procedure for the health personnel.[15,33,49] However, since zoonotic diseases emerge mostly as outbreaks in certain limited geographic areas, they do not receive enough weight in the mainstream human health facilities.[50]

Different behavioural factors, such as food, handling sick or dead animal and agricultural activities act as barriers to acknowledge the elements of health hazards.[51] Inadequate preparedness while handling or assisting veterinary personnel during check-up poses a critical risk with potential repercussions. Moreover, consuming milk or milk products directly, eating dead animals or blood is quite common among some communities.[52–54] On the other hand, veterinarians and laboratory technicians can get infected from inadvertent inoculation of animal vaccines or animal specimens if not treated following protocol.[55] In this regard, unavailability and access to appropriate gears or treatment modalities[56] increases the vulnerability to infections originating from animals, accentuating the urgent need for comprehensive readiness strategies to mitigate transmission.

To prevent the transmission of any zoonotic diseases, coordination between human and animal health sector is important, since these diseases can impact global health security. The OH approach, recognising the interconnectedness of human, animal, and environmental health, serves as a framework for such collaboration.[57] Significant activities for such collaboration include two-way communication and sharing surveillance data, diagnostic tools, and best practices for controlling the spread of the disease among humans and animals.[58] These activities promptly help to draw a clear picture of the endemic situation, early detection of outbreaks, prompt response measures, and the implementation of vaccination programs in high-risk areas.[59] Since brucellosis, leptospirosis, and anthrax have potential for cross-border contamination, international efforts on improving livestock management practices, and promoting public awareness about the disease's transmission routes and prevention. Furthermore, vector control through insecticide spraying and positive environmental alteration exclusively for scrub typhus, access to treatment in endemic areas, capacity building, joint research initiatives and exchange of research information on epidemiological trends can facilitate more effective control measures.

Environment being a foundational component of the OH framework, addressing climate change and its cascading effects on disease ecology is quite important. Climate change includes altered rainfall pattern, variation in temperature, natural calamities like flood, cyclone etc. Some studies provided evidence on impact of climate change on reservoir host (hantavirus) and mutation of SARS-CoV-2.[38] Fluctuating temperature

promoting broadening habitat availability[60] altered geographical distribution of the host insects, and deteriorating general health[61] are some of the effects of altered weather. Global warming favours increase in vector-borne diseases, especially in the low- and middle-income countries.[62] Future OH approaches should consider estimating effect of climate change on changing patterns, emergence and spread of agents causing zoonotic diseases. Fostering collaboration between climate experts, ecologists, and OH stakeholders will enable comprehensive strategies that can effectively manage and prevent the growing health threats posed by a changing climate.

Climate change enhances vector survival, reproduction, and abundance, impacting the spread of infections. For example, the mosquito *Aedes aegypti* thrives at 28–32 °C,[63] and El Niño events are linked to dengue outbreaks in southeast Asia.[64,65] Also, a 1 °C rise in temperature has been reported to increase scrub typhus cases by 3.8% in southern China.[66]

Knowledge and perception regarding community's health-seeking behaviour towards zoonotic condition and their transmission, individual activities and hygiene reveals crucial insights into challenges and opportunities to overall well-being and prevention of disease transmission from its zoonotic sources to humans. While shifted the focus to budding veterinary health professionals, occupational health hazards were highlighted as a risk factor of diseases transmission.[36] Similarly, importance of health literacy in public health interventions was also pointed out in another study.[16] The authors also demonstrated that a significant proportion of households were visited by health workers, primarily female Accredited Social Health Activists (ASHAs) and *Anganwadi* workers, highlighting the vital role of community health workers in disseminating information about zoonotic diseases.[16]

Identifying the symptoms and seeking prompt medical attention can be beneficial for the community. However, to confront the zoonotic diseases like anthrax, brucellosis or leptospirosis, which are yet to receive enough attention as other mainstream diseases, having idea of disease epidemiology is not enough but also the requirement to seek timely medical assistance. The OH approach, while primarily focused on the prevention and control of highly pathogenic, emerging, re-emerging, and high-impact diseases affecting humans and animals, also has a broader vision for promoting sustainable and eco-friendly development. To support OH approach, southeast Asian countries have diagnostic laboratories, allowing specific medical or veterinary labs to act as centers of excellence for zoonotic diseases. Additionally, the National Center for Disease Control and WHO have developed a joint training curriculum for medical and veterinary professionals, emphasising zoonoses prevention, control, and intersectoral collaboration.[67] The ICMR and ICAR are also promoting multidisciplinary research in zoonoses and food safety through joint research funding and the establishment of nodal institutions to create a collaborative network. The Public Health Foundation of India (PHFI) is actively supporting the OH concept through research and training initiatives.[65]

Additionally, the cultural practices of consuming dead animal or blood are limited to some communities, living in remote areas.[17,18] Other factors those make the situation more critical are inaccessibility of health or veterinary services[31] poor understanding and practices of risk factors or unwillingness to receive modern medicine.[68,69] Reports show unfamiliarity with anthrax and its transmission route leading to a lack of preventative measures from an anthrax endemic region in India.[31] In a similar context, authors criticised knowledge, cultural beliefs, access to healthcare, and stigma as barriers to health-seeking behaviour towards brucellosis.[70] These barriers can only be tackled with collaborative efforts involving public health officials, veterinarians, and community outreach programs implementing area addressing the stigma and inappropriate customs, mainstreaming contemporary treatment modalities, and making them accessible to all.[71] Although regional bodies and disease surveillance programs exist, southeast Asian countries struggle with public health policy implementation due to limited resources, political instability, and inconsistent coordination. Differing health systems and national priorities further undermine unified regional health strategies.[72]

Considering the strengths of the current study, we did not limit our search to any particular calendar date or year (although the concept of OH is quite recent). We were open to all relevant articles published in English language. Furthermore, we increased inclusivity by adopting different definitions for selecting the countries and through comprehensive examination without excluding any specific study type or their references, that increased chance of providing robust information from this region. However, the current study has few limitations. The review's reliance on relatively small number of included studies may limit to express the complete scenario of the findings. Furthermore, selection bias would have influenced this study because we only considered studies published in English language. Inability to include studies in other than the English language, might have led to miss some relevant information on this context. Moreover, heterogeneity was observed among the study designs and their methods, that could hamper generalisability of the findings.

Conclusion

Since the last century, several zoonotic diseases have endured, caused an outbreak, subsided or gradually settled as an endemic. Several local or national interventions, including disease surveillance, vaccination

Search strategy and selection criteria

The overall methodology of this systematic review was registered in PROSPERO (Regd. No: CRD42023471312). The literature search was divided into three primary 'concepts' or 'themes', viz-a-viz, "One Health" interventions, "South-East Asia" and the target zoonotic diseases: "Anthrax", "Brucellosis" and "Scrub typhus". We prepared separate search strategies for different databases (MQedline, EMBASE, ProQuest and EBSCO-CINHL) using MeSH terms (Medline) or Emtree (EMBASE) and keywords for each component (a detailed search strategy and selection criteria can be accessed in Supplementary information S1). The references of identified studies were searched again to find other relevant studies.

Context

The context was not limited to urban or rural settings or bound to any timeframe. However, a specific focus was maintained on countries situated within the SEA region. We also embraced a diverse range of study types.

Exclusion criteria

- Studies employing the OH approach but not addressing brucellosis, scrub typhus, or anthrax were excluded from our analysis.
- Studies conducted in countries located outside the SEA region.
- Studies that discussed the elimination of disease without mentioning the OH approach.
- Studies published in languages other than English.
- Papers with no appropriate original data were excluded to avoid duplication of data.

for human and cattle, and intersectoral collaboration were opted to control (prevent emergence and transmission) and manage zoonotic diseases like brucellosis, anthrax and scrub typhus in majority of the countries, but hardly a cross-border activity was noted from the southeast Asian region. Most importantly, none of the studies enlightens the environmental changes and its effect on health of the living world. Countries with varying socio-cultural strata should plan for area-specific interventions, with a common guideline covering every aspect (human- and animal-health, plus environmental alterations) of the OH holistic approach. Moreover, governments and international organisations must encourage cross-border research and data sharing, as well as collaborative interventions in border areas to effectively manage and control zoonotic diseases. Simultaneously, behavioural modification and spreading health literacy to the target population and capacity building of the health workforce could be another key component to the goal of disease-free community.

Future studies should concentrate towards estimating national and regional prevalence of zoonotic diseases, or pooled prevalence from meta-analysis. Analysing geo-spatial data and estimating their significance on EIDs is another aspect of viewing to this problem. Furthermore, since this systematic review focused on several interventions already taken by the southeast Asian countries, identifying the strength, gaps and opportunities of such activities in regions where they were not implemented need to be explored, like a recommendation or criticising the existing policies and required modifications. Beyond that, development of a common standard operating procedure (SOP) or a guideline must be prioritised, that can be used for local or national emergencies as a template or may be applicable to other pandemic regions as well. Effectiveness of the OH activities, summarised in this study, are to be estimated in different regions. The estimation of the pooled effectiveness of OH activities can lead to a ranking system to identify the best method for a particular situation.

Contributors

SP, DB and SG conceptualised the study. SG, RP, SS and SK designed the protocol and data extraction process. SG, RP, SS and SK were involved in primary and secondary screening, investigation, and were responsible for data analysis. HRC and MP conducted literature search and data collection from the references of included studies. SG, RP, SS, SK, HRC and MP drafted the paper, with critical inputs from AV and DP. SP and DB, the corresponding authors, were involved in supervision, project administration, reviewing and editing, and directly accessed and verified the underlying data reported in the manuscript. All authors had full access to all the data in the study, critically revised the manuscript, accept responsibility to submit for publication, and gave approval for the final version to be published.

Declaration of interests

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. All the authors declare that they have no competing interests.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.lansea.2024.100503.

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