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Policies to prevent the spillover of zoonotic diseases: protocol for a systematic scoping review of evaluative evidence

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Abstract

Introduction

The increasing incidence of disease transmission from vertebrate animals to humans (zoonotic spillover events) has been attributed to ecological, behavioural and socioeconomic change. As these events sometimes involve diseases with epidemic or pandemic potential, they pose a serious threat to population health. Public policies may play a key role in preventing these events. The aim of this review is to identify evaluations of public policies that target the determinants of zoonotic spillover, examining approaches taken to evaluation, choice of outcomes measures and evidence of effectiveness. Our approach to identifying and analysing this literature will be informed by a population health perspective and a One Health lens, acknowledging the inter-connectedness of human, animal and environmental health.

Methods and analysis

A systematic scoping review methodology will be used. To identify articles, we will search Medline, SCOPUS, Web of Science and Global Health using search terms combining public policy, prevention, zoonoses and spillover events. We will screen titles and abstracts and extract data according to published guidelines for scoping reviews. All evaluations of public policies aiming to prevent zoonotic spillover events will be eligible for inclusion. We will summarise key data from each study, mapping policies along the disease transmission pathway and outlining the range of policies, approaches to evaluation and outcome measures. Review findings will provide a useful reference for researchers and practitioners, outlining the state of the evaluative evidence around policies to prevent zoonotic spillover.

Ethics and dissemination

Formal ethical approval is not required, as the study does not involve primary data collection. The findings of this study will be disseminated through a peer-reviewed publication, presentations, and summaries for key stakeholders.

Strengths and limitations

- This scoping review protocol outlines the first piece of work to systematically identify and review evaluations of public policies designed to prevent the spillover of zoonotic diseases, and will be undertaken in line with published guidelines for best practice in scoping reviews.
- The review will be informed by a One Health lens, encompassing distal determinants and risk factors for spillover events and acknowledging the interconnectedness of human, animal and environmental health.

- Due to the complex drivers of spillover events, some potentially relevant policy evaluations may not be identified in searches where their outcome measures are too far removed from the spillover of zoonotic diseases.

Introduction

The increasing incidence of zoonotic emerging infectious diseases (EIDs) has been attributed to ecological, behavioural and socioeconomic change, and is predicted to continue in the coming years (1). Higher levels of anthropogenic activity, including agricultural intensification, urbanisation and other forms of land use change, have led to increased interactions between wildlife, humans and livestock, increasing the risk of cross-species transmission (2). In response, a call has been issued by leading organisations and experts, including the United Nations Environment Programme, the International Livestock Research Institute and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, to complement reactive policy responses with policies that prevent zoonotic EIDs (1,3–6).

A preventive medicine approach to tackling the 'causes of the causes' of spillover events

Zoonotic spillover, defined as the transmission of a pathogen from a vertebrate animal to a human, depends on the alignment of ecological, epidemiological and behavioural factors (7). Zoonotic pathogens must meet a series of conditions in order to induce spillover infections in humans, including appropriate density and distribution of reservoir hosts, pathogen prevalence, infection intensity and human exposure (7). Across this transmission pathway, a number of drivers of zoonotic spillover have been identified, including changes in wildlife and livestock populations (8); deforestation, urbanisation and other forms of land use change (9); and a variety of necessary human practices including hunting, farming, animal husbandry, and trade (5,6,10,11).

These large-scale changes have on multiple occasions given rise to spillover events, sometimes involving diseases with epidemic or pandemic potential. In this context, the concept of preventive medicine can be useful in determining how to intervene to reduce the risk of spillover events (12), where spillover events may be understood as 'deviant' cases situated within a much broader 'population' of non-events or possible events. A broad-based approach to tackling the 'causes of the causes' of these events could be a key part of the solution.

Considering the causes of the causes of spillover events, there are a number of modifiable determinants that may be targeted with preventive interventions. These interventions include surveillance of pools of viruses in wildlife and management of wildlife populations (13); enhanced food safety measures in both the wildlife and livestock value chain, pre- and post-farm gate (11,14–16); replacement of traditional 'wet' markets with supermarkets (17); controls on wildlife hunting, trade and consumption (10,18,19); and phasing out of unsustainable agriculture practices (5,20).

Preventive policies in a real-world context: multi-sectoral efforts, One Health governance and complex systems

While some evaluative evidence exists around the effectiveness of these interventions (21–24), they have often been implemented as short- to medium-term programmes or academic investigations (5). In some cases, zoonoses have re-emerged after successful programmes have ended (24). As a result, experts have argued for the incorporation of successful interventions into policy frameworks, providing interventions with the sustainability required for long-term disease control (5). By policy, we refer here to *public* policy: 'a set of interrelated decisions taken by a political actor or group of actors concerning the selection of goals and the means of achieving them' (25). While policy implementation requires the involvement of public and private actors, we understand policy decisions as being ultimately in the hands of government, which for this review we extend to include supranational governing bodies, and having greater longevity compared to many programmes, which are often implemented for a fixed term.

Although the longevity and scope of government actions may make policy an effective vehicle for disease prevention, implementing policy is a complex process involving numerous stakeholders with competing views and interests (26). The responsibility for addressing zoonotic disease frequently spans multiple sectors of governance due to its relevance for both animals and humans. Where relevant policies are designed and implemented in isolation, opportunities for synergy may be missed and efforts may even be counter-productive.

Successful policy measures require not only a sound evidence base, but also governance structures that enable action to be taken. Given the range of possible risk factors that might contribute to emerging zoonoses, and the possible impacts of preventive policies, a One Health response has been advocated, requiring coordination between institutions and government departments involved in human and animal health, trade, agriculture and the environment (27). At the international level, the World Health Organization, the Food and Agriculture Organization and the World Organisation for Animal Health have endorsed a One Health policy framework to respond to zoonotic infectious diseases, emphasising collaboration between agencies (28). Within countries, national and local governments have also emphasised the need for multi-sectoral efforts, although many report that further integration is still required (29).

Further, given the complex social-ecological systems within which policies to prevent zoonotic spillover are implemented, the risk of unintended consequences is high. For example, bans on economic activities associated with higher risks of disease transmission may lead to the emergence or growth of illegal marketplaces where regulation is impossible (30,31). Region-specific closures of live animal markets have been shown to spread diseases further afield as vendors seek new venues to sell their animals (32). Meanwhile, attempts to manage

populations of wild animals may alter disease dynamics, unintentionally increasing the risk of spillover into livestock or people (33).

Given these particular characteristics of policy development and implementation, they may be usefully considered as a particular case of intervention, and the evidence around them assessed accordingly. Different types of interventions might be more or less feasibly implemented by governments (or their partners), and their impacts might be different given potentially more complex implementation contexts, longer timespans and broader geographic ranges. Evaluations of these policies should also include consideration and monitoring of potential unintended consequences. In order to facilitate this, multi-sectoral involvement in both policy development and evaluation may be required.

Aims and scope

Preventive approaches to managing epidemic and pandemic infectious diseases once they have entered human populations have been systematically catalogued in the medical literature (34–40). These measures include hand washing, face masks, school closures, and contract tracing and case isolation. Further upstream, systematic reviews of interventions targeting the spillover pathway have predominantly focused on programmes rather than policies, and have been restricted by various characteristics such as geographic region (23) or disease type (24), or focused on programmes with an explicit endorsement of a One Health approach (22). In consequence, a comprehensive understanding of how policies have been evaluated, and what evidence there is of their effectiveness, is lacking. To address these research gaps, our objectives are to:

1. Identify evaluations of population health policies that target the determinants of zoonotic spillover;
2. Synthesise the nature of how the interventions were evaluated; and
3. Examine the effectiveness of the interventions and identify gaps in the literature.

Our approach to identifying and analysing this literature will be informed by a One Health lens, acknowledging the inter-connectedness of human, animal and environmental health.

Methods and analysis

We will conduct a systematic scoping review of evaluations of policies aimed at preventing zoonotic spillover events. The scoping review will be conducted in line with guidelines published by Arksey and O'Malley and refined by Levac and colleagues (41–43), which emphasise an iterative approach suited to an exploratory research question.

Stage 1: Identifying the research question

The aim of this review is to use a One Health lens to identify and describe the range of policies that have been evaluated, the approaches to evaluation, and the evaluative evidence. Informed by this aim, our research questions are:

1. What population health policies aimed at preventing the spillover of emerging infectious diseases of zoonotic origin have been evaluated?
    a. What types of policies?
    b. Which policy actors (single department, multi-sectoral, whole of government)?
2. How are these interventions evaluated?
    a. What methods/study designs?
    b. What outcomes?
3. What is the evidence around the relative effectiveness of these interventions?

Stage 2: Identifying relevant studies

We will systematically search four electronic databases (Medline, Scopus, Web of Science, Global Health). The search strategy will be informed by the main concepts in our research question using the PICO framework designed to frame research questions in evidence-based medicine (44) (see Table 1). See Supplementary File 1 for details of search strategy.

Table 1: Concepts from the research question used in developing the search strategy according to the PICO Framework.

Population	All actors within systems (animal or human populations; institution including government and industry)
Intervention	Preventive public policy
Comparator	N/A

Outcome	Spillover events, or any upstream determinants or risk factors for spillover events

Stage 3: Study selection

Records identified through the searches will be collated and double screened using the online platform Covidence (45). Studies will be included where they meet all of the following criteria:

1. Primary empirical study from any country or region;
2. Report empirical findings from an evaluation of any sort; and
3. Focus on a policy implemented by government that targets the determinants of zoonotic spillover.

Titles and abstracts will initially be screened, followed by full-text screening. Title and abstract screening of an initial set of 100 papers will be undertaken by two independent researchers. Results will be compared in order to ensure consistency in decisions around study eligibility, and discrepancies resolved through discussion of the inclusion criteria. This process will be repeated until an acceptable level of agreement (>90%) is reached. The remaining papers will then be screened by one of the two reviewers. Full-text screening will be undertaken by two independent researchers and discrepancies will be resolved by discussing reasons for inclusion or exclusions among the screeners.

In line with published guidelines, the approach to study selection may be refined iteratively when reviewing articles for inclusion (41–43).

Stage 4: Charting the data

Data charting will be conducted using a data charting form designed to identify the information required to answer the research question and sub-research questions (see Table 2). As recommended, the data charting form will be piloted with ten records to ensure that it is consistent with the research question, and the data charting form will be revised iteratively in order to ensure the purpose of the research is being met (41–43).

Table 2: Data charting form

Record	Author(s)
	Year
Policy	Country

	World region (World Bank grouping) (46)
	Country income (World Bank grouping) (46)
	Disease
	Stakeholders or sector responsible for implementing policy (retail, agriculture, conservation, etc.)
	Implementation date (start date, or range if the policy has been changed)
	Intervention type
	Location along spillover pathway adapted from Plowright et al. (7,21)
	Policy level (local, national, regional, global)
	Multi-sectoral initiative (Y/N)
	Sector(s) responsible for policy
Evaluation	Aim
	Type (Process/outcome)
	Study design
	Period of observation
	Outcome measure(s) and change in measure(s)
	Consideration of unintended consequences (Y/N)
	If yes, which unintended consequences? (e.g., economic outcomes, food security)

Stage 5: Collating, summarising and reporting the results

We will undertake quality assessment of the included studies using the Quality Assessment Tool for Quantitative Studies developed by the Effective Public Health Practice Project (47), which has previously been used to assess the quality of natural experiments including public policy evaluations (48).

We will analyse the extracted data, presenting a numerical summary of the included studies in table form, allowing us to describe the range of policy interventions that have been evaluated, approaches to evaluation, and evidence of effectiveness. We will also conduct a thematic analysis of the contents of the included articles in order to identify, if possible, the

challenges encountered in evaluating these policies, as well as insights into why policies succeeded or failed in achieving their aims.

Patient and public involvement

Patients or the public were not involved in the design, conduct, reporting or dissemination plans of our research.

Strengths and weaknesses of the study

To our knowledge, this is the first attempt to systematically identify and document evaluations of policies aiming to prevent the spillover of zoonoses into human populations. However, because of the complex drivers of spillover events, some potentially relevant policy evaluations may be excluded where their outcome measures are too far removed from the spillover of zoonotic diseases. For example, it has been hypothesised that declines in vulture populations may increase the risk of disease transmission by increasing the number of uneaten carcasses, as well as, potentially, the population of feral dogs (49). In 2006, India, Pakistan and Nepal implemented a ban on the veterinary drug diclofenac, which had been identified as a driver of declining vulture populations. While policy evaluations suggest that this ban has resulted in a resurgence of vultures (50–53), the knock-on effects of this on zoonotic disease transmission risk have not been included in these evaluations. While relevant, such evaluations will be difficult to systematically identify as they make no reference to zoonotic disease.

In addition, this review will focus on policy evaluations that have been reported in the peer-reviewed literature. Policies that have been implemented but not evaluated, or evaluated but not published in the academic literature, will therefore be excluded from this review. As a result, potentially effective and important policies in the prevention of zoonotic spillover events may not be identified. However, we hope that the findings from this review will highlight these gaps in the evaluative evidence. We also hope that this review, by extracting practical dimensions such as study design, outcome measures and the challenges encountered in the evaluation process, will support policymakers and researchers in carrying out policy evaluations in this space.

Ethics and dissemination

Formal ethical approval is not required, as the study does not involve primary data collection. The findings of this study will be disseminated through a peer-reviewed publication, presentations, and summaries for key stakeholders.

List of abbreviations

EID: Emerging infectious disease

Declarations

Ethics approval and consent to participate

Not applicable.

Patient consent for publication

Not applicable.

Availability of data and material

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

Competing interests

The authors declare that they have no competing interests.

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Contributors

CCA, KML and TLP conceived and designed the study. CCA prepared the manuscript. All authors provided critical input on the manuscript and methods and have read and approved the final manuscript.

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References

1. Morse SS, Mazet JA, Woolhouse M, Parrish CR, Carroll D, Karesh WB, et al. Prediction and prevention of the next pandemic zoonosis. The Lancet. 2012 Dec 1;380(9857):1956–65.

2. Pulliam JRC, Epstein JH, Dushoff J, Rahman SA, Bunning M, Jamaluddin AA, et al. Agricultural intensification, priming for persistence and the emergence of Nipah virus: a lethal bat-borne zoonosis. Journal of The Royal Society Interface. 2012 Jan 7;9(66):89–101.

3. Marco MD, Baker ML, Daszak P, Barro PD, Eskew EA, Godde CM, et al. Opinion: Sustainable development must account for pandemic risk. PNAS. 2020 Feb 25;117(8):3888–92.

4. Heymann DL, Dixon M. Infections at the Animal/Human Interface: Shifting the Paradigm from Emergency Response to Prevention at Source. In: Mackenzie JS, Jeggo M, Daszak P, Richt JA, editors. One Health: The Human-Animal-Environment Interfaces in Emerging Infectious Diseases: Food Safety and Security, and International and National Plans for Implementation of One Health Activities [Internet]. Berlin, Heidelberg: Springer; 2013 [cited 2021 Apr 6]. p. 207–15. (Current Topics in Microbiology and Immunology). Available from: https://doi.org/10.1007/82_2012_285

5. United Nations Environment Programme, International Livestock Research Institute. Preventing the next pandemic: Zoonotic diseases and how to break the chain of transmission. Nairobi, Kenya; 2020 p. 82.

6. Intergovernmental Science-Policy Platform On Biodiversity And Ecosystem Services (IPBES). Workshop Report on Biodiversity and Pandemics of the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) [Internet]. Zenodo; 2020 Oct [cited 2021 Jan 7]. Available from: https://zenodo.org/record/4147317

7. Plowright RK, Parrish CR, McCallum H, Hudson PJ, Ko AI, Graham AL, et al. Pathways to zoonotic spillover. Nat Rev Microbiol. 2017;15(8):502–10.

8. Johnson CK, Hitchens PL, Pandit PS, Rushmore J, Evans TS, Young CCW, et al. Global shifts in mammalian population trends reveal key predictors of virus spillover risk. Proceedings of the Royal Society B: Biological Sciences. 2020 Apr 8;287(1924):20192736.

9. Allen T, Murray KA, Zambrana-Torrelio C, Morse SS, Rondinini C, Di Marco M, et al. Global hotspots and correlates of emerging zoonotic diseases. Nature Communications. 2017 Oct 24;8(1):1124.

10. Aguirre AA, Catherina R, Frye H, Shelley L. Illicit Wildlife Trade, Wet Markets, and COVID-19: Preventing Future Pandemics. World Medical & Health Policy. 2020;12(3):256–65.

11. Nadimpalli ML, Pickering AJ. A call for global monitoring of WASH in wet markets. The Lancet Planetary Health. 2020 Oct 1;4(10):e439–40.

12. Rose G, Khaw K-T, Marmot M. Rose's Strategy of Preventive Medicine: The Complete Original Text. Oxford University Press; 2008. 190 p.

13. Kelly TR, Karesh WB, Johnson CK, Gilardi KVK, Anthony SJ, Goldstein T, et al. One Health proof of concept: Bringing a transdisciplinary approach to surveillance for zoonotic viruses at the human-wild animal interface. Preventive Veterinary Medicine. 2017 Feb 1;137:112–8.

14. Aiyar A, Pingali P. Pandemics and food systems - towards a proactive food safety approach to disease prevention & management. Food Sec. 2020 Aug 1;12(4):749–56.

15. Sasaki Y, Furutani A, Furuichi T, Hayakawa Y, Ishizeki S, Kano R, et al. Development of a biosecurity assessment tool and the assessment of biosecurity levels by this tool on Japanese commercial swine farms. Preventive Veterinary Medicine. 2020 Feb 1;175:104848.

16. Soon JM, Abdul Wahab IR. On-site hygiene and biosecurity assessment: A new tool to assess live bird stalls in wet markets. Food Control. 2021 Sep 1;127:108108.

17. Maruyama M, Wu L, Huang L. The modernization of fresh food retailing in China: The role of consumers. Journal of Retailing and Consumer Services. 2016 May 1;30:33–9.

18. Challender DWS, Harrop SR, MacMillan DC. Towards informed and multi-faceted wildlife trade interventions. Global Ecology and Conservation. 2015 Jan 1;3:129–48.

19. Gómez A, Aguirre AA. Infectious Diseases and the Illegal Wildlife Trade. Annals of the New York Academy of Sciences. 2008 Dec;1149(1):16–9.

20. Kessler MK, Becker DJ, Peel AJ, Justice NV, Lunn T, Crowley DE, et al. Changing resource landscapes and spillover of henipaviruses. Annals of the New York Academy of Sciences. 2018;1429(1):78–99.

21. Sokolow SH, Nova N, Pepin KM, Peel AJ, Pulliam JRC, Manlove K, et al. Ecological interventions to prevent and manage zoonotic pathogen spillover. Philosophical Transactions of the Royal Society B: Biological Sciences. 2019 Sep 30;374(1782):20180342.

22. Baum SE, Machalaba C, Daszak P, Salerno RH, Karesh WB. Evaluating one health: Are we demonstrating effectiveness? One Health. 2017 Jun 1;3:5–10.

23. Halton K, Sarna M, Barnett A, Leonardo L, Graves N. A systematic review of community-based interventions for emerging zoonotic infectious diseases in Southeast Asia. JBI Database System Rev Implement Rep. 2013 Feb;11(2):1–235.

24. Meyer A, Holt HR, Selby R, Guitian J. Past and Ongoing Tsetse and Animal Trypanosomiasis Control Operations in Five African Countries: A Systematic Review. PLOS Neglected Tropical Diseases. 2016 Dec 27;10(12):e0005247.

25. Jenkins WI. Policy Analysis: A Political and Organisational Perspective. M. Robertson; 1978. 278 p.

26. Howlett M, Cashore B. Conceptualizing Public Policy. In: Engeli I, Allison CR, editors. Comparative Policy Studies: Conceptual and Methodological Challenges [Internet]. London: Palgrave Macmillan UK; 2014 [cited 2020 Oct 19]. p. 17–33. (Research Methods Series). Available from: https://doi.org/10.1057/9781137314154_2

27. Mazet JAK, Uhart MM, Keyyu JD. Stakeholders in One Health. Rev sci tech Off int Epiz. 2014 Aug;33(2):443–52.

28. Chien Y-J. How did international agencies perceive the avian influenza problem? The adoption and manufacture of the 'One World, One Health' framework. Sociology of Health & Illness. 2013;35(2):213–26.

29. Maxwell MJ, Carvalho MHF de, Hoet AE, Vigilato MAN, Pompei JC, Cosivi O, et al. Building the road to a regional zoonoses strategy: A survey of zoonoses programmes in the Americas. PLOS ONE. 2017 Mar 23;12(3):e0174175.

30. Lynteris C, Fearnley L. Why shutting down Chinese 'wet markets' could be a terrible mistake [Internet]. The Conversation. [cited 2021 Apr 6]. Available from: http://theconversation.com/why-shutting-down-chinese-wet-markets-could-be-a-terrible-mistake-130625

31. Webster RG. Wet markets—a continuing source of severe acute respiratory syndrome and influenza? The Lancet. 2004 Jan 17;363(9404):234–6.

32. Li Y, Wang Y, Shen C, Huang J, Kang J, Huang B, et al. Closure of live bird markets leads to the spread of H7N9 influenza in China. PLoS One [Internet]. 2018 Dec 12 [cited 2021 Apr 6];13(12). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6291110/

33. Cotterill GG, Cross PC, Cole EK, Fuda RK, Rogerson JD, Scurlock BM, et al. Winter feeding of elk in the Greater Yellowstone Ecosystem and its effects on disease dynamics. Philosophical Transactions of the Royal Society B: Biological Sciences. 2018 May 5;373(1745):20170093.

34. Saunders-Hastings P, Crispo JAG, Sikora L, Krewski D. Effectiveness of personal protective measures in reducing pandemic influenza transmission: A systematic review and meta-analysis. Epidemics. 2017 Sep;20:1–20.

35. Bin Nafisah S, Alamery AH, Al Nafesa A, Aleid B, Brazanji NA. School closure during novel influenza: A systematic review. Journal of Infection and Public Health. 2018 Sep 1;11(5):657–61.

36. Viner RM, Russell SJ, Croker H, Packer J, Ward J, Stansfield C, et al. School closure and management practices during coronavirus outbreaks including COVID-19: a rapid systematic review. The Lancet Child & Adolescent Health. 2020 May 1;4(5):397–404.

37. Juneau C-E, Pueyo T, Bell M, Gee G, Collazzo P, Potvin L. Evidence-Based, Cost-Effective Interventions To Suppress The COVID-19 Pandemic: A Systematic Review. medRxiv. 2020 Jun 15;2020.04.20.20054726.

38. MacIntyre CR, Chughtai AA. Facemasks for the prevention of infection in healthcare and community settings. BMJ. 2015 Apr 9;350:h694.

39. Smith SMS, Sonego S, Wallen GR, Waterer G, Cheng AC, Thompson P. Use of non-pharmaceutical interventions to reduce the transmission of influenza in adults: A systematic review. Respirology. 2015 Aug;20(6):896–903.

40. Jefferson T, Del Mar CB, Dooley L, Ferroni E, Al-Ansary LA, Bawazeer GA, et al. Physical interventions to interrupt or reduce the spread of respiratory viruses. Cochrane Database Syst Rev. 2011 Jul 6;(7):CD006207.

41. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. International Journal of Social Research Methodology. 2005 Feb 1;8(1):19–32.

42. Levac D, Colquhoun H, O'Brien KK. Scoping studies: advancing the methodology. Implementation Sci. 2010 Sep 20;5(1):69.

43. Colquhoun HL, Levac D, O'Brien KK, Straus S, Tricco AC, Perrier L, et al. Scoping reviews: time for clarity in definition, methods, and reporting. Journal of Clinical Epidemiology. 2014 Dec 1;67(12):1291–4.

44. Richardson WS, Wilson MC, Nishikawa J, Hayward RSA. The well-built clinical question: a key to evidence-based decisions. ACP Journal Club. 1995 Nov 1;123(3):A12.

45. Covidence - Better systematic review management [Internet]. [cited 2020 Jul 17]. Available from: https://www.covidence.org/home

46. World Bank. World Bank Country and Lending Groups – World Bank Data Help Desk [Internet]. 2020 [cited 2020 Jul 2]. Available from: https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups

47. Effective Public Health Practice Project. Quality Assessment Tool for Quantitative Studies [Internet]. 2009 [cited 2021 May 17] p. 4. Available from: https://merst.ca/wp-content/uploads/2018/02/quality-assessment-tool_2010.pdf

48. Bramante CT, Thornton RLJ, Bennett WL, Zhang A, Wilson RF, Bass EB, et al. Systematic Review of Natural Experiments for Childhood Obesity Prevention and Control. American Journal of Preventive Medicine. 2019 Jan 1;56(1):147–58.

49. Ogada DL, Torchin ME, Kinnaird MF, Ezenwa VO. Effects of Vulture Declines on Facultative Scavengers and Potential Implications for Mammalian Disease Transmission. Conservation Biology. 2012;26(3):453–60.

50. Chaudhry MJI, Ogada DL, Malik RN, Virani MZ, Giovanni MD. First evidence that populations of the critically endangered Long-billed Vulture *Gyps indicus* in Pakistan

have increased following the ban of the toxic veterinary drug diclofenac in south Asia. Bird Conservation International. 2012 Dec;22(4):389–97.

51. Cuthbert R, Taggart MA, Prakash V, Saini M, Swarup D, Upreti S, et al. Effectiveness of Action in India to Reduce Exposure of Gyps Vultures to the Toxic Veterinary Drug Diclofenac. Willis SG, editor. PLoS ONE. 2011 May 11;6(5):e19069.

52. Nambirajan K, Muralidharan S, Roy AA, Manonmani S. Residues of Diclofenac in Tissues of Vultures in India: A Post-ban Scenario. Arch Environ Contam Toxicol. 2018 Feb 1;74(2):292–7.

53. Prakash V, Bishwakarma MC, Chaudhary A, Cuthbert R, Dave R, Kulkarni M, et al. The Population Decline of Gyps Vultures in India and Nepal Has Slowed since Veterinary Use of Diclofenac was Banned. PLOS ONE. 2012 Nov 7;7(11):e49118.

Supplementary file 1

Search strings for academic databases

Scopus search, all terms in TITLE-ABS-KEY; Block 1 AND 2 AND 3 AND 4

P – Population: All actors within a system (no specific search terms)

I – Intervention: Preventive public policy

Block 1 – Policy interventions

policy OR law OR legal OR legislat* OR regulat* OR tariff OR subsidy OR tax OR ban OR "voluntary agreement" OR incentive OR fiscal OR guidelines OR govern* OR federal* OR closure OR closing OR state* OR "rest day*" OR "border control*" OR "habitat protection" OR "wetland protection" OR "supplement* fed" OR "supplement* feed*" OR "market size"

Block 2 – Prevention

Prevent* OR "ecological intervention*" OR "non-pharmaceutical intervention*" OR "public health" OR "risk management" OR "risk minimisation" OR "control strateg*" OR "outbreak risk" OR "reduc* W/5 transmission" OR "reduc* W/5 infection"

C – Comparator: N/A

O – Outcome: Zoonotic spillover events or their upstream determinants and risk factors

Block 3 - Zoonoses

Zika OR ebola OR covid-19 OR sars-cov-2 OR coronavirus OR sars OR mers OR h1n1 OR h7n9 OR h5n1 OR "one health" OR dengue OR "nipah virus" OR influenza OR zoonoses OR zoonosis OR zoonotic OR "West Nile" OR "HIV/AIDS" OR "avian flu" OR "hendra virus" OR "marburg virus" OR "yellow fever" OR "tick-borne encephalitis" OR "emerging infectious diseases" OR "emergent infectious diseases" OR brucellosis OR rabies OR chikungunya OR "bovine spongiform encephalopathy" OR "rift valley fever"

Block 4 – Spillover events

Spillover OR "spill over" OR "cross-species transmission" OR poultry OR wildlife OR bushmeat OR "bush meat" OR livestock OR "animal market*" OR "wet market*" OR "bird market*" OR horse* OR waterfowl OR fowl OR bat OR bats OR mammal* OR swine OR pig* OR poaching OR "pet trade" OR pork OR "trade W/5 animal"

PRISMA-P 2015 Checklist

This checklist has been adapted for use with systematic review protocol submissions to BioMed Central journals from Table 3 in Moher D et al: Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Systematic Reviews* 2015 **4**:1

An Editorial from the Editors-in-Chief of *Systematic Reviews* details why this checklist was adapted - **Moher D, Stewart L & Shekelle P:** Implementing PRISMA-P: recommendations for prospective authors. *Systematic Reviews* 2016 **5**:15

Section/topic	#	Checklist item	Information reported		Line number(s)
			Yes	No	
ADMINISTRATIVE INFORMATION					
Title					
Identification	1a	Identify the report as a protocol of a systematic review	☒	☐	p.1 l.1-2
Update	1b	If the protocol is for an update of a previous systematic review, identify as such	☐	☒	N/A
Registration	2	If registered, provide the name of the registry (e.g., PROSPERO) and registration number in the Abstract	☐	☒	N/A
Authors					
Contact	3a	Provide name, institutional affiliation, and e-mail address of all protocol authors; provide physical mailing address of corresponding author	☒	☐	p.1 l.3-25
Contributions	3b	Describe contributions of protocol authors and identify the guarantor of the review	☒	☐	p.12 l.16-18
Amendments	4	If the protocol represents an amendment of a previously completed or published protocol, identify as such and list changes; otherwise, state plan for documenting important protocol amendments	☐	☒	N/A
Support					
Sources	5a	Indicate sources of financial or other support for the review	☒	☐	p.12 l.14-16
Sponsor	5b	Provide name for the review funder and/or sponsor	☒	☐	p.12 l.14-16
Role of sponsor/funder	5c	Describe roles of funder(s), sponsor(s), and/or institution(s), if any, in developing the protocol	☒	☐	p.12 l.16
INTRODUCTION					
Rationale	6	Describe the rationale for the review in the context of what is already known	☒	☐	p.4-6
Objectives	7	Provide an explicit statement of the question(s) the review will address with reference to	☒	☐	p.6 l.12-27

Section/topic	#	Checklist item	Information reported		Line number(s)
			Yes	No	
		participants, interventions, comparators, and outcomes (PICO)			
METHODS					
Eligibility criteria	8	Specify the study characteristics (e.g., PICO, study design, setting, time frame) and report characteristics (e.g., years considered, language, publication status) to be used as criteria for eligibility for the review	☒	☐	p.8 l.2-8
Information sources	9	Describe all intended information sources (e.g., electronic databases, contact with study authors, trial registers, or other grey literature sources) with planned dates of coverage	☒	☐	p.7 l.19-20
Search strategy	10	Present draft of search strategy to be used for at least one electronic database, including planned limits, such that it could be repeated	☒	☐	p.11
STUDY RECORDS					
Data management	11a	Describe the mechanism(s) that will be used to manage records and data throughout the review	☒	☐	p.8 l.3-4; 20-24
Selection process	11b	State the process that will be used for selecting studies (e.g., two independent reviewers) through each phase of the review (i.e., screening, eligibility, and inclusion in meta-analysis)	☒	☐	p.8 l.9-16
Data collection process	11c	Describe planned method of extracting data from reports (e.g., piloting forms, done independently, in duplicate), any processes for obtaining and confirming data from investigators	☒	☐	p.8 l.19-25
Data items	12	List and define all variables for which data will be sought (e.g., PICO items, funding sources), any pre-planned data assumptions and simplifications	☒	☐	Table 2, p.8-9
Outcomes and prioritization	13	List and define all outcomes for which data will be sought, including prioritization of main and additional outcomes, with rationale	☐	☒	N/A – scoping review
Risk of bias in individual studies	14	Describe anticipated methods for assessing risk of bias of individual studies, including whether this will be done at the outcome or study level, or both; state how this information will be used in data synthesis	☒	☐	p.9 l.3-6
DATA					
Synthesis	15a	Describe criteria under which study data will be quantitatively synthesized	☒	☐	Table 2, p.8-9
	15b	If data are appropriate for quantitative synthesis, describe planned summary measures, methods of handling data, and methods of combining data from studies, including any planned exploration of consistency (e.g., I^2, Kendall's tau)	☐	☒	N/A
	15c	Describe any proposed additional analyses (e.g., sensitivity or subgroup analyses, meta-regression)	☐	☒	N/A
	15d	If quantitative synthesis is not appropriate, describe the type of summary planned	☒	☐	p.9 l.7-10, p.10 l.1-2
Meta-bias(es)	16	Specify any planned assessment of meta-bias(es) (e.g., publication bias across studies, selective	☐	☒	N/A – scoping

Section/topic	#	Checklist item	Information reported		Line number(s)
			Yes	No	
		reporting within studies)			review
Confidence in cumulative evidence	17	Describe how the strength of the body of evidence will be assessed (e.g., GRADE)	☐	☒	N/A – scoping review

BMJ Open

Policies to prevent zoonotic spillover: protocol for a systematic scoping review of evaluative evidence

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Policies to prevent zoonotic spillover: protocol for a systematic scoping review of evaluative evidence

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Abstract

Introduction

The increasing incidence of pathogen transmission from animals to humans (zoonotic spillover events) has been attributed to behavioural practices and ecological and socioeconomic change. As these events sometimes involve pathogens with epidemic or pandemic potential, they pose a serious threat to population health. Public policies may play a key role in preventing these events. The aim of this review is to identify evaluations of public policies that target the determinants of zoonotic spillover, examining approaches taken to evaluation, choice of outcomes measures and evidence of effectiveness. Our approach to identifying and analysing this literature will be informed by a One Health lens, acknowledging the inter-connectedness of human, animal and environmental health.

Methods and analysis

A systematic scoping review methodology will be used. To identify articles, we will search Medline, SCOPUS, Web of Science and Global Health in March 2022 using search terms combining animal health and the animal-human interface, public policy, prevention and zoonoses. We will screen titles and abstracts and extract data according to published guidelines for scoping reviews. All evaluations of public policies aiming to prevent zoonotic spillover events will be eligible for inclusion. We will summarise key data from each study, mapping policies along the spillover pathway and outlining the range of policies, approaches to evaluation and outcome measures. Review findings will provide a useful reference for researchers and practitioners, outlining the state of the evaluative evidence around policies to prevent zoonotic spillover.

Ethics and dissemination

Formal ethical approval is not required, because the study does not involve primary data collection. The findings of this study will be disseminated through a peer-reviewed publication, presentations, and summaries for key stakeholders.

Strengths and limitations

- This scoping review protocol outlines the first piece of work to systematically identify and review evaluations of public policies designed to prevent zoonotic spillover, and will be undertaken in line with published guidelines for best practice in scoping reviews.
- The review will be informed by a One Health lens, encompassing distal determinants and risk factors for spillover events and acknowledging the interconnectedness of human, animal and environmental health.

- Due to the complex drivers of spillover events, some potentially relevant policy evaluations may not be identified where outcome measures are too far removed from zoonotic spillover.

Introduction

The increasing incidence of zoonotic emerging infectious diseases (EIDs) has been attributed to behavioural practices and ecological and socioeconomic change, and is predicted to continue in the coming years (1). Higher levels of anthropogenic activity, including agricultural intensification, urbanisation and other forms of land use change, have led to increased interactions between wildlife, humans and livestock, increasing the risk of cross-species transmission (2,3). In response, a call has been issued by leading organisations and experts, including the United Nations Environment Programme, the International Livestock Research Institute and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, to complement reactive policy responses with policies that prevent zoonotic EIDs (1,4–7).

Preventing zoonotic spillover from a One Health perspective

Zoonotic spillover, defined as the transmission of a pathogen from an animal to a human, depends on the alignment of ecological, epidemiological and behavioural factors (8). Zoonotic pathogens must meet a series of conditions in order to induce spillover infections in humans, including appropriate density and distribution of reservoir hosts, pathogen prevalence, infection intensity and human exposure (8). Across this transmission pathway, a number of drivers of zoonotic spillover have been identified, including changes in wildlife and livestock populations (9); deforestation, urbanisation and other forms of land use change (10); and a variety of human practices including hunting, farming, animal husbandry, keeping of exotic pets and trade (6,7,11,12). These large-scale changes have on multiple occasions given rise to spillover events, sometimes involving pathogens with epidemic or pandemic potential.

A One Health perspective, which recognises the health of humans, animals and ecosystems as being closely linked and inter-dependent (13), can be useful in conceptualizing a range of potential determinants of spillover events. From this perspective, interventions could include surveillance of pools of viruses in wildlife and management of wildlife populations (14); enhanced food safety measures in both the wildlife and livestock value chain, pre- and post-farm gate (12,15–17); replacement of traditional 'wet' markets with supermarkets (18); controls on wildlife hunting, trade and consumption (11,19,20); and phasing out of unsustainable agriculture practices (6,21).

While some evaluative evidence exists around the effectiveness of interventions (22–25), they have often been implemented as short- to medium-term programmes or academic investigations (6). In some cases, zoonoses have re-emerged after successful programmes have ended (25). As a result, experts have argued for the incorporation of successful

interventions into policy frameworks, providing interventions with the sustainability required for long-term disease control (6).

Governance, systems and the role of multi-sectoral actors

Public policy is 'a set of interrelated decisions taken by a political actor or group of actors concerning the selection of goals and the means of achieving them' (26). Public policy decisions are ultimately in the hands of government and supranational governing bodies, and have greater longevity compared to many programmes, which are often implemented for a fixed term. Non-government actors, including vested interest stakeholders, can also play a powerful role in shaping government decisions (27,28).

Although the longevity and scope of government actions may make policy an effective vehicle for prevention of emergent diseases, implementing policy is a complex process involving numerous stakeholders with competing views and interests (29). The responsibility for addressing zoonotic disease frequently spans multiple sectors of governance due to its relevance for both animals and humans. Where relevant policies are designed and implemented in isolation, opportunities for synergy may be missed and efforts may even be counter-productive.

Successful policy measures require not only a sound evidence base, but also governance structures that enable action to be taken. Given the range of possible risk factors that might contribute to emerging zoonoses, and the possible impacts of policies to prevent zoonotic spillover, a One Health response has been advocated, requiring coordination between institutions and government departments involved in human and animal health, trade, agriculture and the environment (30). At the international level, the World Health Organization, the Food and Agriculture Organization and the World Organisation for Animal Health have endorsed a One Health policy framework to respond to zoonotic infectious diseases, emphasising collaboration between agencies (31). Within countries, national and local governments have also emphasised the need for multi-sectoral efforts, although many report that further integration is still required (32).

Further, given the complex social-ecological systems within which policies to prevent zoonotic spillover are implemented, the risk of unintended consequences is high. For example, region-specific closures of live animal markets have been shown to spread pathogens further afield as vendors seek new venues to sell their animals (33). Meanwhile, attempts to manage populations of wild animals may alter pathogen dynamics, unintentionally increasing the risk of spillover into livestock or people (34).

Given these particular characteristics of policy development and implementation, they may be usefully considered as a particular case of intervention, and the evidence around them

assessed accordingly. Different types of interventions might be more or less feasibly implemented by governments (or their partners), and their impacts might be different given potentially more complex implementation contexts, longer timespans and broader geographic ranges. Evaluations of these policies should also include consideration and monitoring of potential unintended consequences. In order to facilitate this, multi-sectoral involvement in both policy development and evaluation may be required.

Aims and scope

Approaches to managing epidemic and pandemic infectious pathogens once they have entered human populations have been systematically catalogued in the medical literature (35–41). These measures include hand washing, face masks, school closures, and contact tracing and case isolation. Further upstream, systematic reviews of interventions targeting the spillover pathway have predominantly focused on programmes rather than policies, and have been restricted by various characteristics such as geographic region (24) or pathogen type (25), or focused on programmes with an explicit endorsement of a One Health approach (23). In consequence, a comprehensive understanding of how policies to prevent zoonotic spillover have been evaluated, and what evidence there is of their effectiveness, is lacking. To address these research gaps, our objectives are to:

1. Identify evaluations of policies that target the determinants of zoonotic spillover included in the spillover pathway (8) (i.e. human and animal health and interactions);
2. Synthesise the nature of how the interventions were evaluated; and
3. Examine the effectiveness of the interventions and identify gaps in the literature.

Our approach to identifying and analysing this literature will be informed by a One Health lens, acknowledging the inter-connectedness of human, animal and environmental health.

Methods and analysis

We will conduct a systematic scoping review of evaluations of policies aimed at preventing zoonotic spillover events. The scoping review will be conducted in line with guidelines published by Arksey and O'Malley and refined by Levac and colleagues (42–44), which emphasise an iterative approach suited to an exploratory research question.

Stage 1: Identifying the research question

The aim of this review is to use a One Health lens to identify and describe the range of policies that have been evaluated, the approaches to evaluation, and the evaluative evidence. Informed by this aim, our research questions are:

1. What policies aimed at preventing zoonotic spillover have been evaluated?
    a. What types of policies?
    b. Which policy actors (single department, multi-sectoral, whole of government)?
2. How are these interventions evaluated?
    a. What methods/study designs?
    b. What outcomes?
3. What is the evidence around the relative effectiveness of these interventions?

Stage 2: Identifying relevant studies

We will systematically search four electronic databases (Medline, Scopus, Web of Science, Global Health) in March 2022. The search strategy is organized by the main concepts in our research question: the spillover pathway; public policy; prevention; and zoonotic pathogens (see Supplementary File 1 for details of search strategy). The search strategy was developed iteratively, informed by existing systematic reviews focused on related concepts (24,45–49) and known indicator papers meeting inclusion criteria.

Stage 3: Study selection

Records identified through the searches will be collated and double screened using the online platform Covidence (50). Studies will be included where they meet all of the following criteria:

1. Primary empirical study from any country or region with English-language abstracts;
2. Report empirical findings from an evaluation of any sort; and
3. Focus on a policy implemented by government that targets the determinants of zoonotic spillover.

Titles and abstracts will initially be screened, followed by full-text screening. Title and abstract screening of an initial set of 100 papers will be undertaken by two independent researchers. Results will be compared in order to ensure consistency in decisions around study eligibility,

and discrepancies resolved through discussion of the inclusion criteria. This process will be repeated until an acceptable level of agreement (>90%) is reached. The remaining papers will then be screened by one of the two reviewers. Full-text screening will be undertaken by two independent researchers and discrepancies will be resolved by discussing reasons for inclusion or exclusions among the screeners. Studies with full-texts in languages other than English will be eligible for inclusion if they include an English-language abstract. Full-text studies published in French, Spanish or Chinese will be single-screened by a member of the research team fluent in that language. Studies published in other languages will be translated as necessary.

In line with published guidelines, the approach to study selection may be refined iteratively when reviewing articles for inclusion (42–44). Reporting on the search and screening process will follow the guidelines provided in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (51).

Stage 4: Charting the data

Data charting will be conducted using a data charting form designed to identify the information required to answer the research question and sub-research questions (see Supplementary File 2). As recommended, the data charting form will be piloted with ten records to ensure that it is consistent with the research question, and the data charting form will be revised iteratively in order to ensure the purpose of the research is being met (42–44).

Stage 5: Collating, summarising and reporting the results

We will undertake quality assessment of the included studies using the Quality Assessment Tool for Quantitative Studies developed by the Effective Public Health Practice Project (52), which has previously been used to assess the quality of natural experiments including public policy evaluations (53).

We will analyse the extracted data, presenting a numerical summary of the included studies in table form, allowing us to describe the range of policy interventions that have been evaluated, approaches to evaluation, and evidence of effectiveness. We will also conduct a thematic analysis of the contents of the included articles in order to identify, if possible, barriers and facilitators to implementing and evaluating these policies, as well as insights into why policies succeeded or failed in achieving their aims.

Patient and public involvement

This scoping review is being undertaken as part of a larger project involving policy actors at national and international levels as research team members, knowledge users and participants. Insights from the project have informed protocol development and stakeholders

are able to provide input and perspectives on the results of the review. Project-level dissemination events involving policy stakeholders are also planned, where findings from the proposed review will be shared.

Strengths and weaknesses of the study

To our knowledge, this is the first attempt to systematically identify and document evaluations of policies aiming to prevent the spillover of zoonoses into human populations. However, because of the complex drivers of spillover events, some potentially relevant policy evaluations may be excluded where their outcome measures are too far removed from zoonotic spillover. For example, it has been hypothesised that declines in vulture populations may increase the risk of pathogen transmission by increasing the number of uneaten carcasses, as well as, potentially, the population of feral dogs (54). In 2006, India, Pakistan and Nepal implemented a ban on the veterinary drug diclofenac, which had been identified as a driver of declining vulture populations. While policy evaluations suggest that this ban has resulted in a resurgence of vultures (55–58), the knock-on effects of this on zoonotic pathogen transmission risk have not been included in these evaluations. While relevant, such evaluations will be difficult to systematically identify as they make no reference to zoonotic disease.

In addition, this review will focus on policy evaluations that have been reported in the peer-reviewed literature. Policies that have been implemented but not evaluated, or evaluated but not published in the academic literature, will therefore be excluded from this review. As a result, potentially effective and important policies in the prevention of zoonotic spillover events may not be identified. However, we hope that the findings from this review will highlight these gaps in the evaluative evidence. We also hope that this review, by extracting practical dimensions such as study design, outcome measures and the challenges encountered in the evaluation process, will support policymakers and researchers in carrying out policy evaluations in this space.

Ethics and dissemination

Formal ethical approval is not required, because the study does not involve primary data collection. The findings of this study will be disseminated through a peer-reviewed publication, presentations, and summaries for key stakeholders.

List of abbreviations

EID: Emerging infectious disease

Declarations

Ethics approval and consent to participate

Not applicable.

Patient consent for publication

Not applicable.

Availability of data and material

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

Competing interests

The authors declare that they have no competing interests.

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Contributors

CCA, KML and TLP conceived and designed the study. CCA prepared the manuscript. KML, TLP, RA, AA, MB, JC, RL, AR, KCT, AMV, MW and AY provided critical input on the manuscript and methods and have read and approved the final manuscript.

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1 Not applicable.

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References

1. Morse SS, Mazet JA, Woolhouse M, Parrish CR, Carroll D, Karesh WB, et al. Prediction and prevention of the next pandemic zoonosis. The Lancet. 2012 Dec 1;380(9857):1956–65.

2. Pulliam JRC, Epstein JH, Dushoff J, Rahman SA, Bunning M, Jamaluddin AA, et al. Agricultural intensification, priming for persistence and the emergence of Nipah virus: a lethal bat-borne zoonosis. Journal of The Royal Society Interface. 2012 Jan 7;9(66):89–101.

3. IPCC. Climate Change 2022: Impacts, Adaptation and Vulnerability [Internet]. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press [In press]; 2022 [cited 2022 Mar 7]. Available from: https://www.ipcc.ch/report/ar6/wg2/

4. Marco MD, Baker ML, Daszak P, Barro PD, Eskew EA, Godde CM, et al. Opinion: Sustainable development must account for pandemic risk. PNAS. 2020 Feb 25;117(8):3888–92.

5. Heymann DL, Dixon M. Infections at the Animal/Human Interface: Shifting the Paradigm from Emergency Response to Prevention at Source. In: Mackenzie JS, Jeggo M, Daszak P, Richt JA, editors. One Health: The Human-Animal-Environment Interfaces in Emerging Infectious Diseases: Food Safety and Security, and International and National Plans for Implementation of One Health Activities [Internet]. Berlin, Heidelberg: Springer; 2013 [cited 2021 Apr 6]. p. 207–15. (Current Topics in Microbiology and Immunology). Available from: https://doi.org/10.1007/82_2012_285

6. United Nations Environment Programme, International Livestock Research Institute. Preventing the next pandemic: Zoonotic diseases and how to break the chain of transmission. Nairobi, Kenya; 2020 p. 82.

7. Intergovernmental Science-Policy Platform On Biodiversity And Ecosystem Services (IPBES). Workshop Report on Biodiversity and Pandemics of the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) [Internet]. Zenodo; 2020 Oct [cited 2021 Jan 7]. Available from: https://zenodo.org/record/4147317

8. Plowright RK, Parrish CR, McCallum H, Hudson PJ, Ko AI, Graham AL, et al. Pathways to zoonotic spillover. Nat Rev Microbiol. 2017;15(8):502–10.

9. Johnson CK, Hitchens PL, Pandit PS, Rushmore J, Evans TS, Young CCW, et al. Global shifts in mammalian population trends reveal key predictors of virus spillover risk. Proceedings of the Royal Society B: Biological Sciences. 2020 Apr 8;287(1924):20192736.

10. Allen T, Murray KA, Zambrana-Torrelio C, Morse SS, Rondinini C, Di Marco M, et al. Global hotspots and correlates of emerging zoonotic diseases. Nature Communications. 2017 Oct 24;8(1):1124.

11. Aguirre AA, Catherina R, Frye H, Shelley L. Illicit Wildlife Trade, Wet Markets, and COVID-19: Preventing Future Pandemics. World Medical & Health Policy. 2020;12(3):256–65.

12. Nadimpalli ML, Pickering AJ. A call for global monitoring of WASH in wet markets. The Lancet Planetary Health. 2020 Oct 1;4(10):e439–40.

13. Joint Tripartite (FAO, OIE, WHO) and UNEP Statement. Tripartite and UNEP support OHHLEP's definition of "One Health" [Internet]. OIE - World Organisation for Animal Health. 2021 [cited 2022 Feb 18]. Available from: https://www.oie.int/en/tripartite-and-unep-support-ohhleps-definition-of-one-health/

14. Kelly TR, Karesh WB, Johnson CK, Gilardi KVK, Anthony SJ, Goldstein T, et al. One Health proof of concept: Bringing a transdisciplinary approach to surveillance for zoonotic viruses at the human-wild animal interface. Preventive Veterinary Medicine. 2017 Feb 1;137:112–8.

15. Aiyar A, Pingali P. Pandemics and food systems - towards a proactive food safety approach to disease prevention & management. Food Sec. 2020 Aug 1;12(4):749–56.

16. Sasaki Y, Furutani A, Furuichi T, Hayakawa Y, Ishizeki S, Kano R, et al. Development of a biosecurity assessment tool and the assessment of biosecurity levels by this tool on Japanese commercial swine farms. Preventive Veterinary Medicine. 2020 Feb 1;175:104848.

17. Soon JM, Abdul Wahab IR. On-site hygiene and biosecurity assessment: A new tool to assess live bird stalls in wet markets. Food Control. 2021 Sep 1;127:108108.

18. Maruyama M, Wu L, Huang L. The modernization of fresh food retailing in China: The role of consumers. Journal of Retailing and Consumer Services. 2016 May 1;30:33–9.

19. Challender DWS, Harrop SR, MacMillan DC. Towards informed and multi-faceted wildlife trade interventions. Global Ecology and Conservation. 2015 Jan 1;3:129–48.

20. Gómez A, Aguirre AA. Infectious Diseases and the Illegal Wildlife Trade. Annals of the New York Academy of Sciences. 2008 Dec;1149(1):16–9.

21. Kessler MK, Becker DJ, Peel AJ, Justice NV, Lunn T, Crowley DE, et al. Changing resource landscapes and spillover of henipaviruses. Annals of the New York Academy of Sciences. 2018;1429(1):78–99.

22. Sokolow SH, Nova N, Pepin KM, Peel AJ, Pulliam JRC, Manlove K, et al. Ecological interventions to prevent and manage zoonotic pathogen spillover. Philosophical Transactions of the Royal Society B: Biological Sciences. 2019 Sep 30;374(1782):20180342.

23. Baum SE, Machalaba C, Daszak P, Salerno RH, Karesh WB. Evaluating one health: Are we demonstrating effectiveness? One Health. 2017 Jun 1;3:5–10.

24. Halton K, Sarna M, Barnett A, Leonardo L, Graves N. A systematic review of community-based interventions for emerging zoonotic infectious diseases in Southeast Asia. JBI Database System Rev Implement Rep. 2013 Feb;11(2):1–235.

25. Meyer A, Holt HR, Selby R, Guitian J. Past and Ongoing Tsetse and Animal Trypanosomiasis Control Operations in Five African Countries: A Systematic Review. PLOS Neglected Tropical Diseases. 2016 Dec 27;10(12):e0005247.

26. Jenkins WI. Policy Analysis: A Political and Organisational Perspective. M. Robertson; 1978. 278 p.

27. Renn O, Schweizer P-J. Inclusive risk governance: concepts and application to environmental policy making. Environmental Policy and Governance. 2009;19(3):174–85.

28. Keck ME, Sikkink K. Transnational advocacy networks in international and regional politics. International Social Science Journal. 1999;51(159):89–101.

29. Howlett M, Cashore B. Conceptualizing Public Policy. In: Engeli I, Allison CR, editors. Comparative Policy Studies: Conceptual and Methodological Challenges [Internet]. London: Palgrave Macmillan UK; 2014 [cited 2020 Oct 19]. p. 17–33. (Research Methods Series). Available from: https://doi.org/10.1057/9781137314154_2

30. Mazet JAK, Uhart MM, Keyyu JD. Stakeholders in One Health. Rev sci tech Off int Epiz. 2014 Aug;33(2):443–52.

31. Chien Y-J. How did international agencies perceive the avian influenza problem? The adoption and manufacture of the 'One World, One Health' framework. Sociology of Health & Illness. 2013;35(2):213–26.

32. Maxwell MJ, Carvalho MHF de, Hoet AE, Vigilato MAN, Pompei JC, Cosivi O, et al. Building the road to a regional zoonoses strategy: A survey of zoonoses programmes in the Americas. PLOS ONE. 2017 Mar 23;12(3):e0174175.

33. Li Y, Wang Y, Shen C, Huang J, Kang J, Huang B, et al. Closure of live bird markets leads to the spread of H7N9 influenza in China. PLoS One [Internet]. 2018 Dec 12 [cited 2021 Apr 6];13(12). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6291110/

34. Cotterill GG, Cross PC, Cole EK, Fuda RK, Rogerson JD, Scurlock BM, et al. Winter feeding of elk in the Greater Yellowstone Ecosystem and its effects on disease dynamics. Philosophical Transactions of the Royal Society B: Biological Sciences. 2018 May 5;373(1745):20170093.

35. Saunders-Hastings P, Crispo JAG, Sikora L, Krewski D. Effectiveness of personal protective measures in reducing pandemic influenza transmission: A systematic review and meta-analysis. Epidemics. 2017 Sep;20:1–20.

36. Bin Nafisah S, Alamery AH, Al Nafesa A, Aleid B, Brazanji NA. School closure during novel influenza: A systematic review. Journal of Infection and Public Health. 2018 Sep 1;11(5):657–61.

37. Viner RM, Russell SJ, Croker H, Packer J, Ward J, Stansfield C, et al. School closure and management practices during coronavirus outbreaks including COVID-19: a rapid systematic review. The Lancet Child & Adolescent Health. 2020 May 1;4(5):397–404.

38. Juneau C-E, Pueyo T, Bell M, Gee G, Collazzo P, Potvin L. Evidence-Based, Cost-Effective Interventions To Suppress The COVID-19 Pandemic: A Systematic Review. medRxiv. 2020 Jun 15;2020.04.20.20054726.

39. MacIntyre CR, Chughtai AA. Facemasks for the prevention of infection in healthcare and community settings. BMJ. 2015 Apr 9;350:h694.

40. Smith SMS, Sonego S, Wallen GR, Waterer G, Cheng AC, Thompson P. Use of non-pharmaceutical interventions to reduce the transmission of influenza in adults: A systematic review. Respirology. 2015 Aug;20(6):896–903.

41. Jefferson T, Del Mar CB, Dooley L, Ferroni E, Al-Ansary LA, Bawazeer GA, et al. Physical interventions to interrupt or reduce the spread of respiratory viruses. Cochrane Database Syst Rev. 2011 Jul 6;(7):CD006207.

42. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. International Journal of Social Research Methodology. 2005 Feb 1;8(1):19–32.

43. Levac D, Colquhoun H, O'Brien KK. Scoping studies: advancing the methodology. Implementation Sci. 2010 Sep 20;5(1):69.

44. Colquhoun HL, Levac D, O'Brien KK, Straus S, Tricco AC, Perrier L, et al. Scoping reviews: time for clarity in definition, methods, and reporting. Journal of Clinical Epidemiology. 2014 Dec 1;67(12):1291–4.

45. Zhou X, Wang Y, Liu H, Guo F, Doi SA, Smith C, et al. Effectiveness of Market-Level Biosecurity at Reducing Exposure of Poultry and Humans to Avian Influenza: A Systematic Review and Meta-Analysis. The Journal of Infectious Diseases. 2018 Nov 5;218(12):1861–75.

46. Conan A, Goutard FL, Sorn S, Vong S. Biosecurity measures for backyard poultry in developing countries: a systematic review. BMC Veterinary Research. 2012 Dec 7;8(1):240.

47. Youssef DM, Wieland B, Knight GM, Lines J, Naylor NR. The effectiveness of biosecurity interventions in reducing the transmission of bacteria from livestock to humans at the farm level: A systematic literature review. Zoonoses and Public Health. 2021;68(6):549–62.

48. Shi N, Huang J, Zhang X, Bao C, Yue N, Wang Q, et al. Interventions in Live Poultry Markets for the Control of Avian Influenza: A Systematic Review and Meta-analysis. The Journal of Infectious Diseases. 2020 Feb 3;221(4):553–60.

49. Cupertino MC, Resende MB, Mayer NA, Carvalho LM, Siqueira-Batista R. Emerging and re-emerging human infectious diseases: A systematic review of the role of wild animals with a focus on public health impact. Asian Pacific Journal of Tropical Medicine. 2020 Jan 3;13(3):99.

50. Covidence - Better systematic review management [Internet]. [cited 2020 Jul 17]. Available from: https://www.covidence.org/home

51. Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. Ann Intern Med. 2018 Oct 2;169(7):467–73.

52. Effective Public Health Practice Project. Quality Assessment Tool for Quantitative Studies [Internet]. 2009 [cited 2021 May 17] p. 4. Available from: https://merst.ca/wp-content/uploads/2018/02/quality-assessment-tool_2010.pdf

53. Bramante CT, Thornton RLJ, Bennett WL, Zhang A, Wilson RF, Bass EB, et al. Systematic Review of Natural Experiments for Childhood Obesity Prevention and Control. American Journal of Preventive Medicine. 2019 Jan 1;56(1):147–58.

54. Ogada DL, Torchin ME, Kinnaird MF, Ezenwa VO. Effects of Vulture Declines on Facultative Scavengers and Potential Implications for Mammalian Disease Transmission. Conservation Biology. 2012;26(3):453–60.

55. Chaudhry MJI, Ogada DL, Malik RN, Virani MZ, Giovanni MD. First evidence that populations of the critically endangered Long-billed Vulture *Gyps indicus* in Pakistan have increased following the ban of the toxic veterinary drug diclofenac in south Asia. Bird Conservation International. 2012 Dec;22(4):389–97.

56. Cuthbert R, Taggart MA, Prakash V, Saini M, Swarup D, Upreti S, et al. Effectiveness of Action in India to Reduce Exposure of Gyps Vultures to the Toxic Veterinary Drug Diclofenac. Willis SG, editor. PLoS ONE. 2011 May 11;6(5):e19069.

57. Nambirajan K, Muralidharan S, Roy AA, Manonmani S. Residues of Diclofenac in Tissues of Vultures in India: A Post-ban Scenario. Arch Environ Contam Toxicol. 2018 Feb 1;74(2):292–7.

58. Prakash V, Bishwakarma MC, Chaudhary A, Cuthbert R, Dave R, Kulkarni M, et al. The Population Decline of Gyps Vultures in India and Nepal Has Slowed since Veterinary Use of Diclofenac was Banned. PLOS ONE. 2012 Nov 7;7(11):e49118.

Supplementary file 1

Example search string framed by core concepts

Example from Scopus search, all terms in TITLE-ABS-KEY; Block 1 AND 2 AND 3 AND 4

Block 1 - Spillover pathway **(**Animal populations and human-animal interface)

Spillover OR “spill over” OR “cross-species transmission” OR poultry OR wildlife OR bushmeat OR “bush meat” OR livestock OR “animal market*” OR “wet market*” OR “bird market*” OR horse* OR waterfowl OR fowl OR bat OR bats OR mammal* OR swine OR pig* OR poaching OR “pet trade” OR pork OR “trade W/5 animal”

Block 2 – Public policy

policy OR law OR legal OR legislat* OR regulat* OR tariff OR subsidy OR tax OR ban OR “voluntary agreement” OR incentive OR fiscal OR guidelines OR govern* OR federal* OR closure OR closing OR state* OR “rest day*” OR “border control*” OR “habitat protection” OR “wetland protection” OR “supplement* fed” OR “supplement* feed*” OR “market size”

Block 3 – Prevention

Prevent* OR “ecological intervention*” OR “non-pharmaceutical intervention*” OR “public health” OR “risk management” OR “risk minimisation” OR “control strateg*” OR “outbreak risk” OR “reduc* W/5 transmission” OR “reduc* W/5 infection”

Block 4 - Zoonotic pathogens

Zika OR ebola OR covid-19 OR sars-cov-2 OR coronavirus OR sars OR mers OR h1n1 OR h7n9 OR h5n1 OR “one health” OR dengue OR “nipah virus” OR influenza OR zoonoses OR zoonosis OR zoonotic OR “West Nile” OR “HIV/AIDS” OR “avian flu” OR “hendra virus” OR “marburg virus” OR “yellow fever” OR “tick-borne encephalitis” OR “emerging infectious diseases” OR “emergent infectious diseases” OR brucellosis OR rabies OR chikungunya OR “bovine spongiform encephalopathy” OR “rift valley fever”

Search strings for all included academic databases

Scopus search

TITLE-ABS-KEY(Zika OR ebola OR covid-19 OR sars-cov-2 OR coronavirus OR sars OR mers OR h1n1 OR h7n9 OR h5n1 OR “one health” OR dengue OR “nipah virus” OR influenza OR zoonoses OR zoonosis OR zoonotic OR “West Nile” OR “HIV/AIDS” OR “avian flu” OR “hendra virus” OR “marburg virus” OR “yellow fever” OR “tick-borne encephalitis” OR “emerging

infectious diseases" OR "emergent infectious diseases" OR brucellosis OR rabies OR chikungunya OR "bovine spongiform encephalopathy" OR "rift valley fever") AND TITLE-ABS-KEY(Spillover OR "spill over" OR "cross-species transmission" OR poultry OR wildlife OR bushmeat OR "bush meat" OR livestock OR "animal market*" OR "wet market*" OR "bird market*" OR horse* OR waterfowl OR fowl OR bat OR bats OR mammal* OR swine OR pig* OR poaching OR "pet trade" OR pork OR "trade W/5 animal") AND TITLE-ABS-KEY(policy OR law OR legal OR legislat* OR regulat* OR tariff OR subsidy OR tax OR ban OR "voluntary agreement" OR incentive OR fiscal OR guidelines OR govern* OR federal* OR closure OR closing OR state* OR "rest day*" OR "border control*" OR "habitat protection" OR "wetland protection" OR "supplement* fed" OR "supplement* feed*" OR "market size") AND TITLE-ABS-KEY(Prevent* OR "ecological intervention*" OR "non-pharmaceutical intervention*" OR "public health" OR "risk management" OR "risk minimisation" OR "control strateg*" OR "outbreak risk" OR "reduc* W/5 transmission" OR "reduc* W/5 infection")

Medline search

(((Zika[Title/Abstract] OR ebola[Title/Abstract] OR covid-19[Title/Abstract] OR sars-cov-2[Title/Abstract] OR coronavirus[Title/Abstract] OR sars[Title/Abstract] OR mers[Title/Abstract] OR h1n1[Title/Abstract] OR h7n9[Title/Abstract] OR h5n1[Title/Abstract] OR "one health"[Title/Abstract] OR dengue[Title/Abstract] OR "nipah virus"[Title/Abstract] OR influenza[Title/Abstract] OR zoonoses[Title/Abstract] OR zoonosis[Title/Abstract] OR zoonotic[Title/Abstract] OR "West Nile"[Title/Abstract] OR "HIV/AIDS"[Title/Abstract] OR "avian flu"[Title/Abstract] OR "hendra virus"[Title/Abstract] OR "marburg virus"[Title/Abstract] OR "yellow fever"[Title/Abstract] OR "tick-borne encephalitis"[Title/Abstract] OR "emerging infectious diseases"[Title/Abstract] OR "emergent infectious diseases"[Title/Abstract] OR brucellosis[Title/Abstract] OR rabies[Title/Abstract] OR chikungunya[Title/Abstract] OR "bovine spongiform encephalopathy"[Title/Abstract] OR "rift valley fever"[Title/Abstract] OR zoonoses [mesh]) AND (Spillover[Title/Abstract] OR "spill over"[Title/Abstract] OR "cross-species transmission"[Title/Abstract] OR poultry[Title/Abstract] OR wildlife[Title/Abstract] OR bushmeat[Title/Abstract] OR "bush meat"[Title/Abstract] OR livestock[Title/Abstract] OR "animal market"[Title/Abstract] OR "animal markets"[Title/Abstract] OR "wet market"[Title/Abstract] OR "wet markets"[Title/Abstract] OR "bird market"[Title/Abstract] OR "bird markets"[Title/Abstract] OR horse[Title/Abstract] OR horses[Title/Abstract] OR waterfowl[Title/Abstract] OR fowl[Title/Abstract] OR bat[Title/Abstract] OR bats[Title/Abstract] OR mammal[Title/Abstract] OR

mammals[Title/Abstract] OR mammalian[Title/Abstract] OR swine[Title/Abstract] OR pig[Title/Abstract] OR pigs[Title/Abstract] OR poaching[Title/Abstract] OR "pet trade"[Title/Abstract] OR pork[Title/Abstract] OR animal N5 trade[Title/Abstract] OR disease reservoir [mesh])) AND (policy[Title/Abstract] OR law[Title/Abstract] OR legal[Title/Abstract] OR legislation[Title/Abstract] OR legislative[Title/Abstract] OR legislating[Title/Abstract] OR regulation[Title/Abstract] OR regulations[Title/Abstract] OR regulatory[Title/Abstract] OR tariff[Title/Abstract] OR subsidy[Title/Abstract] OR tax[Title/Abstract] OR ban[Title/Abstract] OR "voluntary agreement"[Title/Abstract] OR incentive[Title/Abstract] OR fiscal[Title/Abstract] OR guidelines[Title/Abstract] OR government[Title/Abstract] OR governments[Title/Abstract] OR federal[Title/Abstract] OR federally[Title/Abstract] OR closure[Title/Abstract] OR closing[Title/Abstract] OR state[Title/Abstract] OR "rest day"[Title/Abstract] OR "rest days"[Title/Abstract] OR "border control"[Title/Abstract] OR "border controls"[Title/Abstract] OR "habitat protection"[Title/Abstract] OR "wetland protection"[Title/Abstract] OR "supplemental feeding"[Title/Abstract] OR "market size"[Title/Abstract])) AND (Prevent[Title/Abstract] OR prevention[Title/Abstract] OR "ecological intervention"[Title/Abstract] OR "ecological interventions"[Title/Abstract] OR "non-pharmaceutical intervention"[Title/Abstract] OR "non-pharmaceutical interventions"[Title/Abstract] OR "public health"[Title/Abstract] OR "risk management"[Title/Abstract] OR "risk minimisation"[Title/Abstract] OR "control strategy"[Title/Abstract] OR "control strategies"[Title/Abstract] OR "outbreak risk"[Title/Abstract] OR reducing N5 transmission[Title/Abstract] OR reducing N5 infection[Title/Abstract])

Web of knowledge search

AB=(Zika OR ebola OR covid-19 OR sars-cov-2 OR coronavirus OR sars OR mers OR h1n1 OR h7n9 OR h5n1 OR “one health” OR dengue OR “nipah virus” OR influenza OR zoonoses OR zoonosis OR zoonotic OR “West Nile” OR “HIV/AIDS” OR “avian flu” OR “hendra virus” OR “marburg virus” OR “yellow fever” OR “tick-borne encephalitis” OR “emerging infectious diseases” OR “emergent infectious diseases” OR brucellosis OR rabies OR chikungunya OR “bovine spongiform encephalopathy” OR “rift valley fever”)

AND

AB=(Spillover OR “spill over” OR “cross-species transmission” OR poultry OR wildlife OR bushmeat OR “bush meat” OR livestock OR “animal market*” OR “wet market*” OR “bird

market*" OR horse* OR waterfowl OR fowl OR bat OR bats OR mammal* OR swine OR pig* OR poaching OR "pet trade" OR pork OR trade NEAR animal)

AND

AB=(policy OR law OR legal OR legislat* OR regulat* OR tariff OR subsidy OR tax OR ban OR "voluntary agreement" OR incentive OR fiscal OR guidelines OR govern* OR federal* OR closure OR closing OR state* OR "rest day*" OR "border control*" OR "habitat protection" OR "wetland protection" OR "supplement* fed" OR "supplement* feed*" OR "market size")

AND

AB=(Prevent* OR "ecological intervention*" OR "non-pharmaceutical intervention*" OR "public health" OR "risk management" OR "risk minimisation" OR "control strateg*" OR "outbreak risk" OR reduc* NEAR transmission OR reduc* NEAR infection)

Ovid Global Health database search (all in abstract)

Zika OR ebola OR covid-19 OR sars-cov-2 OR coronavirus OR sars OR mers OR h1n1 OR h7n9 OR h5n1 OR one health OR dengue OR nipah virus OR influenza OR zoonoses OR zoonosis OR zoonotic OR West Nile OR HIV/AIDS OR avian flu OR hendra virus OR marburg virus OR yellow fever OR tick-borne encephalitis OR emerging infectious diseases OR emergent infectious diseases OR brucellosis OR rabies OR chikungunya OR bovine spongiform encephalopathy OR rift valley fever

AND

Spillover OR spill over OR cross-species transmission OR poultry OR wildlife OR bushmeat OR bush meat OR livestock OR animal market* OR wet market* OR bird market* OR horse* OR waterfowl OR fowl OR bat OR bats OR mammal* OR swine OR pig* OR poaching OR pet trade OR pork OR (trade adj5 animal)

AND

policy OR law OR legal OR legislat* OR regulat* OR tariff OR subsidy OR tax OR ban OR voluntary agreement OR incentive OR fiscal OR guidelines OR govern* OR federal* OR closure OR closing OR state* OR rest day* OR border control* OR habitat protection OR wetland protection OR supplement* fed OR supplement* feed* OR market size

AND

Prevent* OR ecological intervention* OR non-pharmaceutical intervention* OR public health OR risk management OR risk minimisation OR control strateg* OR outbreak risk OR (reduc* adj5 transmission) OR (reduc* adj5 infection)

Supplementary file 2

Data charting form

Record	Author(s)
	Year
Policy	Country
	World region (World Bank grouping) (44)
	Country income (World Bank grouping) (44)
	Disease
	Stakeholders or sector responsible for implementing policy (retail, agriculture, conservation, etc.)
	Implementation date (start date, or range if the policy has been changed)
	Intervention type
	Location along spillover pathway adapted from Plowright et al. (7,21)
	Policy level (local, national, regional, global)
	Multi-sectoral initiative (Y/N)
	Sector(s) responsible for policy
Evaluation	Aim
	Type (Process/outcome)
	Study design
	Theoretical framework and/or logic model underpinning evaluation (if described)
	Period of observation
	Outcome measure(s) and change in measure(s)
	Consideration of unintended consequences (Y/N)
	If yes, which unintended consequences? (e.g., economic outcomes, food security)

PRISMA-P 2015 Checklist

This checklist has been adapted for use with systematic review protocol submissions to BioMed Central journals from Table 3 in Moher D et al: Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Systematic Reviews* 2015 **4**:1

An Editorial from the Editors-in-Chief of *Systematic Reviews* details why this checklist was adapted - **Moher D, Stewart L & Shekelle P:** Implementing PRISMA-P: recommendations for prospective authors. *Systematic Reviews* 2016 **5**:15

Section/topic	#	Checklist item	Information reported		Line number(s)
			Yes	No	
ADMINISTRATIVE INFORMATION					
Title					
Identification	1a	Identify the report as a protocol of a systematic review	☒	☐	p.1 l.1-2
Update	1b	If the protocol is for an update of a previous systematic review, identify as such	☐	☒	N/A
Registration	2	If registered, provide the name of the registry (e.g., PROSPERO) and registration number in the Abstract	☐	☒	N/A
Authors					
Contact	3a	Provide name, institutional affiliation, and e-mail address of all protocol authors; provide physical mailing address of corresponding author	☒	☐	p.1 l.3-25
Contributions	3b	Describe contributions of protocol authors and identify the guarantor of the review	☒	☐	p.12 l.16-18
Amendments	4	If the protocol represents an amendment of a previously completed or published protocol, identify as such and list changes; otherwise, state plan for documenting important protocol amendments	☐	☒	N/A
Support					
Sources	5a	Indicate sources of financial or other support for the review	☒	☐	p.12 l.14-16
Sponsor	5b	Provide name for the review funder and/or sponsor	☒	☐	p.12 l.14-16
Role of sponsor/funder	5c	Describe roles of funder(s), sponsor(s), and/or institution(s), if any, in developing the protocol	☒	☐	p.12 l.16
INTRODUCTION					
Rationale	6	Describe the rationale for the review in the context of what is already known	☒	☐	p.4-6
Objectives	7	Provide an explicit statement of the question(s) the review will address with reference to	☒	☐	p.6 l.12-27

Section/topic	#	Checklist item	Information reported		Line number(s)
			Yes	No	
		participants, interventions, comparators, and outcomes (PICO)			
METHODS					
Eligibility criteria	8	Specify the study characteristics (e.g., PICO, study design, setting, time frame) and report characteristics (e.g., years considered, language, publication status) to be used as criteria for eligibility for the review	☒	☐	p.8 l.2-8
Information sources	9	Describe all intended information sources (e.g., electronic databases, contact with study authors, trial registers, or other grey literature sources) with planned dates of coverage	☒	☐	p.7 l.19-20
Search strategy	10	Present draft of search strategy to be used for at least one electronic database, including planned limits, such that it could be repeated	☒	☐	p.11
STUDY RECORDS					
Data management	11a	Describe the mechanism(s) that will be used to manage records and data throughout the review	☒	☐	p.8 l.3-4; 20-24
Selection process	11b	State the process that will be used for selecting studies (e.g., two independent reviewers) through each phase of the review (i.e., screening, eligibility, and inclusion in meta-analysis)	☒	☐	p.8 l.9-16
Data collection process	11c	Describe planned method of extracting data from reports (e.g., piloting forms, done independently, in duplicate), any processes for obtaining and confirming data from investigators	☒	☐	p.8 l.19-25
Data items	12	List and define all variables for which data will be sought (e.g., PICO items, funding sources), any pre-planned data assumptions and simplifications	☒	☐	Table 2, p.8-9
Outcomes and prioritization	13	List and define all outcomes for which data will be sought, including prioritization of main and additional outcomes, with rationale	☐	☒	N/A – scoping review
Risk of bias in individual studies	14	Describe anticipated methods for assessing risk of bias of individual studies, including whether this will be done at the outcome or study level, or both; state how this information will be used in data synthesis	☒	☐	p.9 l.3-6
DATA					
Synthesis	15a	Describe criteria under which study data will be quantitatively synthesized	☒	☐	Table 2, p.8-9
	15b	If data are appropriate for quantitative synthesis, describe planned summary measures, methods of handling data, and methods of combining data from studies, including any planned exploration of consistency (e.g., I^2, Kendall's tau)	☐	☒	N/A
	15c	Describe any proposed additional analyses (e.g., sensitivity or subgroup analyses, meta-regression)	☐	☒	N/A
	15d	If quantitative synthesis is not appropriate, describe the type of summary planned	☒	☐	p.9 l.7-10, p.10 l.1-2
Meta-bias(es)	16	Specify any planned assessment of meta-bias(es) (e.g., publication bias across studies, selective	☐	☒	N/A – scoping

Section/topic	#	Checklist item	Information reported		Line number(s)
			Yes	No	
		reporting within studies)			review
Confidence in cumulative evidence	17	Describe how the strength of the body of evidence will be assessed (e.g., GRADE)	☐	☒	N/A – scoping review

BMJ Open

Policies to prevent zoonotic spillover: protocol for a systematic scoping review of evaluative evidence

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2021-058437.R2
Article Type:	Protocol
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Primary Subject Heading:	Health policy
Secondary Subject Heading:	Global health, Health policy, Infectious diseases
Keywords:	Public health < INFECTIOUS DISEASES, Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, PUBLIC HEALTH

Policies to prevent zoonotic spillover: protocol for a systematic scoping review of evaluative evidence

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Abstract

Introduction

The increasing incidence of pathogen transmission from animals to humans (zoonotic spillover events) has been attributed to behavioural practices and ecological and socioeconomic change. As these events sometimes involve pathogens with epidemic or pandemic potential, they pose a serious threat to population health. Public policies may play a key role in preventing these events. The aim of this review is to identify evaluations of public policies that target the determinants of zoonotic spillover, examining approaches taken to evaluation, choice of outcomes measures and evidence of effectiveness. Our approach to identifying and analysing this literature will be informed by a One Health lens, acknowledging the inter-connectedness of human, animal and environmental health.

Methods and analysis

A systematic scoping review methodology will be used. To identify articles, we will search Medline, SCOPUS, Web of Science and Global Health in March 2022 using search terms combining animal health and the animal-human interface, public policy, prevention and zoonoses. We will screen titles and abstracts and extract data according to published guidelines for scoping reviews. All evaluations of public policies aiming to prevent zoonotic spillover events will be eligible for inclusion. We will summarise key data from each study, mapping policies along the spillover pathway and outlining the range of policies, approaches to evaluation and outcome measures. Review findings will provide a useful reference for researchers and practitioners, outlining the state of the evaluative evidence around policies to prevent zoonotic spillover.

Ethics and dissemination

Formal ethical approval is not required, because the study does not involve primary data collection. The findings of this study will be disseminated through a peer-reviewed publication, presentations, and summaries for key stakeholders.

Strengths and limitations

- This scoping review protocol outlines the first piece of work to systematically identify and review evaluations of public policies designed to prevent zoonotic spillover, and will be undertaken in line with published guidelines for best practice in scoping reviews.
- The review will be informed by a One Health lens, encompassing distal determinants and risk factors for spillover events and acknowledging the interconnectedness of human, animal and environmental health.

- Due to the complex drivers of spillover events, some potentially relevant policy evaluations may not be identified where outcome measures are too far removed from zoonotic spillover.

Introduction

The increasing incidence of zoonotic emerging infectious diseases (EIDs) has been attributed to behavioural practices and ecological and socioeconomic change, and is predicted to continue in the coming years (1). Higher levels of anthropogenic activity, including agricultural intensification, urbanisation and other forms of land use change, have led to increased interactions between wildlife, humans and livestock, increasing the risk of cross-species transmission (2,3). In response, a call has been issued by leading organisations and experts, including the United Nations Environment Programme, the International Livestock Research Institute and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, to complement reactive policy responses with policies that prevent zoonotic EIDs (1,4–7).

Preventing zoonotic spillover from a One Health perspective

Zoonotic spillover, defined as the transmission of a pathogen from an animal to a human, depends on the alignment of ecological, epidemiological and behavioural factors (8). Zoonotic pathogens must meet a series of conditions in order to induce spillover infections in humans, including appropriate density and distribution of reservoir hosts, pathogen prevalence, infection intensity and human exposure (8). Across this transmission pathway, a number of drivers of zoonotic spillover have been identified, including changes in wildlife and livestock populations (9); deforestation, urbanisation and other forms of land use change (10); and a variety of human practices including hunting, farming, animal husbandry, keeping of exotic pets and trade (6,7,11,12). These large-scale changes have on multiple occasions given rise to spillover events, sometimes involving pathogens with epidemic or pandemic potential.

A One Health perspective, which recognises the health of humans, animals and ecosystems as being closely linked and inter-dependent (13), can be useful in conceptualizing a range of potential determinants of spillover events. From this perspective, interventions could include surveillance of pools of viruses in wildlife and management of wildlife populations (14); enhanced food safety measures in both the wildlife and livestock value chain, pre- and post-farm gate (12,15–17); replacement of traditional 'wet' markets with supermarkets (18); controls on wildlife hunting, trade and consumption (11,19,20); and phasing out of unsustainable agriculture practices (6,21).

While some evaluative evidence exists around the effectiveness of interventions (22–25), they have often been implemented as short- to medium-term programmes or academic investigations (6). In some cases, zoonoses have re-emerged after successful programmes have ended (25). As a result, experts have argued for the incorporation of successful

interventions into policy frameworks, providing interventions with the sustainability required for long-term disease control (6).

Governance, systems and the role of multi-sectoral actors

Public policy is 'a set of interrelated decisions taken by a political actor or group of actors concerning the selection of goals and the means of achieving them' (26). Public policy decisions are ultimately in the hands of government and supranational governing bodies, and have greater longevity compared to many programmes, which are often implemented for a fixed term. Non-government actors, including vested interest stakeholders, can also play a powerful role in shaping government decisions (27,28).

Although the longevity and scope of government actions may make policy an effective vehicle for prevention of emergent diseases, implementing policy is a complex process involving numerous stakeholders with competing views and interests (29). The responsibility for addressing zoonotic disease frequently spans multiple sectors of governance due to its relevance for both animals and humans. Where relevant policies are designed and implemented in isolation, opportunities for synergy may be missed and efforts may even be counter-productive.

Successful policy measures require not only a sound evidence base, but also governance structures that enable action to be taken. Given the range of possible risk factors that might contribute to emerging zoonoses, and the possible impacts of policies to prevent zoonotic spillover, a One Health response has been advocated, requiring coordination between institutions and government departments involved in human and animal health, trade, agriculture and the environment (30). At the international level, the World Health Organization, the Food and Agriculture Organization and the World Organisation for Animal Health have endorsed a One Health policy framework to respond to zoonotic infectious diseases, emphasising collaboration between agencies (31). Within countries, national and local governments have also emphasised the need for multi-sectoral efforts, although many report that further integration is still required (32).

Further, given the complex social-ecological systems within which policies to prevent zoonotic spillover are implemented, the risk of unintended consequences is high. For example, region-specific closures of live animal markets have been shown to spread pathogens further afield as vendors seek new venues to sell their animals (33). Meanwhile, attempts to manage populations of wild animals may alter pathogen dynamics, unintentionally increasing the risk of spillover into livestock or people (34).

Given these particular characteristics of policy development and implementation, they may be usefully considered as a particular case of intervention, and the evidence around them

assessed accordingly. Different types of interventions might be more or less feasibly implemented by governments (or their partners), and their impacts might be different given potentially more complex implementation contexts, longer timespans and broader geographic ranges. Evaluations of these policies should also include consideration and monitoring of potential unintended consequences. In order to facilitate this, multi-sectoral involvement in both policy development and evaluation may be required.

Aims and scope

Approaches to managing epidemic and pandemic infectious pathogens once they have entered human populations have been systematically catalogued in the medical literature (35–41). These measures include hand washing, face masks, school closures, and contact tracing and case isolation. Further upstream, systematic reviews of interventions targeting the spillover pathway have predominantly focused on programmes rather than policies, and have been restricted by various characteristics such as geographic region (24) or pathogen type (25), or focused on programmes with an explicit endorsement of a One Health approach (23). In consequence, a comprehensive understanding of how policies to prevent zoonotic spillover have been evaluated, and what evidence there is of their effectiveness, is lacking. To address these research gaps, our objectives are to:

1. Identify evaluations of policies that target the determinants of zoonotic spillover included in the spillover pathway (8) (i.e. human and animal health and interactions);
2. Identify insights around policy success and failure, and unintended consequences of policy implementation; and
3. Describe approaches to evaluation and key barriers and facilitators to evaluating policies to reduce the risk of zoonotic spillover.

Our approach to identifying and analysing this literature will be informed by a One Health lens, acknowledging the inter-connectedness of human, animal and environmental health.

Methods and analysis

We will conduct a systematic scoping review of evaluations of policies aimed at preventing zoonotic spillover events. The scoping review will be conducted in line with guidelines published by Arksey and O'Malley and refined by Levac and colleagues (42–44), which emphasise an iterative approach suited to an exploratory research question.

Stage 1: Identifying the research question

The aim of this review is to use a One Health lens to identify and describe the range of policies that have been evaluated, the approaches to evaluation, and the evaluative evidence. Informed by this aim, our research questions are:

1. What policies aimed at preventing zoonotic spillover have been evaluated?
    a. What are the types of policies?
    b. Which policy actors (single department, multi-sectoral, whole of government) are engaged?
2. What are the reasons for policy success and failure, and the unintended consequences of implementing these policies?
3. How has evaluation of these policies been approached in the literature?
    a. What are the methods or study designs used?
    b. What are the outcomes?
    c. What are the barriers and facilitators to evaluation?

Stage 2: Identifying relevant studies

We searched four electronic databases (Medline, Scopus, Web of Science, Global Health) in May 2021. The search strategy is organized by the main concepts in our research question: the spillover pathway; public policy; prevention; and zoonotic pathogens. The search strategy was developed iteratively, informed by existing systematic reviews focused on related concepts (24,45–49) and known indicator papers meeting inclusion criteria. We also searched the websites of 18 organisations involved in the prevention of zoonotic spillover to identify relevant grey literature. See Supplementary File 1 for details of search strategy and websites searched.

Stage 3: Study selection

Records identified through the searches will be collated and double screened using the online platform Covidence (50). Studies will be included where they meet all of the following criteria:

1. Primary empirical study from any country or region with English-language abstracts;
2. Report empirical findings from an evaluation of any sort; and

3. Focus on a policy implemented by government that targets a determinant of zoonotic spillover located on the spillover pathway (see Figure 1).

[Insert Figure 1]

Figure 1 Spillover pathway adapted from Plowright et al. (8,22)

Titles and abstracts will initially be screened, followed by full-text screening. Title and abstract screening of an initial set of 100 papers will be undertaken by two independent researchers. Results will be compared in order to ensure consistency in decisions around study eligibility, and discrepancies resolved through discussion of the inclusion criteria. This process will be repeated until an acceptable level of agreement (>90%) is reached. The remaining papers will then be screened by one of the two reviewers. Full-text screening will be undertaken by two independent researchers and discrepancies will be resolved by discussing reasons for inclusion or exclusions among the screeners. Studies with full-texts in languages other than English will be eligible for inclusion if they include an English-language abstract. Full-text studies published in French, Spanish or Chinese will be single-screened by a member of the research team fluent in that language. Studies published in other languages will be translated as necessary.

In line with published guidelines, the approach to study selection may be refined iteratively when reviewing articles for inclusion (42–44). Reporting on the search and screening process will follow the guidelines provided in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (51).

Stage 4: Charting the data

Data charting will be conducted using a data charting form designed to identify the information required to answer the research question and sub-research questions (see Supplementary File 2). Data charting focused on characteristics of the study, the policy and the evaluation. For each policy, this included identifying which determinant of zoonotic spillover situated along the spillover pathway was being targeted. For the purpose of this study, we used a model of the spillover pathway adapted from Plowright et al.'s work (8,22), in which we differentiated between wildlife and domesticated animals (Figure 1). This differentiation is important in the policy context, as the wildlife-domesticated animal interface is an important site for intervention, as well as the human-animal interface.

As recommended, the data charting form will be piloted with ten records to ensure that it is consistent with the research question, and the data charting form will be revised iteratively in order to ensure the purpose of the research is being met (42–44).

Stage 5: Collating, summarising and reporting the results

We will undertake quality assessment of the included studies using the Quality Assessment Tool for Quantitative Studies developed by the Effective Public Health Practice Project (52), which has previously been used to assess the quality of natural experiments including public policy evaluations (53).

We will analyse the extracted data, presenting a numerical summary of the included studies in table form, allowing us to describe the range of policy interventions that have been evaluated, approaches to evaluation, and evidence of effectiveness. We will also conduct a thematic analysis of the contents of the included articles in order to identify, if possible, barriers and facilitators to implementing and evaluating these policies, as well as insights into why policies succeeded or failed in achieving their aims.

Patient and public involvement

This scoping review is being undertaken as part of a larger project involving policy actors at national and international levels as research team members, knowledge users and participants. Insights from the project have informed protocol development and stakeholders are able to provide input and perspectives on the results of the review. Project-level dissemination events involving policy stakeholders are also planned, where findings from the proposed review will be shared.

Strengths and weaknesses of the study

To our knowledge, this is the first attempt to systematically identify and document evaluations of policies aiming to prevent the spillover of zoonoses into human populations. However, because of the complex drivers of spillover events, some potentially relevant policy evaluations may be excluded where their outcome measures are too far removed from zoonotic spillover. For example, it has been hypothesised that declines in vulture populations may increase the risk of pathogen transmission by increasing the number of uneaten carcasses, as well as, potentially, the population of feral dogs (54). In 2006, India, Pakistan and Nepal implemented a ban on the veterinary drug diclofenac, which had been identified as a driver of declining vulture populations. While policy evaluations suggest that this ban has resulted in a resurgence of vultures (55–58), the knock-on effects of this on zoonotic pathogen transmission risk have not been included in these evaluations. While relevant, such evaluations will be difficult to systematically identify as they make no reference to zoonotic disease.

In addition, this review will focus on policy evaluations that have been reported in the peer-reviewed and grey literature. Policies that have been implemented but not evaluated, or evaluated but not reported in the literature, will therefore be excluded from this review. As a result, potentially effective and important policies in the prevention of zoonotic spillover events

may not be identified. However, we hope that the findings from this review will highlight these gaps in the evaluative evidence. We also hope that this review, by extracting practical dimensions such as study design, outcome measures and the challenges encountered in the evaluation process, will support policymakers and researchers in carrying out policy evaluations in this space.

Ethics and dissemination

Formal ethical approval is not required, because the study does not involve primary data collection. The findings of this study will be disseminated through a peer-reviewed publication, presentations, and summaries for key stakeholders.

List of abbreviations

EID: Emerging infectious disease

Declarations

Ethics approval and consent to participate

Not applicable.

Patient consent for publication

Not applicable.

Availability of data and material

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

Competing interests

The authors declare that they have no competing interests.

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Contributors

CCA, KML and TLP conceived and designed the study. CCA prepared the manuscript. KML, TLP, RA, AA, MB, JC, RL, AR, KCT, AMV, MW and AY provided critical input on the manuscript and methods and have read and approved the final manuscript.

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References

1. Morse SS, Mazet JA, Woolhouse M, Parrish CR, Carroll D, Karesh WB, et al. Prediction and prevention of the next pandemic zoonosis. The Lancet. 2012 Dec 1;380(9857):1956–65.

2. Pulliam JRC, Epstein JH, Dushoff J, Rahman SA, Bunning M, Jamaluddin AA, et al. Agricultural intensification, priming for persistence and the emergence of Nipah virus: a lethal bat-borne zoonosis. Journal of The Royal Society Interface. 2012 Jan 7;9(66):89–101.

3. IPCC. Climate Change 2022: Impacts, Adaptation and Vulnerability [Internet]. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press [In press]; 2022 [cited 2022 Mar 7]. Available from: https://www.ipcc.ch/report/ar6/wg2/

4. Marco MD, Baker ML, Daszak P, Barro PD, Eskew EA, Godde CM, et al. Opinion: Sustainable development must account for pandemic risk. PNAS. 2020 Feb 25;117(8):3888–92.

5. Heymann DL, Dixon M. Infections at the Animal/Human Interface: Shifting the Paradigm from Emergency Response to Prevention at Source. In: Mackenzie JS, Jeggo M, Daszak P, Richt JA, editors. One Health: The Human-Animal-Environment Interfaces in Emerging Infectious Diseases: Food Safety and Security, and International and National Plans for Implementation of One Health Activities [Internet]. Berlin, Heidelberg: Springer; 2013 [cited 2021 Apr 6]. p. 207–15. (Current Topics in Microbiology and Immunology). Available from: https://doi.org/10.1007/82_2012_285

6. United Nations Environment Programme, International Livestock Research Institute. Preventing the next pandemic: Zoonotic diseases and how to break the chain of transmission. Nairobi, Kenya; 2020 p. 82.

7. Intergovernmental Science-Policy Platform On Biodiversity And Ecosystem Services (IPBES). Workshop Report on Biodiversity and Pandemics of the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) [Internet]. Zenodo; 2020 Oct [cited 2021 Jan 7]. Available from: https://zenodo.org/record/4147317

8. Plowright RK, Parrish CR, McCallum H, Hudson PJ, Ko AI, Graham AL, et al. Pathways to zoonotic spillover. Nat Rev Microbiol. 2017;15(8):502–10.

9. Johnson CK, Hitchens PL, Pandit PS, Rushmore J, Evans TS, Young CCW, et al. Global shifts in mammalian population trends reveal key predictors of virus spillover risk. Proceedings of the Royal Society B: Biological Sciences. 2020 Apr 8;287(1924):20192736.

10. Allen T, Murray KA, Zambrana-Torrelio C, Morse SS, Rondinini C, Di Marco M, et al. Global hotspots and correlates of emerging zoonotic diseases. Nature Communications. 2017 Oct 24;8(1):1124.

11. Aguirre AA, Catherina R, Frye H, Shelley L. Illicit Wildlife Trade, Wet Markets, and COVID-19: Preventing Future Pandemics. World Medical & Health Policy. 2020;12(3):256–65.

12. Nadimpalli ML, Pickering AJ. A call for global monitoring of WASH in wet markets. The Lancet Planetary Health. 2020 Oct 1;4(10):e439–40.

13. Joint Tripartite (FAO, OIE, WHO) and UNEP Statement. Tripartite and UNEP support OHHLEP's definition of "One Health" [Internet]. OIE - World Organisation for Animal Health. 2021 [cited 2022 Feb 18]. Available from: https://www.oie.int/en/tripartite-and-unep-support-ohhleps-definition-of-one-health/

14. Kelly TR, Karesh WB, Johnson CK, Gilardi KVK, Anthony SJ, Goldstein T, et al. One Health proof of concept: Bringing a transdisciplinary approach to surveillance for zoonotic viruses at the human-wild animal interface. Preventive Veterinary Medicine. 2017 Feb 1;137:112–8.

15. Aiyar A, Pingali P. Pandemics and food systems - towards a proactive food safety approach to disease prevention & management. Food Sec. 2020 Aug 1;12(4):749–56.

16. Sasaki Y, Furutani A, Furuichi T, Hayakawa Y, Ishizeki S, Kano R, et al. Development of a biosecurity assessment tool and the assessment of biosecurity levels by this tool on Japanese commercial swine farms. Preventive Veterinary Medicine. 2020 Feb 1;175:104848.

17. Soon JM, Abdul Wahab IR. On-site hygiene and biosecurity assessment: A new tool to assess live bird stalls in wet markets. Food Control. 2021 Sep 1;127:108108.

18. Maruyama M, Wu L, Huang L. The modernization of fresh food retailing in China: The role of consumers. Journal of Retailing and Consumer Services. 2016 May 1;30:33–9.

19. Challender DWS, Harrop SR, MacMillan DC. Towards informed and multi-faceted wildlife trade interventions. Global Ecology and Conservation. 2015 Jan 1;3:129–48.

20. Gómez A, Aguirre AA. Infectious Diseases and the Illegal Wildlife Trade. Annals of the New York Academy of Sciences. 2008 Dec;1149(1):16–9.

21. Kessler MK, Becker DJ, Peel AJ, Justice NV, Lunn T, Crowley DE, et al. Changing resource landscapes and spillover of henipaviruses. Annals of the New York Academy of Sciences. 2018;1429(1):78–99.

22. Sokolow SH, Nova N, Pepin KM, Peel AJ, Pulliam JRC, Manlove K, et al. Ecological interventions to prevent and manage zoonotic pathogen spillover. Philosophical Transactions of the Royal Society B: Biological Sciences. 2019 Sep 30;374(1782):20180342.

23. Baum SE, Machalaba C, Daszak P, Salerno RH, Karesh WB. Evaluating one health: Are we demonstrating effectiveness? One Health. 2017 Jun 1;3:5–10.

24. Halton K, Sarna M, Barnett A, Leonardo L, Graves N. A systematic review of community-based interventions for emerging zoonotic infectious diseases in Southeast Asia. JBI Database System Rev Implement Rep. 2013 Feb;11(2):1–235.

25. Meyer A, Holt HR, Selby R, Guitian J. Past and Ongoing Tsetse and Animal Trypanosomiasis Control Operations in Five African Countries: A Systematic Review. PLOS Neglected Tropical Diseases. 2016 Dec 27;10(12):e0005247.

26. Jenkins WI. Policy Analysis: A Political and Organisational Perspective. M. Robertson; 1978. 278 p.

27. Renn O, Schweizer P-J. Inclusive risk governance: concepts and application to environmental policy making. Environmental Policy and Governance. 2009;19(3):174–85.

28. Keck ME, Sikkink K. Transnational advocacy networks in international and regional politics. International Social Science Journal. 1999;51(159):89–101.

29. Howlett M, Cashore B. Conceptualizing Public Policy. In: Engeli I, Allison CR, editors. Comparative Policy Studies: Conceptual and Methodological Challenges [Internet]. London: Palgrave Macmillan UK; 2014 [cited 2020 Oct 19]. p. 17–33. (Research Methods Series). Available from: https://doi.org/10.1057/9781137314154_2

30. Mazet JAK, Uhart MM, Keyyu JD. Stakeholders in One Health. Rev sci tech Off int Epiz. 2014 Aug;33(2):443–52.

31. Chien Y-J. How did international agencies perceive the avian influenza problem? The adoption and manufacture of the 'One World, One Health' framework. Sociology of Health & Illness. 2013;35(2):213–26.

32. Maxwell MJ, Carvalho MHF de, Hoet AE, Vigilato MAN, Pompei JC, Cosivi O, et al. Building the road to a regional zoonoses strategy: A survey of zoonoses programmes in the Americas. PLOS ONE. 2017 Mar 23;12(3):e0174175.

33. Li Y, Wang Y, Shen C, Huang J, Kang J, Huang B, et al. Closure of live bird markets leads to the spread of H7N9 influenza in China. PLoS One [Internet]. 2018 Dec 12 [cited 2021 Apr 6];13(12). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6291110/

34. Cotterill GG, Cross PC, Cole EK, Fuda RK, Rogerson JD, Scurlock BM, et al. Winter feeding of elk in the Greater Yellowstone Ecosystem and its effects on disease dynamics. Philosophical Transactions of the Royal Society B: Biological Sciences. 2018 May 5;373(1745):20170093.

35. Saunders-Hastings P, Crispo JAG, Sikora L, Krewski D. Effectiveness of personal protective measures in reducing pandemic influenza transmission: A systematic review and meta-analysis. Epidemics. 2017 Sep;20:1–20.

36. Bin Nafisah S, Alamery AH, Al Nafesa A, Aleid B, Brazanji NA. School closure during novel influenza: A systematic review. Journal of Infection and Public Health. 2018 Sep 1;11(5):657–61.

37. Viner RM, Russell SJ, Croker H, Packer J, Ward J, Stansfield C, et al. School closure and management practices during coronavirus outbreaks including COVID-19: a rapid systematic review. The Lancet Child & Adolescent Health. 2020 May 1;4(5):397–404.

38. Juneau C-E, Pueyo T, Bell M, Gee G, Collazzo P, Potvin L. Evidence-Based, Cost-Effective Interventions To Suppress The COVID-19 Pandemic: A Systematic Review. medRxiv. 2020 Jun 15;2020.04.20.20054726.

39. MacIntyre CR, Chughtai AA. Facemasks for the prevention of infection in healthcare and community settings. BMJ. 2015 Apr 9;350:h694.

40. Smith SMS, Sonego S, Wallen GR, Waterer G, Cheng AC, Thompson P. Use of non-pharmaceutical interventions to reduce the transmission of influenza in adults: A systematic review. Respirology. 2015 Aug;20(6):896–903.

41. Jefferson T, Del Mar CB, Dooley L, Ferroni E, Al-Ansary LA, Bawazeer GA, et al. Physical interventions to interrupt or reduce the spread of respiratory viruses. Cochrane Database Syst Rev. 2011 Jul 6;(7):CD006207.

42. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. International Journal of Social Research Methodology. 2005 Feb 1;8(1):19–32.

43. Levac D, Colquhoun H, O'Brien KK. Scoping studies: advancing the methodology. Implementation Sci. 2010 Sep 20;5(1):69.

44. Colquhoun HL, Levac D, O'Brien KK, Straus S, Tricco AC, Perrier L, et al. Scoping reviews: time for clarity in definition, methods, and reporting. Journal of Clinical Epidemiology. 2014 Dec 1;67(12):1291–4.

45. Zhou X, Wang Y, Liu H, Guo F, Doi SA, Smith C, et al. Effectiveness of Market-Level Biosecurity at Reducing Exposure of Poultry and Humans to Avian Influenza: A Systematic Review and Meta-Analysis. The Journal of Infectious Diseases. 2018 Nov 5;218(12):1861–75.

46. Conan A, Goutard FL, Sorn S, Vong S. Biosecurity measures for backyard poultry in developing countries: a systematic review. BMC Veterinary Research. 2012 Dec 7;8(1):240.

47. Youssef DM, Wieland B, Knight GM, Lines J, Naylor NR. The effectiveness of biosecurity interventions in reducing the transmission of bacteria from livestock to humans at the farm level: A systematic literature review. Zoonoses and Public Health. 2021;68(6):549–62.

48. Shi N, Huang J, Zhang X, Bao C, Yue N, Wang Q, et al. Interventions in Live Poultry Markets for the Control of Avian Influenza: A Systematic Review and Meta-analysis. The Journal of Infectious Diseases. 2020 Feb 3;221(4):553–60.

49. Cupertino MC, Resende MB, Mayer NA, Carvalho LM, Siqueira-Batista R. Emerging and re-emerging human infectious diseases: A systematic review of the role of wild animals with a focus on public health impact. Asian Pacific Journal of Tropical Medicine. 2020 Jan 3;13(3):99.

50. Covidence - Better systematic review management [Internet]. [cited 2020 Jul 17]. Available from: https://www.covidence.org/home

51. Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. Ann Intern Med. 2018 Oct 2;169(7):467–73.

52. Effective Public Health Practice Project. Quality Assessment Tool for Quantitative Studies [Internet]. 2009 [cited 2021 May 17] p. 4. Available from: https://merst.ca/wp-content/uploads/2018/02/quality-assessment-tool_2010.pdf

53. Bramante CT, Thornton RLJ, Bennett WL, Zhang A, Wilson RF, Bass EB, et al. Systematic Review of Natural Experiments for Childhood Obesity Prevention and Control. American Journal of Preventive Medicine. 2019 Jan 1;56(1):147–58.

54. Ogada DL, Torchin ME, Kinnaird MF, Ezenwa VO. Effects of Vulture Declines on Facultative Scavengers and Potential Implications for Mammalian Disease Transmission. Conservation Biology. 2012;26(3):453–60.

55. Chaudhry MJI, Ogada DL, Malik RN, Virani MZ, Giovanni MD. First evidence that populations of the critically endangered Long-billed Vulture *Gyps indicus* in Pakistan have increased following the ban of the toxic veterinary drug diclofenac in south Asia. Bird Conservation International. 2012 Dec;22(4):389–97.

56. Cuthbert R, Taggart MA, Prakash V, Saini M, Swarup D, Upreti S, et al. Effectiveness of Action in India to Reduce Exposure of Gyps Vultures to the Toxic Veterinary Drug Diclofenac. Willis SG, editor. PLoS ONE. 2011 May 11;6(5):e19069.

57. Nambirajan K, Muralidharan S, Roy AA, Manonmani S. Residues of Diclofenac in Tissues of Vultures in India: A Post-ban Scenario. Arch Environ Contam Toxicol. 2018 Feb 1;74(2):292–7.

58. Prakash V, Bishwakarma MC, Chaudhary A, Cuthbert R, Dave R, Kulkarni M, et al. The Population Decline of Gyps Vultures in India and Nepal Has Slowed since Veterinary Use of Diclofenac was Banned. PLOS ONE. 2012 Nov 7;7(11):e49118.

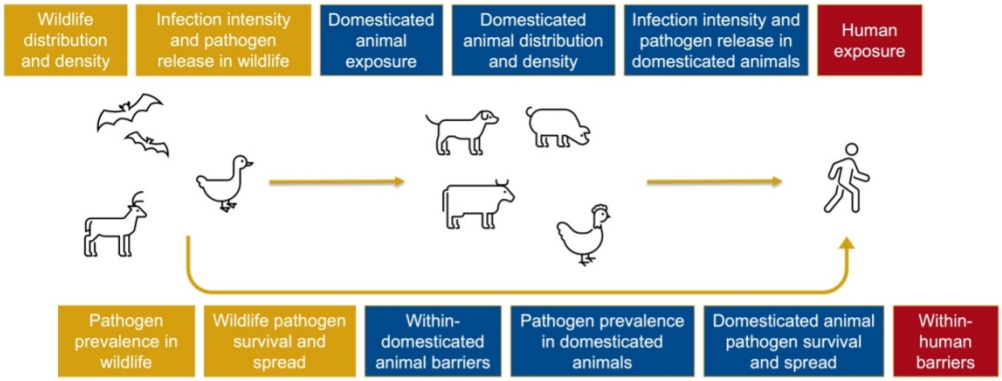

Figure 1 Spillover pathway adapted from Plowright et al. (8,22)

159x61mm (220 x 220 DPI)

Supplementary file 1

Example search string framed by core concepts

Example from Scopus search, all terms in TITLE-ABS-KEY; Block 1 AND 2 AND 3 AND 4

Block 1 - Spillover pathway **(**Animal populations and human-animal interface)

Spillover OR “spill over” OR “cross-species transmission” OR poultry OR wildlife OR bushmeat OR “bush meat” OR livestock OR “animal market*” OR “wet market*” OR “bird market*” OR horse* OR waterfowl OR fowl OR bat OR bats OR mammal* OR swine OR pig* OR poaching OR “pet trade” OR pork OR “trade W/5 animal”

Block 2 – Public policy

policy OR law OR legal OR legislat* OR regulat* OR tariff OR subsidy OR tax OR ban OR “voluntary agreement” OR incentive OR fiscal OR guidelines OR govern* OR federal* OR closure OR closing OR state* OR “rest day*” OR “border control*” OR “habitat protection” OR “wetland protection” OR “supplement* fed” OR “supplement* feed*” OR “market size”

Block 3 – Prevention

Prevent* OR “ecological intervention*” OR “non-pharmaceutical intervention*” OR “public health” OR “risk management” OR “risk minimisation” OR “control strateg*” OR “outbreak risk” OR “reduc* W/5 transmission” OR “reduc* W/5 infection”

Block 4 - Zoonotic pathogens

Zika OR ebola OR covid-19 OR sars-cov-2 OR coronavirus OR sars OR mers OR h1n1 OR h7n9 OR h5n1 OR “one health” OR dengue OR “nipah virus” OR influenza OR zoonoses OR zoonosis OR zoonotic OR “West Nile” OR “HIV/AIDS” OR “avian flu” OR “hendra virus” OR “marburg virus” OR “yellow fever” OR “tick-borne encephalitis” OR “emerging infectious diseases” OR “emergent infectious diseases” OR brucellosis OR rabies OR chikungunya OR “bovine spongiform encephalopathy” OR “rift valley fever”

Search strings for all included academic databases

Scopus search

TITLE-ABS-KEY(Zika OR ebola OR covid-19 OR sars-cov-2 OR coronavirus OR sars OR mers OR h1n1 OR h7n9 OR h5n1 OR “one health” OR dengue OR “nipah virus” OR influenza OR zoonoses OR zoonosis OR zoonotic OR “West Nile” OR “HIV/AIDS” OR “avian flu” OR “hendra virus” OR “marburg virus” OR “yellow fever” OR “tick-borne encephalitis” OR “emerging

infectious diseases" OR "emergent infectious diseases" OR brucellosis OR rabies OR chikungunya OR "bovine spongiform encephalopathy" OR "rift valley fever") AND TITLE-ABS-KEY(Spillover OR "spill over" OR "cross-species transmission" OR poultry OR wildlife OR bushmeat OR "bush meat" OR livestock OR "animal market*" OR "wet market*" OR "bird market*" OR horse* OR waterfowl OR fowl OR bat OR bats OR mammal* OR swine OR pig* OR poaching OR "pet trade" OR pork OR "trade W/5 animal") AND TITLE-ABS-KEY(policy OR law OR legal OR legislat* OR regulat* OR tariff OR subsidy OR tax OR ban OR "voluntary agreement" OR incentive OR fiscal OR guidelines OR govern* OR federal* OR closure OR closing OR state* OR "rest day*" OR "border control*" OR "habitat protection" OR "wetland protection" OR "supplement* fed" OR "supplement* feed*" OR "market size") AND TITLE-ABS-KEY(Prevent* OR "ecological intervention*" OR "non-pharmaceutical intervention*" OR "public health" OR "risk management" OR "risk minimisation" OR "control strateg*" OR "outbreak risk" OR "reduc* W/5 transmission" OR "reduc* W/5 infection")

Medline search

(((Zika[Title/Abstract] OR ebola[Title/Abstract] OR covid-19[Title/Abstract] OR sars-cov-2[Title/Abstract] OR coronavirus[Title/Abstract] OR sars[Title/Abstract] OR mers[Title/Abstract] OR h1n1[Title/Abstract] OR h7n9[Title/Abstract] OR h5n1[Title/Abstract] OR "one health"[Title/Abstract] OR dengue[Title/Abstract] OR "nipah virus"[Title/Abstract] OR influenza[Title/Abstract] OR zoonoses[Title/Abstract] OR zoonosis[Title/Abstract] OR zoonotic[Title/Abstract] OR "West Nile"[Title/Abstract] OR "HIV/AIDS"[Title/Abstract] OR "avian flu"[Title/Abstract] OR "hendra virus"[Title/Abstract] OR "marburg virus"[Title/Abstract] OR "yellow fever"[Title/Abstract] OR "tick-borne encephalitis"[Title/Abstract] OR "emerging infectious diseases"[Title/Abstract] OR "emergent infectious diseases"[Title/Abstract] OR brucellosis[Title/Abstract] OR rabies[Title/Abstract] OR chikungunya[Title/Abstract] OR "bovine spongiform encephalopathy"[Title/Abstract] OR "rift valley fever"[Title/Abstract] OR zoonoses [mesh]) AND (Spillover[Title/Abstract] OR "spill over"[Title/Abstract] OR "cross-species transmission"[Title/Abstract] OR poultry[Title/Abstract] OR wildlife[Title/Abstract] OR bushmeat[Title/Abstract] OR "bush meat"[Title/Abstract] OR livestock[Title/Abstract] OR "animal market"[Title/Abstract] OR "animal markets"[Title/Abstract] OR "wet market"[Title/Abstract] OR "wet markets"[Title/Abstract] OR "bird market"[Title/Abstract] OR "bird markets"[Title/Abstract] OR horse[Title/Abstract] OR horses[Title/Abstract] OR waterfowl[Title/Abstract] OR fowl[Title/Abstract] OR bat[Title/Abstract] OR bats[Title/Abstract] OR mammal[Title/Abstract] OR

mammals[Title/Abstract] OR mammalian[Title/Abstract] OR swine[Title/Abstract] OR pig[Title/Abstract] OR pigs[Title/Abstract] OR poaching[Title/Abstract] OR "pet trade"[Title/Abstract] OR pork[Title/Abstract] OR animal N5 trade[Title/Abstract] OR disease reservoir [mesh])) AND (policy[Title/Abstract] OR law[Title/Abstract] OR legal[Title/Abstract] OR legislation[Title/Abstract] OR legislative[Title/Abstract] OR legislating[Title/Abstract] OR regulation[Title/Abstract] OR regulations[Title/Abstract] OR regulatory[Title/Abstract] OR tariff[Title/Abstract] OR subsidy[Title/Abstract] OR tax[Title/Abstract] OR ban[Title/Abstract] OR "voluntary agreement"[Title/Abstract] OR incentive[Title/Abstract] OR fiscal[Title/Abstract] OR guidelines[Title/Abstract] OR government[Title/Abstract] OR governments[Title/Abstract] OR federal[Title/Abstract] OR federally[Title/Abstract] OR closure[Title/Abstract] OR closing[Title/Abstract] OR state[Title/Abstract] OR "rest day"[Title/Abstract] OR "rest days"[Title/Abstract] OR "border control"[Title/Abstract] OR "border controls"[Title/Abstract] OR "habitat protection"[Title/Abstract] OR "wetland protection"[Title/Abstract] OR "supplemental feeding"[Title/Abstract] OR "market size"[Title/Abstract])) AND (Prevent[Title/Abstract] OR prevention[Title/Abstract] OR "ecological intervention"[Title/Abstract] OR "ecological interventions"[Title/Abstract] OR "non-pharmaceutical intervention"[Title/Abstract] OR "non-pharmaceutical interventions"[Title/Abstract] OR "public health"[Title/Abstract] OR "risk management"[Title/Abstract] OR "risk minimisation"[Title/Abstract] OR "control strategy"[Title/Abstract] OR "control strategies"[Title/Abstract] OR "outbreak risk"[Title/Abstract] OR reducing N5 transmission[Title/Abstract] OR reducing N5 infection[Title/Abstract])

Web of knowledge search

AB=(Zika OR ebola OR covid-19 OR sars-cov-2 OR coronavirus OR sars OR mers OR h1n1 OR h7n9 OR h5n1 OR “one health” OR dengue OR “nipah virus” OR influenza OR zoonoses OR zoonosis OR zoonotic OR “West Nile” OR “HIV/AIDS” OR “avian flu” OR “hendra virus” OR “marburg virus” OR “yellow fever” OR “tick-borne encephalitis” OR “emerging infectious diseases” OR “emergent infectious diseases” OR brucellosis OR rabies OR chikungunya OR “bovine spongiform encephalopathy” OR “rift valley fever”)

AND

AB=(Spillover OR “spill over” OR “cross-species transmission” OR poultry OR wildlife OR bushmeat OR “bush meat” OR livestock OR “animal market*” OR “wet market*” OR “bird

market*" OR horse* OR waterfowl OR fowl OR bat OR bats OR mammal* OR swine OR pig* OR poaching OR "pet trade" OR pork OR trade NEAR animal)

AND

AB=(policy OR law OR legal OR legislat* OR regulat* OR tariff OR subsidy OR tax OR ban OR "voluntary agreement" OR incentive OR fiscal OR guidelines OR govern* OR federal* OR closure OR closing OR state* OR "rest day*" OR "border control*" OR "habitat protection" OR "wetland protection" OR "supplement* fed" OR "supplement* feed*" OR "market size")

AND

AB=(Prevent* OR "ecological intervention*" OR "non-pharmaceutical intervention*" OR "public health" OR "risk management" OR "risk minimisation" OR "control strateg*" OR "outbreak risk" OR reduc* NEAR transmission OR reduc* NEAR infection)

Ovid Global Health database search (all in abstract)

Zika OR ebola OR covid-19 OR sars-cov-2 OR coronavirus OR sars OR mers OR h1n1 OR h7n9 OR h5n1 OR one health OR dengue OR nipah virus OR influenza OR zoonoses OR zoonosis OR zoonotic OR West Nile OR HIV/AIDS OR avian flu OR hendra virus OR marburg virus OR yellow fever OR tick-borne encephalitis OR emerging infectious diseases OR emergent infectious diseases OR brucellosis OR rabies OR chikungunya OR bovine spongiform encephalopathy OR rift valley fever

AND

Spillover OR spill over OR cross-species transmission OR poultry OR wildlife OR bushmeat OR bush meat OR livestock OR animal market* OR wet market* OR bird market* OR horse* OR waterfowl OR fowl OR bat OR bats OR mammal* OR swine OR pig* OR poaching OR pet trade OR pork OR (trade adj5 animal)

AND

policy OR law OR legal OR legislat* OR regulat* OR tariff OR subsidy OR tax OR ban OR voluntary agreement OR incentive OR fiscal OR guidelines OR govern* OR federal* OR closure OR closing OR state* OR rest day* OR border control* OR habitat protection OR wetland protection OR supplement* fed OR supplement* feed* OR market size

AND

Prevent* OR ecological intervention* OR non-pharmaceutical intervention* OR public health OR risk management OR risk minimisation OR control strateg* OR outbreak risk OR (reduc* adj5 transmission) OR (reduc* adj5 infection)

List of organization websites searched for grey literature

1. World Organization for Animal Health (formerly OIE)
2. Food and Agriculture Organization
3. World Health Organization
4. Wildlife Disease Association
5. International Alliance against Health Risks in WildlifeTrade
6. United Nations Environment Program
7. United Nations Office for Drugs and Crime
8. Global Alliance for Rabies Control
9. EcoHealth Alliance
10. Network for EcoHealth and One Health
11. International Livestock Research Institute
12. Preventing Pandemics at the Source
13. World Veterinary Association
14. CITES
15. TRAFFIC
16. One Health Commission
17. World Wildlife Fund
18. World Trade Organization

Supplementary file 2

Data charting form

Record	Author(s)
	Year
Policy	Country
	World region (World Bank grouping) (44)
	Country income (World Bank grouping) (44)
	Disease
	Stakeholders or sector responsible for implementing policy (retail, agriculture, conservation, etc.)
	Implementation date (start date, or range if the policy has been changed)
	Intervention type
	Location along spillover pathway adapted from Plowright et al. (7,21)
	Policy level (local, national, regional, global)
	Multi-sectoral initiative (Y/N)
	Sector(s) responsible for policy
Evaluation	Aim
	Type (Process/outcome)
	Study design
	Theoretical framework and/or logic model underpinning evaluation (if described)
	Period of observation
	Outcome measure(s) and change in measure(s)
	Consideration of unintended consequences (Y/N)
	If yes, which unintended consequences? (e.g., economic outcomes, food security)

PRISMA-P 2015 Checklist

This checklist has been adapted for use with systematic review protocol submissions to BioMed Central journals from Table 3 in Moher D et al: Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Systematic Reviews* 2015 **4**:1

An Editorial from the Editors-in-Chief of *Systematic Reviews* details why this checklist was adapted - **Moher D, Stewart L & Shekelle P:** Implementing PRISMA-P: recommendations for prospective authors. *Systematic Reviews* 2016 **5**:15

Section/topic	#	Checklist item	Information reported		Line number(s)
			Yes	No	
ADMINISTRATIVE INFORMATION					
Title					
Identification	1a	Identify the report as a protocol of a systematic review	☒	☐	p.1 l.1-2
Update	1b	If the protocol is for an update of a previous systematic review, identify as such	☐	☒	N/A
Registration	2	If registered, provide the name of the registry (e.g., PROSPERO) and registration number in the Abstract	☐	☒	N/A
Authors					
Contact	3a	Provide name, institutional affiliation, and e-mail address of all protocol authors; provide physical mailing address of corresponding author	☒	☐	p.1 l.3-25
Contributions	3b	Describe contributions of protocol authors and identify the guarantor of the review	☒	☐	p.12 l.16-18
Amendments	4	If the protocol represents an amendment of a previously completed or published protocol, identify as such and list changes; otherwise, state plan for documenting important protocol amendments	☐	☒	N/A
Support					
Sources	5a	Indicate sources of financial or other support for the review	☒	☐	p.12 l.14-16
Sponsor	5b	Provide name for the review funder and/or sponsor	☒	☐	p.12 l.14-16
Role of sponsor/funder	5c	Describe roles of funder(s), sponsor(s), and/or institution(s), if any, in developing the protocol	☒	☐	p.12 l.16
INTRODUCTION					
Rationale	6	Describe the rationale for the review in the context of what is already known	☒	☐	p.4-6
Objectives	7	Provide an explicit statement of the question(s) the review will address with reference to	☒	☐	p.6 l.12-27

Section/topic	#	Checklist item	Information reported		Line number(s)
			Yes	No	
		participants, interventions, comparators, and outcomes (PICO)			
METHODS					
Eligibility criteria	8	Specify the study characteristics (e.g., PICO, study design, setting, time frame) and report characteristics (e.g., years considered, language, publication status) to be used as criteria for eligibility for the review	☒	☐	p.8 l.2-8
Information sources	9	Describe all intended information sources (e.g., electronic databases, contact with study authors, trial registers, or other grey literature sources) with planned dates of coverage	☒	☐	p.7 l.19-20
Search strategy	10	Present draft of search strategy to be used for at least one electronic database, including planned limits, such that it could be repeated	☒	☐	p.11
STUDY RECORDS					
Data management	11a	Describe the mechanism(s) that will be used to manage records and data throughout the review	☒	☐	p.8 l.3-4; 20-24
Selection process	11b	State the process that will be used for selecting studies (e.g., two independent reviewers) through each phase of the review (i.e., screening, eligibility, and inclusion in meta-analysis)	☒	☐	p.8 l.9-16
Data collection process	11c	Describe planned method of extracting data from reports (e.g., piloting forms, done independently, in duplicate), any processes for obtaining and confirming data from investigators	☒	☐	p.8 l.19-25
Data items	12	List and define all variables for which data will be sought (e.g., PICO items, funding sources), any pre-planned data assumptions and simplifications	☒	☐	Table 2, p.8-9
Outcomes and prioritization	13	List and define all outcomes for which data will be sought, including prioritization of main and additional outcomes, with rationale	☐	☒	N/A – scoping review
Risk of bias in individual studies	14	Describe anticipated methods for assessing risk of bias of individual studies, including whether this will be done at the outcome or study level, or both; state how this information will be used in data synthesis	☒	☐	p.9 l.3-6
DATA					
Synthesis	15a	Describe criteria under which study data will be quantitatively synthesized	☒	☐	Table 2, p.8-9
	15b	If data are appropriate for quantitative synthesis, describe planned summary measures, methods of handling data, and methods of combining data from studies, including any planned exploration of consistency (e.g., I^2, Kendall's tau)	☐	☒	N/A
	15c	Describe any proposed additional analyses (e.g., sensitivity or subgroup analyses, meta-regression)	☐	☒	N/A
	15d	If quantitative synthesis is not appropriate, describe the type of summary planned	☒	☐	p.9 l.7-10, p.10 l.1-2
Meta-bias(es)	16	Specify any planned assessment of meta-bias(es) (e.g., publication bias across studies, selective	☐	☒	N/A – scoping

Section/topic	#	Checklist item	Information reported		Line number(s)
			Yes	No	
		reporting within studies)			review
Confidence in cumulative evidence	17	Describe how the strength of the body of evidence will be assessed (e.g., GRADE)	☐	☒	N/A – scoping review