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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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Manuscripts

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3 1 **Policies to prevent the spillover of zoonotic diseases: protocol for a systematic scoping**
4 **review of evaluative evidence**
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1 **Abstract**

2 **Introduction**

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

12 **Methods and analysis**

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

22 **Ethics and dissemination**

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

26 **Strengths and limitations**

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

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- 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.

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1 Introduction

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

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

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

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

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

34 *Preventive policies in a real-world context: multi-sectoral efforts, One Health governance and* 35 *complex systems*

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3 1 While some evaluative evidence exists around the effectiveness of these interventions (21–
4 24), they have often been implemented as short- to medium-term programmes or academic
5 2 investigations (5). In some cases, zoonoses have re-emerged after successful programmes
6 3 have ended (24). As a result, experts have argued for the incorporation of successful
7 4 interventions into policy frameworks, providing interventions with the sustainability required for
8 5 long-term disease control (5). By policy, we refer here to *public* policy: ‘a set of interrelated
9 6 decisions taken by a political actor or group of actors concerning the selection of goals and
10 7 the means of achieving them’ (25). While policy implementation requires the involvement of
11 8 public and private actors, we understand policy decisions as being ultimately in the hands of
12 9 government, which for this review we extend to include supranational governing bodies, and
13 10 having greater longevity compared to many programmes, which are often implemented for a
14 11 fixed term.
15 12

16 13 Although the longevity and scope of government actions may make policy an effective vehicle
17 14 for disease prevention, implementing policy is a complex process involving numerous
18 15 stakeholders with competing views and interests (26). The responsibility for addressing
19 16 zoonotic disease frequently spans multiple sectors of governance due to its relevance for both
20 17 animals and humans. Where relevant policies are designed and implemented in isolation,
21 18 opportunities for synergy may be missed and efforts may even be counter-productive.

22 19 Successful policy measures require not only a sound evidence base, but also governance
23 20 structures that enable action to be taken. Given the range of possible risk factors that might
24 21 contribute to emerging zoonoses, and the possible impacts of preventive policies, a One
25 22 Health response has been advocated, requiring coordination between institutions and
26 23 government departments involved in human and animal health, trade, agriculture and the
27 24 environment (27). At the international level, the World Health Organization, the Food and
28 25 Agriculture Organization and the World Organisation for Animal Health have endorsed a One
29 26 Health policy framework to respond to zoonotic infectious diseases, emphasising collaboration
30 27 between agencies (28). Within countries, national and local governments have also
31 28 emphasised the need for multi-sectoral efforts, although many report that further integration is
32 29 still required (29).

33 30 Further, given the complex social-ecological systems within which policies to prevent zoonotic
34 31 spillover are implemented, the risk of unintended consequences is high. For example, bans
35 32 on economic activities associated with higher risks of disease transmission may lead to the
36 33 emergence or growth of illegal marketplaces where regulation is impossible (30,31). Region-
37 34 specific closures of live animal markets have been shown to spread diseases further afield as
38 35 vendors seek new venues to sell their animals (32). Meanwhile, attempts to manage

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

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

11 *Aims and scope*

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

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

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

1 **Methods and analysis**

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

6 *Stage 1: Identifying the research question*

7 The aim of this review is to use a One Health lens to identify and describe the range of policies
8 that have been evaluated, the approaches to evaluation, and the evaluative evidence.

9 Informed by this aim, our research questions are:

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

18 *Stage 2: Identifying relevant studies*

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

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

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

Outcome	Spillover events, or any upstream determinants or risk factors for spillover events
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2 *Stage 3: Study selection*

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

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

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

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

19 *Stage 4: Charting the data*

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

25 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)

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2 *Stage 5: Collating, summarising and reporting the results*

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

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

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3 1 challenges encountered in evaluating these policies, as well as insights into why policies
4 2 succeeded or failed in achieving their aims.

6 3 *Patient and public involvement*

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9 4 Patients or the public were not involved in the design, conduct, reporting or dissemination
10 5 plans of our research.

12 6 **Strengths and weaknesses of the study**

14 7 To our knowledge, this is the first attempt to systematically identify and document evaluations
15 8 of policies aiming to prevent the spillover of zoonoses into human populations. However,
16 9 because of the complex drivers of spillover events, some potentially relevant policy
17 10 evaluations may be excluded where their outcome measures are too far removed from the
18 11 spillover of zoonotic diseases. For example, it has been hypothesised that declines in vulture
19 12 populations may increase the risk of disease transmission by increasing the number of
20 13 uneaten carcasses, as well as, potentially, the population of feral dogs (49). In 2006, India,
21 14 Pakistan and Nepal implemented a ban on the veterinary drug diclofenac, which had been
22 15 identified as a driver of declining vulture populations. While policy evaluations suggest that
23 16 this ban has resulted in a resurgence of vultures (50–53), the knock-on effects of this on
24 17 zoonotic disease transmission risk have not been included in these evaluations. While
25 18 relevant, such evaluations will be difficult to systematically identify as they make no reference
26 19 to zoonotic disease.

27 20 In addition, this review will focus on policy evaluations that have been reported in the peer-
28 21 reviewed literature. Policies that have been implemented but not evaluated, or evaluated but
29 22 not published in the academic literature, will therefore be excluded from this review. As a
30 23 result, potentially effective and important policies in the prevention of zoonotic spillover events
31 24 may not be identified. However, we hope that the findings from this review will highlight these
32 25 gaps in the evaluative evidence. We also hope that this review, by extracting practical
33 26 dimensions such as study design, outcome measures and the challenges encountered in the
34 27 evaluation process, will support policymakers and researchers in carrying out policy
35 28 evaluations in this space.

37 29 **Ethics and dissemination**

38 30 Formal ethical approval is not required, as the study does not involve primary data collection.
39 31 The findings of this study will be disseminated through a peer-reviewed publication,
40 32 presentations, and summaries for key stakeholders.
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3 **1 List of abbreviations**
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6 2 EID: Emerging infectious disease
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8 **3 Declarations**
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11 4 *Ethics approval and consent to participate*
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14 5 Not applicable.
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17 6 *Patient consent for publication*
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20 7 Not applicable.
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23 8 *Availability of data and material*
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26 9 Data sharing not applicable to this article as no datasets were generated or analysed
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28 10 during the current study.
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31 11 *Competing interests*
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52 19 CCA, KML and TLP conceived and designed the study. CCA prepared the
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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	<input checked="" type="checkbox"/>	<input type="checkbox"/>	p.1 l.1-2
Update	1b	If the protocol is for an update of a previous systematic review, identify as such	<input type="checkbox"/>	<input checked="" type="checkbox"/>	N/A
Registration	2	If registered, provide the name of the registry (e.g., PROSPERO) and registration number in the Abstract	<input type="checkbox"/>	<input checked="" type="checkbox"/>	N/A
Authors					
Contact	3a	Provide name, institutional affiliation, and e-mail address of all protocol authors; provide physical mailing address of corresponding author	<input checked="" type="checkbox"/>	<input type="checkbox"/>	p.1 l.3-25
Contributions	3b	Describe contributions of protocol authors and identify the guarantor of the review	<input checked="" type="checkbox"/>	<input type="checkbox"/>	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	<input type="checkbox"/>	<input checked="" type="checkbox"/>	N/A
Support					
Sources	5a	Indicate sources of financial or other support for the review	<input checked="" type="checkbox"/>	<input type="checkbox"/>	p.12 l.14-16
Sponsor	5b	Provide name for the review funder and/or sponsor	<input checked="" type="checkbox"/>	<input type="checkbox"/>	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	<input checked="" type="checkbox"/>	<input type="checkbox"/>	p.12 l.16
INTRODUCTION					
Rationale	6	Describe the rationale for the review in the context of what is already known	<input checked="" type="checkbox"/>	<input type="checkbox"/>	p.4-6
Objectives	7	Provide an explicit statement of the question(s) the review will address with reference to	<input checked="" type="checkbox"/>	<input type="checkbox"/>	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	<input checked="" type="checkbox"/>	<input type="checkbox"/>	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	<input checked="" type="checkbox"/>	<input type="checkbox"/>	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	<input checked="" type="checkbox"/>	<input type="checkbox"/>	p.11
STUDY RECORDS					
Data management	11a	Describe the mechanism(s) that will be used to manage records and data throughout the review	<input checked="" type="checkbox"/>	<input type="checkbox"/>	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)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	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	<input checked="" type="checkbox"/>	<input type="checkbox"/>	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	<input checked="" type="checkbox"/>	<input type="checkbox"/>	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	<input type="checkbox"/>	<input checked="" type="checkbox"/>	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	<input checked="" type="checkbox"/>	<input type="checkbox"/>	p.9 l.3-6
DATA					
Synthesis	15a	Describe criteria under which study data will be quantitatively synthesized	<input checked="" type="checkbox"/>	<input type="checkbox"/>	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)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	N/A
	15c	Describe any proposed additional analyses (e.g., sensitivity or subgroup analyses, meta-regression)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	N/A
	15d	If quantitative synthesis is not appropriate, describe the type of summary planned	<input checked="" type="checkbox"/>	<input type="checkbox"/>	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	<input type="checkbox"/>	<input checked="" type="checkbox"/>	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)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	N/A – scoping review

For peer review only

BMJ Open

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

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2021-058437.R1
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

SCHOLARONE™
Manuscripts

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3 1 **Policies to prevent zoonotic spillover: protocol for a systematic scoping review of**
4 **evaluative evidence**
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1 **Abstract**

2 **Introduction**

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

12 **Methods and analysis**

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

23 **Ethics and dissemination**

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

27 **Strengths and limitations**

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

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- 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.

For peer review only

1 Introduction

2 The increasing incidence of zoonotic emerging infectious diseases (EIDs) has been attributed
3 to behavioural practices and ecological and socioeconomic change, and is predicted to
4 continue in the coming years (1). Higher levels of anthropogenic activity, including agricultural
5 intensification, urbanisation and other forms of land use change, have led to increased
6 interactions between wildlife, humans and livestock, increasing the risk of cross-species
7 transmission (2,3). In response, a call has been issued by leading organisations and experts,
8 including the United Nations Environment Programme, the International Livestock Research
9 Institute and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem
10 Services, to complement reactive policy responses with policies that prevent zoonotic EIDs
11 (1,4–7).

12 *Preventing zoonotic spillover from a One Health perspective*

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

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

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

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3 1 interventions into policy frameworks, providing interventions with the sustainability required for
4 2 long-term disease control (6).

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7 3 *Governance, systems and the role of multi-sectoral actors*

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9 4 Public policy is 'a set of interrelated decisions taken by a political actor or group of actors
10 5 concerning the selection of goals and the means of achieving them' (26). Public policy
11 6 decisions are ultimately in the hands of government and supranational governing bodies, and
12 7 have greater longevity compared to many programmes, which are often implemented for a
13 8 fixed term. Non-government actors, including vested interest stakeholders, can also play a
14 9 powerful role in shaping government decisions (27,28).

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19 10 Although the longevity and scope of government actions may make policy an effective vehicle
20 11 for prevention of emergent diseases, implementing policy is a complex process involving
21 12 numerous stakeholders with competing views and interests (29). The responsibility for
22 13 addressing zoonotic disease frequently spans multiple sectors of governance due to its
23 14 relevance for both animals and humans. Where relevant policies are designed and
24 15 implemented in isolation, opportunities for synergy may be missed and efforts may even be
25 16 counter-productive.

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30 17 Successful policy measures require not only a sound evidence base, but also governance
31 18 structures that enable action to be taken. Given the range of possible risk factors that might
32 19 contribute to emerging zoonoses, and the possible impacts of policies to prevent zoonotic
33 20 spillover, a One Health response has been advocated, requiring coordination between
34 21 institutions and government departments involved in human and animal health, trade,
35 22 agriculture and the environment (30). At the international level, the World Health Organization,
36 23 the Food and Agriculture Organization and the World Organisation for Animal Health have
37 24 endorsed a One Health policy framework to respond to zoonotic infectious diseases,
38 25 emphasising collaboration between agencies (31). Within countries, national and local
39 26 governments have also emphasised the need for multi-sectoral efforts, although many report
40 27 that further integration is still required (32).

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48 28 Further, given the complex social-ecological systems within which policies to prevent zoonotic
49 29 spillover are implemented, the risk of unintended consequences is high. For example, region-
50 30 specific closures of live animal markets have been shown to spread pathogens further afield
51 31 as vendors seek new venues to sell their animals (33). Meanwhile, attempts to manage
52 32 populations of wild animals may alter pathogen dynamics, unintentionally increasing the risk
53 33 of spillover into livestock or people (34).

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58 34 Given these particular characteristics of policy development and implementation, they may be
59 35 usefully considered as a particular case of intervention, and the evidence around them

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

7 *Aims and scope*

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

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

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

1 **Methods and analysis**

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

6 *Stage 1: Identifying the research question*

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

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

17 *Stage 2: Identifying relevant studies*

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

24 *Stage 3: Study selection*

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

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

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

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

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

14 *Stage 4: Charting the data*

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

20 *Stage 5: Collating, summarising and reporting the results*

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

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

31 *Patient and public involvement*

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

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2
3 1 are able to provide input and perspectives on the results of the review. Project-level
4 2 dissemination events involving policy stakeholders are also planned, where findings from the
5 3 proposed review will be shared.
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8 4 **Strengths and weaknesses of the study**

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10 5 To our knowledge, this is the first attempt to systematically identify and document evaluations
11 6 of policies aiming to prevent the spillover of zoonoses into human populations. However,
12 7 because of the complex drivers of spillover events, some potentially relevant policy
13 8 evaluations may be excluded where their outcome measures are too far removed from
14 9 zoonotic spillover. For example, it has been hypothesised that declines in vulture populations
15 10 may increase the risk of pathogen transmission by increasing the number of uneaten
16 11 carcasses, as well as, potentially, the population of feral dogs (54). In 2006, India, Pakistan
17 12 and Nepal implemented a ban on the veterinary drug diclofenac, which had been identified as
18 13 a driver of declining vulture populations. While policy evaluations suggest that this ban has
19 14 resulted in a resurgence of vultures (55–58), the knock-on effects of this on zoonotic pathogen
20 15 transmission risk have not been included in these evaluations. While relevant, such
21 16 evaluations will be difficult to systematically identify as they make no reference to zoonotic
22 17 disease.
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31 18 In addition, this review will focus on policy evaluations that have been reported in the peer-
32 19 reviewed literature. Policies that have been implemented but not evaluated, or evaluated but
33 20 not published in the academic literature, will therefore be excluded from this review. As a
34 21 result, potentially effective and important policies in the prevention of zoonotic spillover events
35 22 may not be identified. However, we hope that the findings from this review will highlight these
36 23 gaps in the evaluative evidence. We also hope that this review, by extracting practical
37 24 dimensions such as study design, outcome measures and the challenges encountered in the
38 25 evaluation process, will support policymakers and researchers in carrying out policy
39 26 evaluations in this space.
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46 27 **Ethics and dissemination**

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48 28 Formal ethical approval is not required, because the study does not involve primary data
49 29 collection. The findings of this study will be disseminated through a peer-reviewed publication,
50 30 presentations, and summaries for key stakeholders.
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3 **1 List of abbreviations**
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6 2 EID: Emerging infectious disease
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8 **3 Declarations**
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11 4 *Ethics approval and consent to participate*
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14 5 Not applicable.
15

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17 6 *Patient consent for publication*
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19
20 7 Not applicable.
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22
23 8 *Availability of data and material*
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25
26 9 Data sharing not applicable to this article as no datasets were generated or analysed
27
28 10 during the current study.
29

30
31 11 *Competing interests*
32

33
34 12 The authors declare that they have no competing interests.
35

36
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38

39
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41
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43
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45
46 17 developing the protocol.
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49 18 *Contributors*
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52 19 CCA, KML and TLP conceived and designed the study. CCA prepared the
53
54 20 manuscript. KML, TLP, RA, AA, MB, JC, RL, AR, KCT, AMV, MW and AY provided
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56 21 critical input on the manuscript and methods and have read and approved the final
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58 22 manuscript.
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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

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

27
28 (((Zika[Title/Abstract] OR ebola[Title/Abstract] OR covid-19[Title/Abstract] OR sars-cov-
29 2[Title/Abstract] OR coronavirus[Title/Abstract] OR sars[Title/Abstract] OR mers[Title/Abstract]
30 OR h1n1[Title/Abstract] OR h7n9[Title/Abstract] OR h5n1[Title/Abstract] OR "one
31 health"[Title/Abstract] OR dengue[Title/Abstract] OR "nipah virus"[Title/Abstract] OR
32 influenza[Title/Abstract] OR zoonoses[Title/Abstract] OR zoonosis[Title/Abstract] OR
33 zoonotic[Title/Abstract] OR "West Nile"[Title/Abstract] OR "HIV/AIDS"[Title/Abstract] OR "avian
34 flu"[Title/Abstract] OR "hendra virus"[Title/Abstract] OR "marburg virus"[Title/Abstract] OR
35 "yellow fever"[Title/Abstract] OR "tick-borne encephalitis"[Title/Abstract] OR "emerging
36 infectious diseases"[Title/Abstract] OR "emergent infectious diseases"[Title/Abstract] OR
37 brucellosis[Title/Abstract] OR rabies[Title/Abstract] OR chikungunya[Title/Abstract] OR "bovine
38 spongiform encephalopathy"[Title/Abstract] OR "rift valley fever"[Title/Abstract] OR zoonoses
39 [mesh]) AND (Spillover[Title/Abstract] OR "spill over"[Title/Abstract] OR "cross-species
40 transmission"[Title/Abstract] OR poultry[Title/Abstract] OR wildlife[Title/Abstract] OR
41 bushmeat[Title/Abstract] OR "bush meat"[Title/Abstract] OR livestock[Title/Abstract] OR "animal
42 market"[Title/Abstract] OR "animal markets"[Title/Abstract] OR "wet market"[Title/Abstract] OR
43 "wet markets"[Title/Abstract] OR "bird market"[Title/Abstract] OR "bird markets"[Title/Abstract]
44 OR horse[Title/Abstract] OR horses[Title/Abstract] OR waterfowl[Title/Abstract] OR
45 fowl[Title/Abstract] OR bat[Title/Abstract] OR bats[Title/Abstract] OR mammal[Title/Abstract] OR
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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

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

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

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15 AND

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

20
21 Ovid Global Health database search (all in abstract)

22
23 Zika OR ebola OR covid-19 OR sars-cov-2 OR coronavirus OR sars OR mers OR h1n1 OR
24 h7n9 OR h5n1 OR one health OR dengue OR nipah virus OR influenza OR zoonoses OR
25 zoonosis OR zoonotic OR West Nile OR HIV/AIDS OR avian flu OR hendra virus OR marburg
26 virus OR yellow fever OR tick-borne encephalitis OR emerging infectious diseases OR
27 emergent infectious diseases OR brucellosis OR rabies OR chikungunya OR bovine spongiform
28 encephalopathy OR rift valley fever

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

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39 AND

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

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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)

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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	<input checked="" type="checkbox"/>	<input type="checkbox"/>	p.1 l.1-2
Update	1b	If the protocol is for an update of a previous systematic review, identify as such	<input type="checkbox"/>	<input checked="" type="checkbox"/>	N/A
Registration	2	If registered, provide the name of the registry (e.g., PROSPERO) and registration number in the Abstract	<input type="checkbox"/>	<input checked="" type="checkbox"/>	N/A
Authors					
Contact	3a	Provide name, institutional affiliation, and e-mail address of all protocol authors; provide physical mailing address of corresponding author	<input checked="" type="checkbox"/>	<input type="checkbox"/>	p.1 l.3-25
Contributions	3b	Describe contributions of protocol authors and identify the guarantor of the review	<input checked="" type="checkbox"/>	<input type="checkbox"/>	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	<input type="checkbox"/>	<input checked="" type="checkbox"/>	N/A
Support					
Sources	5a	Indicate sources of financial or other support for the review	<input checked="" type="checkbox"/>	<input type="checkbox"/>	p.12 l.14-16
Sponsor	5b	Provide name for the review funder and/or sponsor	<input checked="" type="checkbox"/>	<input type="checkbox"/>	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	<input checked="" type="checkbox"/>	<input type="checkbox"/>	p.12 l.16
INTRODUCTION					
Rationale	6	Describe the rationale for the review in the context of what is already known	<input checked="" type="checkbox"/>	<input type="checkbox"/>	p.4-6
Objectives	7	Provide an explicit statement of the question(s) the review will address with reference to	<input checked="" type="checkbox"/>	<input type="checkbox"/>	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	<input checked="" type="checkbox"/>	<input type="checkbox"/>	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	<input checked="" type="checkbox"/>	<input type="checkbox"/>	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	<input checked="" type="checkbox"/>	<input type="checkbox"/>	p.11
STUDY RECORDS					
Data management	11a	Describe the mechanism(s) that will be used to manage records and data throughout the review	<input checked="" type="checkbox"/>	<input type="checkbox"/>	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)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	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	<input checked="" type="checkbox"/>	<input type="checkbox"/>	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	<input checked="" type="checkbox"/>	<input type="checkbox"/>	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	<input type="checkbox"/>	<input checked="" type="checkbox"/>	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	<input checked="" type="checkbox"/>	<input type="checkbox"/>	p.9 l.3-6
DATA					
Synthesis	15a	Describe criteria under which study data will be quantitatively synthesized	<input checked="" type="checkbox"/>	<input type="checkbox"/>	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)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	N/A
	15c	Describe any proposed additional analyses (e.g., sensitivity or subgroup analyses, meta-regression)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	N/A
	15d	If quantitative synthesis is not appropriate, describe the type of summary planned	<input checked="" type="checkbox"/>	<input type="checkbox"/>	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	<input type="checkbox"/>	<input checked="" type="checkbox"/>	N/A – scoping

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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)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	N/A – scoping review

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BMJ Open

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

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2021-058437.R2
Article Type:	Protocol
Date Submitted by the Author:	07-Sep-2022
Complete List of Authors:	Clifford Astbury, Chloe; York University Lee, Kirsten M.; York University Aguiar, Raphael; York University, Dahdaleh Institute for Global Health Research Atique, Asma; York University Balolong, Marilen; University of the Philippines Manila Clarke, Janielle; York University Labonte, Ronald; University of Ottawa Ruckert, Arne; University of Ottawa Togño, Kathleen Chelsea; University of the Philippines Manila Viens, A.M.; York University, School of Global Health Wiktorowicz, M; York University Yau, Amy; London School of Hygiene & Tropical Medicine Penney, Tarra; York University
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

SCHOLARONE™
Manuscripts

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3 1 **Policies to prevent zoonotic spillover: protocol for a systematic scoping review of**
4 **evaluative evidence**
5 2

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1 **Abstract**

2 **Introduction**

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

12 **Methods and analysis**

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

23 **Ethics and dissemination**

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

27 **Strengths and limitations**

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

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

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1 Introduction

2 The increasing incidence of zoonotic emerging infectious diseases (EIDs) has been attributed
3 to behavioural practices and ecological and socioeconomic change, and is predicted to
4 continue in the coming years (1). Higher levels of anthropogenic activity, including agricultural
5 intensification, urbanisation and other forms of land use change, have led to increased
6 interactions between wildlife, humans and livestock, increasing the risk of cross-species
7 transmission (2,3). In response, a call has been issued by leading organisations and experts,
8 including the United Nations Environment Programme, the International Livestock Research
9 Institute and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem
10 Services, to complement reactive policy responses with policies that prevent zoonotic EIDs
11 (1,4–7).

12 *Preventing zoonotic spillover from a One Health perspective*

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

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

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

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3 1 interventions into policy frameworks, providing interventions with the sustainability required for
4 2 long-term disease control (6).

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7 3 *Governance, systems and the role of multi-sectoral actors*

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9 4 Public policy is 'a set of interrelated decisions taken by a political actor or group of actors
10 5 concerning the selection of goals and the means of achieving them' (26). Public policy
11 6 decisions are ultimately in the hands of government and supranational governing bodies, and
12 7 have greater longevity compared to many programmes, which are often implemented for a
13 8 fixed term. Non-government actors, including vested interest stakeholders, can also play a
14 9 powerful role in shaping government decisions (27,28).

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19 10 Although the longevity and scope of government actions may make policy an effective vehicle
20 11 for prevention of emergent diseases, implementing policy is a complex process involving
21 12 numerous stakeholders with competing views and interests (29). The responsibility for
22 13 addressing zoonotic disease frequently spans multiple sectors of governance due to its
23 14 relevance for both animals and humans. Where relevant policies are designed and
24 15 implemented in isolation, opportunities for synergy may be missed and efforts may even be
25 16 counter-productive.

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30 17 Successful policy measures require not only a sound evidence base, but also governance
31 18 structures that enable action to be taken. Given the range of possible risk factors that might
32 19 contribute to emerging zoonoses, and the possible impacts of policies to prevent zoonotic
33 20 spillover, a One Health response has been advocated, requiring coordination between
34 21 institutions and government departments involved in human and animal health, trade,
35 22 agriculture and the environment (30). At the international level, the World Health Organization,
36 23 the Food and Agriculture Organization and the World Organisation for Animal Health have
37 24 endorsed a One Health policy framework to respond to zoonotic infectious diseases,
38 25 emphasising collaboration between agencies (31). Within countries, national and local
39 26 governments have also emphasised the need for multi-sectoral efforts, although many report
40 27 that further integration is still required (32).

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48 28 Further, given the complex social-ecological systems within which policies to prevent zoonotic
49 29 spillover are implemented, the risk of unintended consequences is high. For example, region-
50 30 specific closures of live animal markets have been shown to spread pathogens further afield
51 31 as vendors seek new venues to sell their animals (33). Meanwhile, attempts to manage
52 32 populations of wild animals may alter pathogen dynamics, unintentionally increasing the risk
53 33 of spillover into livestock or people (34).

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58 34 Given these particular characteristics of policy development and implementation, they may be
59 35 usefully considered as a particular case of intervention, and the evidence around them

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

7 *Aims and scope*

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

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

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

1 **Methods and analysis**

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

6 *Stage 1: Identifying the research question*

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

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

20 *Stage 2: Identifying relevant studies*

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

29 *Stage 3: Study selection*

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

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

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3 1 3. Focus on a policy implemented by government that targets a determinant of zoonotic
4 2 spillover located on the spillover pathway (see Figure 1).
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7 3 [Insert Figure 1]

8 4 *Figure 1 Spillover pathway adapted from Plowright et al. (8,22)*
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10 5 Titles and abstracts will initially be screened, followed by full-text screening. Title and abstract
11 6 screening of an initial set of 100 papers will be undertaken by two independent researchers.
12 7 Results will be compared in order to ensure consistency in decisions around study eligibility,
13 8 and discrepancies resolved through discussion of the inclusion criteria. This process will be
14 9 repeated until an acceptable level of agreement (>90%) is reached. The remaining papers will
15 10 then be screened by one of the two reviewers. Full-text screening will be undertaken by two
16 11 independent researchers and discrepancies will be resolved by discussing reasons for
17 12 inclusion or exclusions among the screeners. Studies with full-texts in languages other than
18 13 English will be eligible for inclusion if they include an English-language abstract. Full-text
19 14 studies published in French, Spanish or Chinese will be single-screened by a member of the
20 15 research team fluent in that language. Studies published in other languages will be translated
21 16 as necessary.

22 17 In line with published guidelines, the approach to study selection may be refined iteratively
23 18 when reviewing articles for inclusion (42–44). Reporting on the search and screening process
24 19 will follow the guidelines provided in the Preferred Reporting Items for Systematic Reviews
25 20 and Meta-Analyses Extension for Scoping Reviews (51).
26

27 21 *Stage 4: Charting the data*

28 22 Data charting will be conducted using a data charting form designed to identify the information
29 23 required to answer the research question and sub-research questions (see Supplementary
30 24 File 2). Data charting focused on characteristics of the study, the policy and the evaluation.
31 25 For each policy, this included identifying which determinant of zoonotic spillover situated along
32 26 the spillover pathway was being targeted. For the purpose of this study, we used a model of
33 27 the spillover pathway adapted from Plowright et al.'s work (8,22), in which we differentiated
34 28 between wildlife and domesticated animals (Figure 1). This differentiation is important in the
35 29 policy context, as the wildlife-domesticated animal interface is an important site for
36 30 intervention, as well as the human-animal interface.

37 31 As recommended, the data charting form will be piloted with ten records to ensure that it is
38 32 consistent with the research question, and the data charting form will be revised iteratively in
39 33 order to ensure the purpose of the research is being met (42–44).
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41 34 *Stage 5: Collating, summarising and reporting the results*

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3 1 We will undertake quality assessment of the included studies using the Quality Assessment
4 2 Tool for Quantitative Studies developed by the Effective Public Health Practice Project (52),
5 3 which has previously been used to assess the quality of natural experiments including public
6 4 policy evaluations (53).

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10 5 We will analyse the extracted data, presenting a numerical summary of the included studies
11 6 in table form, allowing us to describe the range of policy interventions that have been
12 7 evaluated, approaches to evaluation, and evidence of effectiveness. We will also conduct a
13 8 thematic analysis of the contents of the included articles in order to identify, if possible, barriers
14 9 and facilitators to implementing and evaluating these policies, as well as insights into why
15 10 policies succeeded or failed in achieving their aims.

11 *Patient and public involvement*

12 12 This scoping review is being undertaken as part of a larger project involving policy actors at
13 13 national and international levels as research team members, knowledge users and
14 14 participants. Insights from the project have informed protocol development and stakeholders
15 15 are able to provide input and perspectives on the results of the review. Project-level
16 16 dissemination events involving policy stakeholders are also planned, where findings from the
17 17 proposed review will be shared.

18 **Strengths and weaknesses of the study**

19 19 To our knowledge, this is the first attempt to systematically identify and document evaluations
20 20 of policies aiming to prevent the spillover of zoonoses into human populations. However,
21 21 because of the complex drivers of spillover events, some potentially relevant policy
22 22 evaluations may be excluded where their outcome measures are too far removed from
23 23 zoonotic spillover. For example, it has been hypothesised that declines in vulture populations
24 24 may increase the risk of pathogen transmission by increasing the number of uneaten
25 25 carcasses, as well as, potentially, the population of feral dogs (54). In 2006, India, Pakistan
26 26 and Nepal implemented a ban on the veterinary drug diclofenac, which had been identified as
27 27 a driver of declining vulture populations. While policy evaluations suggest that this ban has
28 28 resulted in a resurgence of vultures (55–58), the knock-on effects of this on zoonotic pathogen
29 29 transmission risk have not been included in these evaluations. While relevant, such
30 30 evaluations will be difficult to systematically identify as they make no reference to zoonotic
31 31 disease.

32 32 In addition, this review will focus on policy evaluations that have been reported in the peer-
33 33 reviewed and grey literature. Policies that have been implemented but not evaluated, or
34 34 evaluated but not reported in the literature, will therefore be excluded from this review. As a
35 35 result, potentially effective and important policies in the prevention of zoonotic spillover events

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3 1 may not be identified. However, we hope that the findings from this review will highlight these
4 2 gaps in the evaluative evidence. We also hope that this review, by extracting practical
5 3 dimensions such as study design, outcome measures and the challenges encountered in the
6 4 evaluation process, will support policymakers and researchers in carrying out policy
7 5 evaluations in this space.
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11 6 **Ethics and dissemination**

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13 7 Formal ethical approval is not required, because the study does not involve primary data
14 8 collection. The findings of this study will be disseminated through a peer-reviewed publication,
15 9 presentations, and summaries for key stakeholders.
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3 **1 List of abbreviations**
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6 2 EID: Emerging infectious disease
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8 **3 Declarations**
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11 4 *Ethics approval and consent to participate*
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14 5 Not applicable.
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17 6 *Patient consent for publication*
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20 7 Not applicable.
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23 8 *Availability of data and material*
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25 9 Data sharing not applicable to this article as no datasets were generated or analysed
26
27 10 during the current study.
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29
30 11 *Competing interests*
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32
33 12 The authors declare that they have no competing interests.
34

35
36 13 *Funding*
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38
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40
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42
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44
45 17 developing the protocol.
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48 18 *Contributors*
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51 19 CCA, KML and TLP conceived and designed the study. CCA prepared the
52
53 20 manuscript. KML, TLP, RA, AA, MB, JC, RL, AR, KCT, AMV, MW and AY provided
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55 21 critical input on the manuscript and methods and have read and approved the final
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57 22 manuscript.
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59
60 23 *Acknowledgements*

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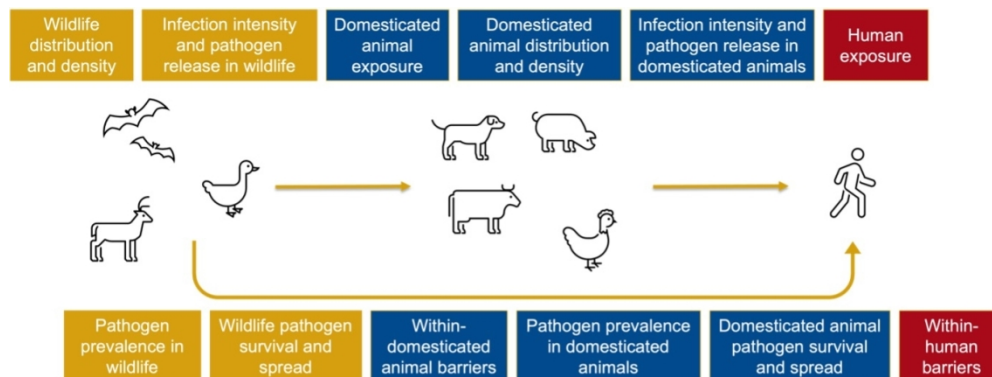


Figure 1 Spillover pathway adapted from Plowright et al. (8,22)

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

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

27
28 (((Zika[Title/Abstract] OR ebola[Title/Abstract] OR covid-19[Title/Abstract] OR sars-cov-
29 2[Title/Abstract] OR coronavirus[Title/Abstract] OR sars[Title/Abstract] OR mers[Title/Abstract]
30 OR h1n1[Title/Abstract] OR h7n9[Title/Abstract] OR h5n1[Title/Abstract] OR "one
31 health"[Title/Abstract] OR dengue[Title/Abstract] OR "nipah virus"[Title/Abstract] OR
32 influenza[Title/Abstract] OR zoonoses[Title/Abstract] OR zoonosis[Title/Abstract] OR
33 zoonotic[Title/Abstract] OR "West Nile"[Title/Abstract] OR "HIV/AIDS"[Title/Abstract] OR "avian
34 flu"[Title/Abstract] OR "hendra virus"[Title/Abstract] OR "marburg virus"[Title/Abstract] OR
35 "yellow fever"[Title/Abstract] OR "tick-borne encephalitis"[Title/Abstract] OR "emerging
36 infectious diseases"[Title/Abstract] OR "emergent infectious diseases"[Title/Abstract] OR
37 brucellosis[Title/Abstract] OR rabies[Title/Abstract] OR chikungunya[Title/Abstract] OR "bovine
38 spongiform encephalopathy"[Title/Abstract] OR "rift valley fever"[Title/Abstract] OR zoonoses
39 [mesh]) AND (Spillover[Title/Abstract] OR "spill over"[Title/Abstract] OR "cross-species
40 transmission"[Title/Abstract] OR poultry[Title/Abstract] OR wildlife[Title/Abstract] OR
41 bushmeat[Title/Abstract] OR "bush meat"[Title/Abstract] OR livestock[Title/Abstract] OR "animal
42 market"[Title/Abstract] OR "animal markets"[Title/Abstract] OR "wet market"[Title/Abstract] OR
43 "wet markets"[Title/Abstract] OR "bird market"[Title/Abstract] OR "bird markets"[Title/Abstract]
44 OR horse[Title/Abstract] OR horses[Title/Abstract] OR waterfowl[Title/Abstract] OR
45 fowl[Title/Abstract] OR bat[Title/Abstract] OR bats[Title/Abstract] OR mammal[Title/Abstract] OR
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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

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

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7 AND

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

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16 AND

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

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23 Ovid Global Health database search (all in abstract)

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

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

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44 AND

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

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53 AND

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3 Prevent* OR ecological intervention* OR non-pharmaceutical intervention* OR public health OR
4 risk management OR risk minimisation OR control strateg* OR outbreak risk OR (reduc* adj5
5 transmission) OR (reduc* adj5 infection)
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8 *List of organization websites searched for grey literature*
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- 10 1. World Organization for Animal Health (formerly OIE)
- 11 2. Food and Agriculture Organization
- 12 3. World Health Organization
- 13 4. Wildlife Disease Association
- 14 5. International Alliance against Health Risks in WildlifeTrade
- 15 6. United Nations Environment Program
- 16 7. United Nations Office for Drugs and Crime
- 17 8. Global Alliance for Rabies Control
- 18 9. EcoHealth Alliance
- 19 10. Network for EcoHealth and One Health
- 20 11. International Livestock Research Institute
- 21 12. Preventing Pandemics at the Source
- 22 13. World Veterinary Association
- 23 14. CITES
- 24 15. TRAFFIC
- 25 16. One Health Commission
- 26 17. World Wildlife Fund
- 27 18. World Trade Organization
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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	<input checked="" type="checkbox"/>	<input type="checkbox"/>	p.1 l.1-2
Update	1b	If the protocol is for an update of a previous systematic review, identify as such	<input type="checkbox"/>	<input checked="" type="checkbox"/>	N/A
Registration	2	If registered, provide the name of the registry (e.g., PROSPERO) and registration number in the Abstract	<input type="checkbox"/>	<input checked="" type="checkbox"/>	N/A
Authors					
Contact	3a	Provide name, institutional affiliation, and e-mail address of all protocol authors; provide physical mailing address of corresponding author	<input checked="" type="checkbox"/>	<input type="checkbox"/>	p.1 l.3-25
Contributions	3b	Describe contributions of protocol authors and identify the guarantor of the review	<input checked="" type="checkbox"/>	<input type="checkbox"/>	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	<input type="checkbox"/>	<input checked="" type="checkbox"/>	N/A
Support					
Sources	5a	Indicate sources of financial or other support for the review	<input checked="" type="checkbox"/>	<input type="checkbox"/>	p.12 l.14-16
Sponsor	5b	Provide name for the review funder and/or sponsor	<input checked="" type="checkbox"/>	<input type="checkbox"/>	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	<input checked="" type="checkbox"/>	<input type="checkbox"/>	p.12 l.16
INTRODUCTION					
Rationale	6	Describe the rationale for the review in the context of what is already known	<input checked="" type="checkbox"/>	<input type="checkbox"/>	p.4-6
Objectives	7	Provide an explicit statement of the question(s) the review will address with reference to	<input checked="" type="checkbox"/>	<input type="checkbox"/>	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	<input checked="" type="checkbox"/>	<input type="checkbox"/>	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	<input checked="" type="checkbox"/>	<input type="checkbox"/>	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	<input checked="" type="checkbox"/>	<input type="checkbox"/>	p.11
STUDY RECORDS					
Data management	11a	Describe the mechanism(s) that will be used to manage records and data throughout the review	<input checked="" type="checkbox"/>	<input type="checkbox"/>	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)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	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	<input checked="" type="checkbox"/>	<input type="checkbox"/>	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	<input checked="" type="checkbox"/>	<input type="checkbox"/>	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	<input type="checkbox"/>	<input checked="" type="checkbox"/>	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	<input checked="" type="checkbox"/>	<input type="checkbox"/>	p.9 l.3-6
DATA					
Synthesis	15a	Describe criteria under which study data will be quantitatively synthesized	<input checked="" type="checkbox"/>	<input type="checkbox"/>	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)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	N/A
	15c	Describe any proposed additional analyses (e.g., sensitivity or subgroup analyses, meta-regression)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	N/A
	15d	If quantitative synthesis is not appropriate, describe the type of summary planned	<input checked="" type="checkbox"/>	<input type="checkbox"/>	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	<input type="checkbox"/>	<input checked="" type="checkbox"/>	N/A – scoping

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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)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	N/A – scoping review

For peer review only