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Risk Prioritization tools for emerging and epidemic-prone diseases: A One Health scoping review

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Abstract

Background and Aim: The threat of emerging and epidemic-prone diseases is a significant public health concern and there is an urgent need to work on the prevention and control of these diseases. In view of the limited time and other resources available to the animal and human health sector, it is crucial to prioritize the most essential and critical risk factors and diseases. This scoping review aims to document the available disease and risk prioritization tools by evaluating their characteristics and suitability from the One Health perspective.

Materials and Methods: Databases such as PubMed, Scopus, and Google Scholar were used to extract available tools for prioritization. We compared and synthesized the objective of the tool, methodology and prioritization process of the available tools.

Results: A total of six tools, including One Health Zoonotic Disease Prioritization, European Centre for Disease Prevention and Control, Strategic Toolkit for Assessing Risks, One Health Systems Mapping and Analysis Resource Toolkit, Health Hazard Assessment and Prioritization tool, Risk Ranger, are included in this scoping review. Various prioritization methods are available; however, multi-criteria decision analysis is the most commonly used.

Conclusion: A thorough analysis showed that different tools employ different prioritizing approaches, including mixed-method, quantitative, and qualitative approaches. The summary of the findings suggests the development of a new robust tool with a One Health approach, which will focus on risk prioritization and disease prioritization.

Keywords: disease prioritization, prioritization in public health, prioritization tool, risk prioritization.

Introduction

The current increase in epidemics and pandemics has led to a prioritization of health and related issues affecting individuals, society, and global economies [1]. However, quantifying the significance of diseases is challenging because they can negatively impact society, economy, and the environment. The majority of diseases have several adverse effects that cover these broad categories. In addition, the magnitude of the consequences varies and is often intangible, and decision-makers' opinions on the relevance of each impact change are also important. The economic consequences include expenditure on disease prevention and control and loss of productivity due to disease and its perceived threat (for example, severe acute respiratory syndrome [SARS] has been estimated to cost between US$30 and US$100 billion in different sectors, including travel and tourism). As is evident from the foot-and-mouth disease outbreak in the United Kingdom in 2001, individual and community repercussions can include psychological and social consequences of illness burden, loss, and altered life. The ecological balance may vary due to species distribution and abundance changes affecting the environment. Some of these impact areas also overlap; for example, economic implications can lead to social impacts, making comparison of disease impact more difficult [2].

The primary purpose of prioritization is to make the best possible use of limited human and financial resources while keeping in mind changing demands. Priorities should be set to ensure that resource allocation and planning are logical, precise, and straightforward [3]. According to Merriam-Webster [4], prioritization is defined as "organizing (things) so that the most important thing is done or dealt with first." This may include organizing tasks or things that must be performed and prioritized based on different characteristics. Prioritization enables us to determine what needs to be given priority in order to accomplish more. To prioritize resource allocation for diseases, stakeholders' impact and importance should be compared. To assist decision-makers in of creating ethical health

policies, the prioritization process must also be open, transparent, and repeatable (and hence auditable). Risk prioritizing involves analyzing the detected risks and selecting those that need immediate attention [5]. Prioritization is based on the likelihood of a risk and its possible harm to the organization [6].

Another emerging problem is the surge of emerging and recurrent diseases. Numerous new zoonotic infections spread naturally between humans and vertebrates. More than 60% of all infectious diseases that affect people and 75% of newly emerging infectious diseases are zoonotic in origin, each posing a different risk to the public health [7]. "Emerging zoonosis is newly recognized or evolved, or has previously occurred but has increased in incidence or geographical, host, or vector range expansion." For example-domesticated animals regularly transmit pathogens to humans and act as reservoirs for zoonotic diseases. Some zoonotic diseases, such as human tuberculosis, may eventually adapt to the transfer from person to person. The majority of emerging zoonotic diseases, such as Swine flu, Avian influenza, Nipah virus infection, Middle East respiratory syndrome, and SARS, cause severe conditions in people all over the world and pose serious risks to public health while directly endangering human life [8]. Due to limited funding for research, surveillance, control, and prevention of zoonotic diseases, it is essential to prioritize diseases to allocate a budget to those most in need [9].

In view of the significant impact on human and animal populations, emerging and endemic zoonoses are an appropriate place to start cooperation between the human and animal health sectors. Establishing zoonotic disease priorities of legislative importance to governments and organizations as cooperation efforts grow becomes critical [10]. It is challenging to prioritize One Health because it involves a human–animal–environment interface. An increase in interactions between people, animals, and the environment has been attributed to the consumption of meat, deforestation, unpasteurized milk, exotic pets, exotic foods, proximity to wild and domestic animals, migration across national and international borders, and the emergence and reemergence of infectious diseases [11]. There is an urgent need to highlight the risks associated with One Health and diseases and make policy recommendations.

This scoping review aims to document the available disease and risk prioritization tools by evaluating their characteristics and suitability from the One Health perspective.

Materials and Methods

Ethical approval

This is a secondary scoping review so ethical approval is not required.

Study period and location

This scoping review was conducted from December 2022 to June 2023 at the Indian Institute of Public Health Gandhinagar, Gujarat, India.

Search strategies

We conducted a broad search using keywords like disease and risk prioritization. PubMed, Scopus, and Google Scholar search engines were used.

PECO formulation

Problem	Emerging and re-emerging diseases and risks at the interface of human-animal ecosystems
Exposure	Detecting the risks of emerging and re-emerging diseases
Comparison	NA
Outcome	Prioritization of risks of emerging and re-emerging diseases and prioritized diseases

Eligibility criteria

Inclusion criteria

We have included articles with tools for prioritizing diseases, risks, hazards, and management disciplines. Review articles published exclusively in English were included. To date, all the articles have been included.

Exclusion criteria

Articles that were insufficiently detailed and difficult to access were excluded. In addition, articles containing only screening, risk assessment, or risk management tools were excluded.

Quality assurance

Two reviewers searched the databases separately, while the third reviewer assessed eligibility by screening titles, abstracts, and full text to identify suitable titles. Another reviewer confirmed that 20% of the screened articles were eligible for publication. Any differences among the reviewers were resolved by consensus.

Data extraction

The two reviewers independently extracted the data from the eligible studies to summarize the data. Initially, the information about the tool, such as title, year of publication, country, agency or institute involved, and purpose of the tool, was extracted and tabulated. Second, the methodology tools were reviewed in detail, and information such as steps or scoring process and ranking was extracted and tabulated. Furthermore, the tools were documented using the One Health approach.

Results

Search results

The initial database screening resulted in the identification of 636 articles. After the initial title and abstract screening, 400 articles were excluded from consideration, and a further 184 articles were excluded after the full-text screening. These publications were excluded for various reasons, including inadequate tool descriptions, inadequate methodology descriptions, tool objectives that differed from those of the current study, or restricted access to the article. For the final review, we included 52 articles that contained the prioritizing tool (Figure 1).

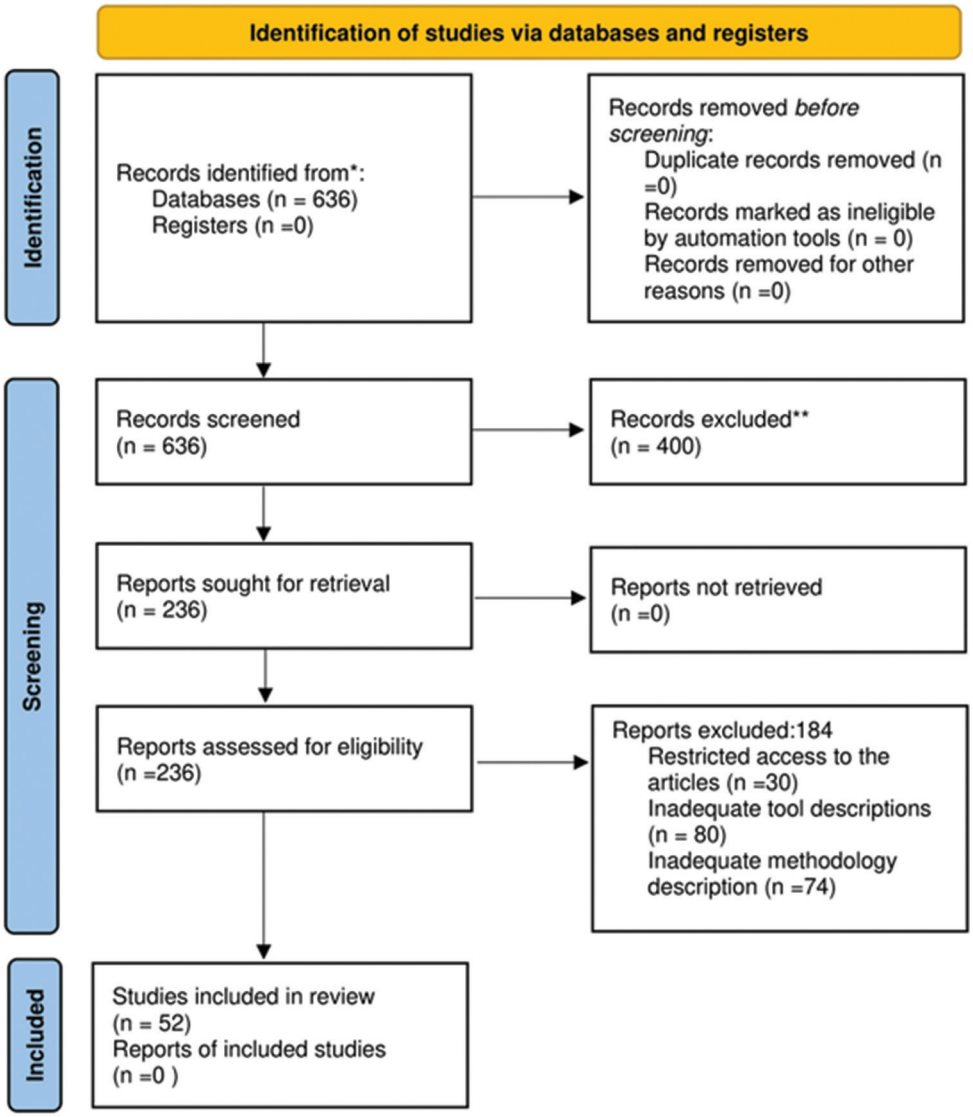

Figure-1: PRISMA diagram.

Multi-criteria decision analysis (MCDA), program budgeting and marginal analysis, Hanlon method, prioritization matrix, criteria weighting method, nominal group technique, Delphi technique, multi-voting technique, strategy grids, simplex technique, and quick and colorful approach are some of the prioritization techniques that were mainly used to reach a consensus [12–14]. MCDA is the most commonly used prioritization technique in public health. The further details of prioritization methods and their use are depicted in Table-1.

One Health Zoonotic Disease Prioritization (OHZDP), the European Centre for Disease Prevention and Control (ECDC), the Strategic Toolkit for Assessing Risks (STAR), the One Health Systems Mapping and Analysis Resource Toolkit (OH-SMART), the Health Hazard Assessment and Prioritization tool (hHAP), and Risk Ranger are some of the tools that are currently available and are being used for prioritization [15–21]. Table-2 represents various prioritization tools.

The ECDC

The ECDC has developed a Microsoft Excel 2007 version (Microsoft Office, Washington, USA) tool for prioritizing threats to infectious diseases. The ECDC tool is based on multi-criteria decision analysis (MCDA) and uses a methodological risk-ranking approach. The ECDC tool can be used to determine all values and criteria for the ranking exercise. A total of 60 diseases can be ranked in one Excel worksheet.

The risk-ranking process consists of the following seven steps:

1. Planning should include identifying objectives, adequate resources, and a schedule.
2. Identify diseases for prioritization: An extensive list of diseases will be initially selected and prioritized with an expert group's assistance.
3. Formulate a list of criteria against which diseases can be assessed: Check that the requirements meet the objectives of the risk-ranking exercise. The criteria must be distinguished from one another. For each criterion, a set of criterion levels must be defined. Criteria values or scaled values shall be assigned to each criterion level within 0.1 intervals, where 0 represents the lowest possible value, and 1 represents the highest possible value.

Table-1: Various prioritization methods and their use.

S. No.	Name of the method	Description
1.	Multi-criteria decision analysis	Numerous factors must be reviewed and considered simultaneously to rank or choose options.
2.	PBMA	In PBMA, a panel of experts is engaged to help decision-makers optimize budgetary changes' impact on a local population's health requirements.
3.	Hanlon method	Used to prioritize health problems.
4.	Prioritization matrix	They are used when many criteria must be considered when evaluating health concerns or when an agency can only concentrate on one high-priority health issue.
5.	Criteria weighting method	A mathematical procedure where participants create a list of pertinent criteria and rate issues according to how they adhere to the criteria.
6.	Nominal group technique	Nominal group planning was developed for situations requiring combining different opinions to reach conclusions a single person could not reach.
7.	Delphi technique	A method of predicting based on the aggregate opinion of panel participants.
8.	Multi-voting technique	When a huge number of health issues or problems need to be narrowed down to the top few, multi-voting is usually used.
9.	Strategy Grids	This strategy benefits organizations with limited funding and wanting to focus on projects that provide "the biggest bang for the buck."
10.	Simplex technique	The Simplex Method uses questionnaires to gather opinions from the group.
11.	A quick and colorful approach	It is a quick, simple, and more enjoyable method of prioritizing.

PBMA=Program budgeting and marginal analysis

The ECDC tool has been created for non-linear numbers.

4. Weight criteria according to importance can be calculated using a survey or software. "Probabilistic inversion" is a method by which experts rank a variety of hypothetical diseases using the criteria employed in ranking research. Another strategy is "PAPRIKA," which stands for potentially all pairwise rankings of all conceivable alternatives and entails providing decision-makers with pairs of hypothetical diseases specified by only two criteria.
5. Score diseases against the criteria: A unique score for each disease, which can be established through workshop consensus, and individual scores for each disease, with central tendency and dispersion metrics utilized to calculate the common score.
6. Rank diseases based on relative scores: The program automatically ranks diseases according to their relative scores after choosing the appropriate criterion levels. A linear model incorporating transformed values and criteria weights for all diseases is used in this tool.
7. Evaluation: Sensitivity analysis can be used to evaluate the impact of assumptions on outcomes. The final rankings show only the relative importance of related diseases. The results are not absolute in nature.

STAR

The STAR assesses public health hazards in a timely, strategic, and evidence-based manner to plan and prioritize health emergency and catastrophic risk management measures. STAR methodology is qualitative, participatory, and discussion-based. The STAR method employs the following six key steps:

1. Identify hazards: Participants should identify hazards, potential negative health implications, and the extent and degree of the hazard based on the most likely scenario to trigger a coordinated national response. Finally, assess and describe the exposure to the hazard.
2. Evaluate likelihood: A hazard's likelihood can be determined by defining its frequency, seasonality and calculating its likelihood.
3. Estimate hazard impact: The severity, vulnerability, and coping capacity were assessed separately, and the impact score was calculated using the formula: impact score = severity + vulnerability + coping capacity/3.
4. Determining the risk level: Workshop participants completed two additional tasks: evaluating the level of confidence in the risk assessment and discussing the risk ranking using the automated risk matrix.
5. Finalize recommendations and next steps: During this step, participants should develop critical next steps based on the risk assessment.
6. Incorporating recommendations into national or subnational action planning processes. Recommendations received during the STAR workshop should be integrated according to the specific national or subnational action planning process.

OHZDP

The Centers for Disease Control and Prevention has developed the OHZDP tool to meet the needs of individuals with limited quantitative data on zoonoses. The OHZDP tool has five steps: They are as follows:

1. Prepare for group work: Choose 5–12 participants for group work and prepare a list of zoonoses to be ranked.
2. Develop the criteria for determining the relative importance of zoonoses: 5–8 criteria should be identified. Criteria must be relevant to the prioritization process and agreed upon by all participants.

Table-2: Represents various prioritization tools.

Components	ECDC	Strategic Toolkit for Assessing Risks	One Health Zoonotic Disease Prioritization	Health Hazard Assessment and Prioritization tool	One Health Systems Mapping and Analysis Resource Toolkit	Risk Ranger
Year published	2017	2021	-	2013	-	2002
Agency/ institution	ECDC	World Health Organization Health Emergencies Program	CDC	CDC	The University of Minnesota – United States with Indonesia One Health University – Network	Australian Food Safety Centre of Excellence
The objective of the tool	To prioritize infectious disease threats	To prioritize health emergency preparedness and disaster risk management activities.	To prioritize zoonotic diseases	To assess and prioritize planning and mitigation efforts for hazards	(1) To analyze the interaction between the systems to handle an issue. (2) To strengthen the existing network in responding to the public health issues that need to be done cross-sectorally, such as zoonosis. (3) To assist agencies in coordinating effective outbreak response planning.	They are used to determine relative risks from various product/ pathogen/processing combinations-hazard combinations.
Methodology used	Methodological risk-ranking approach based on MCDA	Qualitative, participatory, and discussion-based	MCDA and analytical hierarchical process	Risk metrics	Qualitative	
Steps	(1) planning (2) identifying diseases (3) formulating a list of criteria to assess diseases (4) weight criteria (5) scoring diseases (6) ranking diseases (7) evaluation	(1) identify hazards (2) evaluate likelihood (3) estimate the impact (4) determine the risk level (5) finalize recommendations and workshop report (6) integrate recommendations and priority actions	(1) identification of zoonoses (2) development of five criteria (3) development of questions with categorical answers (4) weighting the criteria (5) ranking of zoonoses	(1) form a steering committee 2) define the geographic area to be included (3) identify hazards (4) conduct assessments to acquire data to create relative risk score (5) rank and prioritize the results (6) Planning, review, and update	(1) identify network (2) interview stakeholders (3) map system (4) analyze system (5) identify opportunities (6) develop a plan	Eleven questions are to be answered, which are divided into three categories: - (A) susceptibility and severity, (B) probability of exposure to food, and (C) probability of food containing an infectious dose.

MCDA=Multi-criteria decision analysis, CDC=Centre for Disease Control and Prevention, ECDC=European Centre for Disease Prevention and Control

3. Development of the questions: The same group of participants should be used to create one category question for each criterion.
4. Rank the criteria: The selected criteria are ranked using the semi-quantitative analytical hierarchy process.
5. Rank zoonotic diseases: A decision tree is constructed in Microsoft Excel, with the highest-ranked criterion as the first node and the second-highest-ranked criterion as the second node.

hHAP

The Los Angeles County Department of Public Health, together with the Orange County Health Care Agency, the Long Beach Department of Health and Human Services, and the Pasadena Department of Public Health, created the hHAP tool to evaluate and prioritize planning and mitigation efforts for Southern California hazards. The six steps of the hHAP tool are as follows:

1. Form a Steering Committee: The committees should include representatives from the media, the office of aging, business, community leadership, cultural and faith-based groups and organizations, emergency room, fire department, healthcare, law enforcement, social services, housing and shelter, and childcare.
2. Define a geographic area: This can be used for any geographical location.
3. Identifying potential hazards: The steering committee should assess the potential risks according to geographical conditions. Four pre-identified hazards – natural, biological, chemical/radiation, and technological – were chosen for this instrument. Adding or removing hazards based on the Committee's judgment is possible, but the final rating spreadsheet and calculation will also vary.
4. Create a relative risk score: Each hazard's risk is assessed independently, without considering other hazards. The eight risk elements comprising the relative risk score are hazard probability, health severity, community impact, public health impact, healthcare impact, mental-behavioral health, responder agency resources, and community agency resources.
5. Rank and prioritize results: The calculation worksheet automatically calculates the relative risk score for each hazard once all risk factors have been entered for each hazard.
6. Planning, review, and update: This helps identify existing gaps.

OH-SMART

The One Health System Mapping and Resource Tool (OH-SMART) was developed in collaboration between the University of Minnesota and the United States Department of Agriculture. OH-SMART can perform two tasks: (1) To explore system interactions to address an issue and (2) To strengthen the existing network's response to cross-sectoral public health challenges such as zoonosis. The following are the steps in the OH-SMART process:

1. Create a network of public–private academic or cross-sectoral organizations (stakeholders) to be investigated in the context of the OH-SMART process.
2. Conduct "key-stakeholder" interviews with 1–3 key members of each stakeholder organization. Interview information should be collected and recorded, and new stakeholder organizations should be added to the network.
3. At this stage, an accurate map of the existing system is necessary. Each sector is mapped separately, and then a composite map is drawn up, highlighting cross-sectoral cooperation regions and areas where sectors have different definitions of their connections.
4. Analyze the system using a multi-agency workshop – walking workshop participants using a combined map. Examine where discrepancies/differences in responses were recorded, where and why interactions work, and how they may be enhanced or institutionalized.
5. Identify opportunities to improve system operations by recording information on multi-agency consensus on what should happen during each identified discrepancy using computer mapping software.
6. Assist participants in multi-agency meetings in creating an implementation strategy that identifies gaps, outlines agreements on differences and disagreements, and summarizes best practices. Participants should draw up a list of specific tasks to implement the current framework.

Risk Ranger

Risk Ranger is a simple spreadsheet-based application that evaluates food safety concerns. The software is excellent for identifying elements that increase food safety risk and teaching the foundations of food safety risk assessment. It has also been used to rank the risk associated with different product/pathogen combinations. The tool requires the user to answer 11 questions divided into three sections. The first block (susceptibility and severity) raises two questions: How severe is the hazard, and how susceptible is the interest group? The second block focuses on the likelihood of food exposure and asks the following three questions: Frequency of intake, proportion, and size of the consuming population. The third block consists of six questions concerning the likelihood that food contains an infectious dose, the possibility of raw product contamination per serving, the effect of processing, and recontamination after processing,What is the effectiveness of the post-processing control system?, How would an increase in post-processing contamination lead the average consumer to become ill or intoxicated?, Preparation before eating has an effect.

All the above-mentioned tools embrace a One Health perspective, recognizing the close interconnection

between human, animal, and environmental factors. The ECDC tool takes a comprehensive approach and prioritizes communicable diseases spanning the human–animal–environment interface. Meanwhile, the OHZDP tool meticulously follows steps such as identifying, assessing, and ranking zoonotic diseases. STAR contributes by conducting gap analyses in zoonotic disease programs, prioritizing risks and hazards with a specific focus on the human-environment interface, thereby enhancing emergency preparedness. hHAP, however, facilitates assessing and prioritizing risks, hazards, and threats by considering variables such as probability, severity, impact, and resource assets, including One Health components. OH-SMART plays a crucial role in inter-agency mapping and analysis of One Health systems, acknowledging the interconnectedness of various agencies involved in managing health problems across humans and animals. Finally, Risk Ranger focuses on the risk assessment of foodborne zoonoses and assesses the importance of understanding and mitigating risks arising from the intersection of human and animal food systems.

Collectively, these tools embody the One Health approach by addressing a complex network of interactions between humans, animals, and the environment to promote the well-being of all interconnected elements of the ecosystem.

Discussion

This scoping review provides an overview of a few tools for prioritizing diseases, risks, and hazards from one health perspective. The findings of this scoping review suggest that prioritization tools were developed using quantitative, qualitative, or mixed-method approaches. This scoping review included two quantitative, two qualitative, and two mixed-method tools. ECDC and hHAP are quantitative tools [16, 19], STAR and OH-SMART are qualitative tools [17, 18], and OHZDP and Risk Ranger are mixed methods [15, 20]. All the instruments included in the scoping review were well-designed, but specific concerns exist. Both quantitative tools, ECDC and hHAP, have the advantage of being automated Excel tools that are user-friendly and simple to use. The disadvantage of the ECDC tool is that manual entry is required in each sheet to obtain a final risk assessment, which may take time. The disadvantage of hHAP is that it only calculates the risk score once when all cells are filled.

Qualitative tools, such as STAR, can capture all the details and cover all the parameters to assess risk. On the other hand, OH-SMART is a system mapping tool to coordinate outbreak response planning and analysis collaboration in a multi-agency network. The disadvantage of the STAR tool is that no automated tool is available. Therefore, each step must be completed manually by conducting workshops and reaching consensus through workshop participants, a 2-day process. On the other hand, the disadvantage of the OH-SMART process is that it is time-consuming and requires sufficient resources.

Mixed-method tools, such as OHZDP and Risk Ranger, combine qualitative and quantitative approaches to reach a consensus. The OHZDP tool has been developed to prioritize zoonotic diseases and completed with the assistance of a workshop. Risk Ranger has an automated Excel tool for determining the relative risk of food safety. According to the current scoping review, 15 of the 52 articles shortlisted in this document used the OHZDP tool; 75 STAR workshops have been held to date; one study used the ECDC prioritization tool; one study used the hHAP tool; one study used Risk Ranger; and one study mentioned OH-SMART.

Tools such as ECDC and OHZDP demonstrate comprehensive disease prioritization within the One Health framework, effectively addressing the human–animal–environment interface. However, these tools do not explicitly incorporate the components essential for risk prioritization. On the other hand, STAR and hHAP are specifically designed for risk assessment and prioritization, emphasizing emergency preparedness criteria and disaster management. Nevertheless, OH-SMART, functioning as a qualitative tool, contributes to mapping One Health systems, providing insights into the interconnectedness of various agencies involved in One Health across humans and animals. Nevertheless, they lack certain variables necessary for prioritizing diseases and risks within the interconnection of the human–animal–environment interface. On the other hand, Risk Ranger focuses solely on classifying foodborne diseases and narrows its scope to this specific aspect of zoonotic risks.

Conclusion

Most of the reviewed tools fulfill most of One Health's components. Through a meticulous assessment, we could find tools based on disease prioritization; however, we could not find a tool for risk prioritization. Most of these tools focused on risk assessment, risk management, disease management, and disease assessment. It is expected that the insights gathered from this scoping review will be helpful to researchers and will provide valuable guidance in selecting the most appropriate tool for their specific needs. A summary of the findings suggests the development of a new robust tool based on the One Health approach, which will focus on disease and risk prioritization, is required.

Authors' Contributions

SY and DS: Conceptualization and review and finalization of the manuscript. SY, SP, PB, and DS: Methodology. SP and PB: Data extraction and Writing the first draft. SY, SP and PB: Data analysis. All authors have read, reviewed, and approved the final manuscript.

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Competing Interests

The authors declare that they have no competing interests.

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