Increasing Implementation of the COHERE Guidelines to Improve One Health Research

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Abstract

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One Health is the integration of knowledge and collaboration between interdisciplinary teams to reach the goal of optimal health for humans, animals, and the environment. As the field evolves and grows, guidelines and tools are needed to support high quality publications and research. The COHERE guidelines were developed in 2017 by a group of experts as a tool for observational epidemiological studies, providing 19 recommendations covering aspects of a high quality One Health paper. The intent was to provide clear guidance for studies that take a One Health approach so that they fully include all three domains of One Health - human, animal, and environment. This project evaluated COHERE in three ways - comparison between published papers that implement the guidelines versus those that do not, second an examination of how COHERE is cited in in publications, and finally a survey of experts to better understand how the guidelines are being implemented and how they should be improved. The results of this evaluation indicate that the COHERE guidelines are a generally accepted and supported tool that has potential to improve the quality of One Health publications. The COHERE guidelines support data and method standardization and collaboration across disciplines. Future versions of COHERE should provide clear definitions of each domain, particularly the

environment domain, support improving ethical standards, and be designed to encourage increased input from stakeholders outside of current academic and publication structures.

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Introduction

The core principle of One Health, that the health of humans, animals, plants, and ecosystems are interconnected, can be traced back to ancient times[1–3], and is common in many current indigenous belief systems and cultural practices[4]. One Health became a frequently used term in the early 2000s, and was associated with scientific concern about the emergence of zoonotic diseases such as severe acute respiratory syndrome (SARS) and highly pathogenic avian influenza (HPAI) H5N1[5,6]. The recognition of the potential threat of emerging zoonotic diseases expanded research to consider how the health of humans and animals is connected to the ecosystems around them[1]. Surveillance and response to these new threats requires cooperation and collaboration between governments, human medicine, veterinary medicine, and a wide variety of other expertise[6]. In 2007, the AVMA established a One Health Initiative Task Force with the goal of creating a definition of One Health and creating plans to expand this concept into other fields[7]. In 2008, the United Nations and the World Organization for Animal Health started endorsing the concept and beginning their own programs, followed by the CDC in 2009 and the European Union in 2010[2]. In 2008, the World Organization for Animal Health (WOAH), the World Health Organization (WHO), and the Food and Agriculture Organization of the United Nations (FAO) made a Tripartite agreement, to collaboratively address the threat of emerging zoonotic diseases. In 2021, the Tripartite became the Quatripartite with the inclusion of the United Nations Environment Program (UNEP). The One Health High Level Expert Panel (OHHLEP) began in 2020, and continues to provide reports, guidance, and frameworks for One Health research and programs around the world[8]. Many countries and organizations have developed programs and projects to address their specific needs using the One Health approach.

One of the ongoing challenges to the growth of the One Health field is that many groups involved in One Health have their own definitions of One Health that focus on slightly different priorities.

The American Veterinary Medical Association defines One Health as:

First, it is the concept that humans, animals, and the world we live in are inextricably linked. Second, it refers to the collaborative effort of multiple disciplines working locally, nationally, and globally to attain optimal health for people, animals, and the environment.[7]

The OHHLEP uses the definition:

One Health is an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals and ecosystems. It recognizes the health of humans, domestic and wild animals, plants, and the wider environment (including ecosystems) are closely linked and inter-dependent. The approach mobilizes multiple sectors, disciplines and communities at varying levels of society to work together to foster well-being and tackle threats to health and ecosystems, while addressing the collective need for clean water, energy and air, safe and nutritious food, taking action on climate change, and contributing to sustainable development.[9]

The consistent theme is that health in these three domains is interconnected, and that collaboration is required to solve these issues. Most definitions also place all three

domains as equal in importance and priority, although some groups prioritize human health, or human and animal health above the health of the environment. The term "Environmental Health" is often used incorrectly, as this is the study of how environmental factors impact human health, rather than the intended meaning of health of the environment.

The Checklist for One Health Epidemiological Reporting of Evidence (COHERE) Guidelines[10] was developed and published in 2017 in the open access journal One Health, by a group of experts in the field to provide a tool to guide One Health researchers on how to carry out and publish One Health research studies. The COHERE guidelines build off the STROBE guidelines for reporting observational studies. There are 19 guidelines with recommendations, organized to follow a standard journal article, that cover aspects of study design, data collection, analysis, and place results in a One Health context. The two primary goals of the guidelines are to:

A) improve the quality of reporting of observational or interventional epidemiological studies that collect and integrate data from humans, animals and/or vectors, and their environments; and
B) promote the concept that One Health studies should integrate knowledge from these three domains.

COHERE is written for observational epidemiologic studies to fulfill the first goal, but many of the provided standards can be applied to other types of studies, per the second goal. The intent was to create a "living document" that would be revised as the field continues to evolve. The COHERE Guidelines are currently hosted online by the University of Washington Center for One Health Research (COHR). The COHERE Guidelines are currently the only One Health specific guidelines hosted by the EQUATOR network. The full guidelines and recommendations is included in Appendix 1.

COHERE does not provide any definitions of what is included or excluded in each domain, with the exception of some guidance for the classification of vectors. COHERE choses to classify vectors in the animal domain if the biological processes of the vector is included in the study (biological vector), and in the environment domain if the vector is being treated as a mechanical vector like a fomite (mechanical vector). COHERE defines a One Health study as including data collection in all three domains, and fully integrating results between the domains. COHERE suggests that studies that use a One Health approach, but only include one or two domains in their data collection and analysis identify their study using a different term, such as "One Medicine" for studies that include human and animal health. This is an area of ongoing discussion in the field, in part because of the rapidly expanding use of the term "One Health" in a wide variety of contexts.

The origin of the One Health idea in disease ecology is seen in the literature with the vast majority of One Health publications on the topic of zoonoses[11], and the rapid increase in publications, particularly since January 2020. One Health was identified as a MeSH term in PubMed in 2018, although many papers on One Health are not identified with this term, making it of very limited use in searching. There are many papers that would be considered

One Health papers using the COHERE criteria, but do not include the term “One Health” in the title or abstract, and some do not include it anywhere in the text of the paper, making those papers difficult to identify. There are also studies that claim to use a One Health approach but would not be considered a One Health study under COHERE as they do not include data from all 3 domains.

The similar fields of Ecohealth and Planetary Health include the same three domains, with some similarities, with important differences in priorities and emphasis. None of the fields have a single, unifying definition and clear boundaries, but there are differences in approach that can be described. Ecohealth focuses on the health of humans and animals on a population level in relation to the ecosystems, while Planetary Health is generally anthropocentric and focuses on the health of humans and sustainability based on natural resources and biodiversity[12–14]. One Health is very similar to Ecohealth, but usually focuses on the health of individuals and populations rather than the whole system[14]. Collaboration between different sectors is an important component to all these approaches.

As the field of One Health expands and includes new expertise, many new tools are being developed, and tools like COHERE can be revised to include new knowledge and perspectives. COHERE has been available for seven years, and there are now publications and data based on these guidelines to analyze. This thesis explores several questions about COHERE. The first question is whether COHERE is being effectively implemented, and if implementation leads to better studies and publications. The second question is how COHERE is being discussed within One Health literature. The third question is how researchers in the field perceive COHERE, and what improvements can be made. Answering these questions may provide valuable guidance for the next iteration of COHERE and identify ways to increase implementation. This thesis represents a preliminary project to provide a foundation for revision and expansion of COHERE to meet the changing needs of the field.

Methods

Citation of COHERE

The entry for the COHERE paper was found in both the PubMed and Web of Science databases, and the "cited by" function was used to identify all the papers that cited the COHERE paper up to May 5, 2024. A total of 66 papers were identified and screened for inclusion from both sources. 50 papers were identified by the PubMed search, and 62 papers were identified through the Web of Science search. 47 papers were in both, 3 papers were only listed in PubMed, and 15 papers were only found through Web of Science. Of the 66 papers screened for inclusion, two papers were excluded because they were not published in English, and one paper could not be found. Five papers were excluded for incorrect citations, where the information could not have come from the COHERE paper. All correct citations of COHERE are listed in Appendix 2.

The 58 papers that cited COHERE were classified by type. Review papers were identified by including more than one data source and were labeled as review papers. Opinion papers discussed ideas, and did not include any primary data. Method development papers described a new method or proposed study but included no or very limited data. Observational studies included primary data. 11 papers were classified as opinion, 23 papers were classified as review, 13 were classified as method or framework development, and 11 were observational studies. Only 6 of the observational studies implemented the COHERE guidelines. Of these six papers, 5 include one or more COHERE authors as involved in the study.

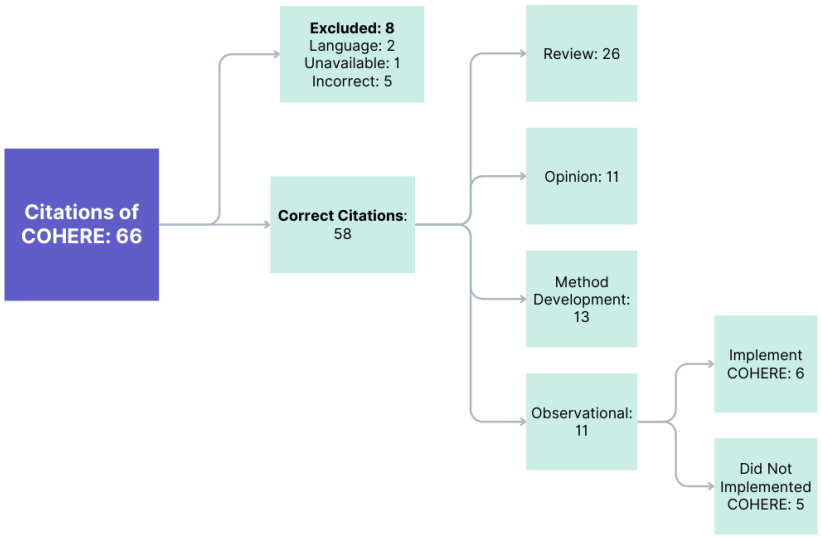

Figure 1: Flow chart of COHERE Citations and classifications.

Scored Comparison

To determine if COHERE can be successfully implemented as it is written, the papers that explicitly implemented COHERE were evaluated for how well they met each of the guideline recommendations. This also identified which guidelines were most and least commonly met, to prioritize which guidelines should be considered for revision. A scoring rubric was created with recommendations derived from each guideline, and each paper was scored for how well it met each guideline on a scale of 0 to 3, where 0 was not meeting the guideline at all, and 3 was fully meeting the recommendations of the guideline. The rubric is included as Appendix 4.

COHERE does not provide any definitions for what is included in each domain, so definitions were generated for this project. The human domain included any measurement of health impacts of humans. The animal domain included any measurement of animal health. The environment domain included the natural and built environment, microbiome, geographic location, and other factors. Following the classification guidance provided in the original COHERE paper, vectors were included in the environment domain when the biological processes of the vector were not involved, when the vector was treated as inert. Proxy measures with clear explanation of which domain they represented were accepted as measuring that domain. The definitions for each domain are broad to be the most comprehensive, rather than narrow and potentially exclusionary.

To understand whether intentional implementation of the guidelines made a difference in how often the criteria were met, a comparison group of 11 papers were selected from papers published from 2019 to 2023 in the One Health Journal. This journal was selected because it is a One Health focused journal, and has published the most One Health papers between 2012-2022[15] of any one journal. Papers were initially screened for inclusion in Group 2 if it included two or more domains in the title, and secondary screening was based on the abstract to make sure it was an observational study and would be appropriate to evaluate using the guidelines as intended. The same rubric used on the papers in Group 1 that implemented COHERE was used to score each paper on the individual guidelines.

A Welch's Two Sample t test was used to compare the scores for each individual guideline between the papers that implemented COHERE and those that did not. The guidelines were also grouped into 7 categories by domain and paper section, to investigate differences between domains and paper sections, and the Welch's Two Sample t test was repeated for each category. The guidelines 4 and 11 were averaged for the human domain category, guidelines 5 and 12 were averaged for the animal domain category, and guidelines 6 and 13 were averaged for the environment domain category. Guidelines 1, 2, and 3 were averaged for the Introduction and study design category. Guidelines 7, 8, 14, and 15 were averaged for the Measurement/Analysis category. Guidelines 16, 17, and 18 were averaged for the One Health Impact category. Guidelines 9 and 10 were averaged for the Study Team/Ethics category.

Context of COHERE Citations

To better understand how COHERE is being cited in the literature, all the papers that cited COHERE were coded for a qualitative analysis to identify common themes. The primary research question was how COHERE is being cited in the literature – what is the context of the citation, what point is it being used to support, and is the discussion of COHERE positive or negative? The literature was also analyzed to identify what existing needs in the field could be addressed or supported through increased implementation of COHERE. This would identify what the priorities are for future iterations of the guidelines, and identification of potential stakeholders.

All papers that cited COHERE were imported into Atlas.ti (ATLAS.ti 24 Scientific Software Development GmbH) as PDFs, and a codebook was developed through a hybrid of inductive and deductive, using a subset of papers as a training set. These papers were chosen as likely representatives of the types of papers that cited COHERE based on a reading of the abstract. The established codebook was then used to review the preliminary set of papers, and then applied to all the remaining papers. The coded excerpts were then analyzed and grouped into themes. Each code was analyzed to identify the common themes, and these themes were then combined to present an overall perspective. The papers were also sorted by type and subject to identify the most common topics. The goal of the analysis was to identify how COHERE is being cited, and how COHERE could be implemented to support emerging and identified needs in the field.

Survey of Experts for Feedback on COHERE

Survey Design

To understand the general opinion of the COHERE Guidelines by researchers currently in the field, a survey was designed and distributed to collect expert opinions about the COHERE guidelines as they are currently written and solicit suggestions for improvements and identification of barriers to implementation. The survey included the individual guidelines as well as questions about the guidelines as a complete document. Due to the length of the COHERE Guidelines and concern about survey fatigue, the scope remained limited to the specifics of the guidelines, and did not include broader questions about the field of One Health. The individual guidelines were ranked on a 3-point scale, and the overall guidelines were ranked on a 5-point scale, for convenience and ease of response. Opportunities for free text response were provided frequently, to capture additional feedback. There were no required responses, allowing respondents to skip any questions they did not want to answer, and ensuring that no identifying information was required to participate.

The survey contained a total of five sections. The first page contained a brief background on the COHERE Guidelines, the goals of the survey, the expected duration, and a notice that

by continuing the survey, the respondent was giving their consent for their answers to be used in the analysis.

The second page contained all 19 of the guidelines, separated into blocks of 2-4 guidelines so that the text was not overwhelming and any text in the open response could be associated with the relevant guideline. Each section of the guidelines had the full text of the guidelines, and then asked the experts to rate each guideline as "No improvement needed", "Minor improvement needed", and "Major improvement needed", and then provided a text box to answer the question "How could these guidelines be improved?". There was also one question about whether the current ethical standards of IACUC/IRB approval are sufficient.

The third page contained questions about the overall opinion, ease of use, and likelihood of the participant implementing COHERE in future projects. These were all answered with a five-point scale, where 1 was a negative opinion, 3 is neutral, and 5 is a positive opinion, although the provided text of the scale used different words based on the logical response to the wording of the question. There were two open text boxes at the end with the questions – "What would be a benefit to increased implementation of the guidelines?" and "What are the guidelines missing?".

The fourth page contained questions with basic demographic information - how long have they been in the field, what countries they live and work in, ranking their expertise in each domain, and their primary affiliation. These questions were designed to collect very broad information that is only relevant to their expertise and avoid any identifying information. The countries where they are based, and work in, were asked in order to capture how diverse of a population was sampled and identify geographic regions with over and under representation.

The final page contained a thank you message and two potential opt-ins - to be involved in future discussions about the COHERE guidelines, and to be notified of any publications that result from this work. If participants answered yes to either or both, they were instructed to enter their email address so they could be contacted in the future. This was never used to connect responses to the participant, so all responses remain deidentified.

The full text of the survey is included as Appendix 6.

Target Survey Population

The survey population was people who self-identify as One Health researchers who had been involved in the field for longer than one year and were reachable via email and social media. The target population is very broad in order to generate a sufficient response. The minimum of one year experience was required to ensure that participants have experience and a foundation in the field. The survey was only provided in English, although participants were able to use online translation services to access it in a different language if they chose.

The survey was distributed using convenience sampling, snowball sampling, email, and social media recruitment efforts. Participants were primarily contacted through email, although a few respondents were recruited in person during meetings. Email addresses were collected from a wide variety of sources. The corresponding author or authors for all the papers that cited COHERE were contacted at least twice. The survey was also distributed through the COHR email list, through personal networks of survey respondents, and included in the One Health Commission regular newsletter. Social media posts were distributed through X, LinkedIn, and Facebook, on personal pages as well as posted in several One Health focused groups. Broad, non-specific internet searches for One Health programs, governmental and private organizations, and ongoing projects yielded some additional emails that were included in the email blasts. Emails and LinkedIn messages were also sent to a selection of poster presenters at the Global Health Security 2024 conference that was hosted in Sydney, Australia. Repeated emails were sent out to offer multiple opportunities to take the survey.

Survey Data Analysis

Participants were asked to categorize their familiarity with the COHERE Guidelines as one of four responses, and that was used to create groups for comparison.
The options provided were:

- Never heard of them before
- Have heard of them, choose not to use
- Have used them to analyze published papers, not implemented in my work
- Have implemented them in the study design, data analysis, or paper writing of my work

These were summarized into the following respective group names:

- Never Heard Of
- Choose Not to Use
- Partial Use
- Full Use

The responses to the individual guidelines were interpreted as: “No improvement needed” was a 0, “Minor improvement needed” was a 1, and “Major improvement needed” was a 2. These values were averaged, and a 0.5 cutoff was used as the distinction between “No improvement needed” and “Minor improvement needed”, and 0.75 was used as the distinction between Minor and Major. These values were selected because they would indicate that a majority of participants thought that the criteria required minor improvement, or several participants thought the criteria required major improvement. The primary determination of status for each criteria was made by averaging the participant responses as a whole, and values for each group are reported as well. The feedback provided in the written responses is summarized with the relevant criteria.

The responses to the questions about COHERE overall, ranked on the 5-point scale, were also averaged to determine the overall opinion, where 1 was very negative and 5 was very positive. The averages were also calculated for each group.

The written responses to the guidelines overall, as well as any repeated feedback on individual criteria, are summarized and reported together.

The responses were also averaged and reported based on which of the 4 levels of experience with the COHERE Guidelines were reported. The differences between the groups were analyzed to identify differences in opinion that could be related to different levels of experience with the guidelines and their implementation.

Participants were removed from the numerical calculations if they chose not to answer over 50% of the scale questions. All written feedback was included in the relevant sections.

Results

Scored Comparison

There were 6 papers of epidemiologic studies that implemented COHERE that were evaluated as Group 1. 11 papers were selected from the One Health journal to form the comparison group. All were epidemiologic studies that described projects including at least two domains. The list of papers, including the domains that were studied, is included as Appendix 3. One paper in Group 1 included the vector as the environment, and 7 papers in Group 2 considered the vector as the environment domain.

The Welch's Two Sample t test was performed on each guideline individually.

Guideline	Group 1 - COHERE	Group 2 - One Health Journal	t	df	p	95% CI	
1	3.00	2.73	1.937	10.000	0.082	-0.041	0.587
2	3.00	2.91	1.000	10.000	0.341	-0.112	0.293
3	3.00	2.82	1.491	10.000	0.167	-0.090	0.454
4	2.67	1.73	2.146	14.338	0.049	0.003	1.876
5	3.00	2.00	3.708	10.000	0.004	0.399	1.601
6	2.67	2.36	0.867	14.937	0.400	-0.442	1.048
7	3.00	2.45	2.206	10.000	0.052	-0.006	1.096
8	3.00	2.55	2.193	10.000	0.053	-0.007	0.916
9	2.17	1.55	1.318	8.877	0.221	-0.448	1.690
10	1.83	1.09	2.135	7.883	0.066	-0.061	1.546
11	2.33	1.27	1.861	12.440	0.087	-0.176	2.298
12	2.50	1.64	2.417	14.774	0.029	0.101	1.626
13	3.00	2.27	3.068	10.000	0.012	0.199	1.255
14	3.00	3.00					
15	3.00	2.36	3.131	10.000	0.011	0.183	1.089
16	3.00	2.55	2.887	10.000	0.016	0.104	0.805
17	3.00	2.36	3.131	10.000	0.011	0.183	1.089
18	3.00	1.36	8.050	10.000	0.000	1.183	2.089
19	3.00	3.00					

Table 1. Averaged scores for each guideline.

Papers that implemented COHERE fully met the suggested criteria for 13 out of the 19 guidelines and fulfilled most of the criteria for 5 out of the 6 remaining criteria. There is a statistically significant difference in scores for Guidelines 4, 5, 12, 13, 15, 16, 17, and 18, when implementing the COHERE Guidelines compared to papers that did not implement

them. The papers that implemented COHERE scored equal or higher for every guideline than papers that did not implement COHERE. The criteria met least often was 10which provides guidance regarding ethical standards. The comparison group from the One Health Journal only fully met 2 of the guidelines. The most significant difference was found in Guideline 18, showing that papers that did not implement COHERE were less likely to discuss the contribution of a One Health approach in the project. Guideline 5, the methods for animal participants, was also statistically different between the groups, suggesting that papers that did not use COHERE were less likely to properly describe the animal population studied.

Guidelines 14 and 19 were met fully in all papers, so no t test could be performed.

The guidelines were also grouped into domains and paper sections, and a Welch's Two Sample t test was performed.

	Group 1 - COHERE	Group 2 - One Health Journal	t	df	p	95% CI	
Human Domain (4, 11)	2.50	1.50	2.077	14.378	0.056	-0.030	2.030
Animal Domain (5, 12)	2.75	1.82	3.691	13.828	0.002	0.390	1.474
Environment Domain (6, 13)	2.83	2.32	2.143	13.766	0.051	-0.001	1.032
Introduction (1, 2, 3)	3.00	2.82	2.206	10.000	0.052	-0.002	0.365
Measurement/ Analysis (7, 8, 14, 15)	3.00	2.59	3.105	10.000	0.011	0.116	0.703
One Health Contribution (16, 17, 18)	3.00	2.09	6.708	10.000	5.31E-05	0.607	1.211
Study Team/ Ethics (9, 10)	2.00	1.32	2.176	6.836	0.067	-0.063	1.426

Table 2. Categorized scores for Group 1 and Group 2 papers.

Guideline 19 was not included in the categorization because it is a standard part of papers, and was met in all papers included.

There is a statistically significant difference in scores for categories Animal Domain, Measurement/Analysis, and One Health Contribution, between papers that implemented

the COHERE guidelines and those that did not. Papers that implemented COHERE had higher averaged scores for all categories. Implementation of COHERE is associated with more closely meeting the criteria regarding reporting of the animal domain. Implementation of COHERE is also strongly associated with meeting more of the criteria regarding reporting of the contribution of a One Health approach to the study.

Context of COHERE Citations

Focus of Papers that Cite COHERE

	Opinion	Review	Method/ Framework	Observational – Implemented COHERE	Observational – Did not Implement COHERE	Total
Antimicrobial Resistance	1	1	1		1	4
Zoonoses and Zoonotic Disease	5	6	3	4		18
One Health Field	3	4	1			8
Medicine (Human and Veterinary)	1	7	6		1	15
Surveillance Systems		2	2		2	6
Agriculture		1		2		3
Other		2	1		1	4
Total	10	23	14	6	5	58

Table 3. Categorized focus of all citations of COHERE by paper type.

The papers that cited COHERE were classified by the type of paper and then by the subject discussed. The most common topics were Zoonoses and Zoonotic Diseases, followed by Medicine.

COHERE as a Definition of One Health

COHERE was used by many papers to define the field of One Health, and where papers used a different source for the definition, it generally agreed with COHERE. Most papers used definitions of One Health that place all three domains as equal in importance, although a few papers used definitions that indicated prioritization of human health or

human and animal health over the health of the environment. Most papers used the term "environment" while a few papers used "ecosystem" or "ecological system" to describe the environment domain.

COHERE Supports Collaboration

COHERE was cited as a tool that supports collaboration and "breaking silos" when bringing together interdisciplinary teams. Multiple papers discussed the importance of involvement of stakeholders beyond academic fields, such as government and community stakeholders. There is also support for greater inclusion of citizen science to include the community as well as increase the data available. Increased collaboration between healthcare providers of humans and animals could improve the ability to address shared risks. COHERE isa tool that could be used to guide collaboration when bringing different groups together.

The benefit of creating interdisciplinary teams regarding greater efficiency and savings of time, effort, and total financial cost, was demonstrated by Davis et al:
Compared to the alternative, which would have been conduct of two separate studies …The study team concluded that while this required more extensive communication and planning, the scientific benefits outweighed the cost[16]. One Health studies frequently require a larger initial investment, which is a barrier to funding, particularly when the study requires collaboration between agencies or groups. Duplication of research projects is one result of this barrier, connected with the lack of structures to share data between silos and groups.

One barrier to increased collaboration can be different definitions and terms between disciplines, so use of COHERE to provide standard definitions and guidance was identified as a potential benefit. Another barrier identified is that different stakeholders often have different priorities and COHERE could provide a unifying framework. One paper reported that there is support within the field to develop guidelines, core values, and shared competencies within the field.

The balance of power between representatives of the different domains is identified as a barrier, with the perception that the primary conflict is between human and animal health stakeholders. However, environmental science was identified as the most poorly represented domain within One Health projects.

COHERE as a Tool for Standardization

Increased implementation of COHERE was also associated with an expectation of improved data standardization as a reporting standard. The challenge of integrating data from multiple sources is a significant barrier identified, due to data formatting, differences in method, and a lack of metadata provided.

Complementary Guidelines and Uses

Five of the method papers introduced or promoted frameworks that could be used as complements to COHERE: OH-CRAC[17], EMBRACE-WATERS[18], OH-EpiCap[19], STROBE-VET[20,21] and CHAIS[22].

OH-CRAC[17] is the One Health Consensus Report Annotation Checklist, which is a tool intended to promote the standardization and increased reporting of metadata in surveillance data reports. EMBRACE-WATERS[18] is the rEporting antimicrobial ResistAnCE in WATERS checklist of recommendations for reporting of antimicrobial resistance studies in wastewater and aquatic environments. OH-EpiCap[19] is a tool developed to assist organizations and governments in evaluating their One Health epidemiological surveillance capability and capacity. CHAIS[22] is the COVID-19 human-animal interactions survey, which is a standardized tool that can be used to measure transmission risk between humans and animals in a shared environment, in the context of the Covid pandemic. STROBE-VET[21] is an extension of the STROBE statement that addresses specific criteria for veterinary medicine studies.

Multiple papers described COHERE as high quality, as a guideline that should be used, and supported greater implementation with the expectation that this would lead to an increased number of high-quality papers. One paper described the use of COHERE in an online class as a tool used to guide journal discussions, and multiple other papers supported the consideration of the criteria provided in the guidelines even if it is not appropriate to apply them to every study.

COHERE to Reinforce Ethics in One Health Research

Several papers discussed the concern that some One Health projects do not treat all three domains as equal, in contrast to the definition provided in COHERE.

COHERE supports consideration of all three domains as equal in importance and that the health of one is not more important than the others. There is some concern about the prioritization of human health over the health of animals and the environment, and whether those projects can be considered One Health or if they should be described differently.

Multiple papers also raised concerns about ethical research practices, particularly when working with indigenous communities and other historically under-represented stakeholders. There is a significant need for transdisciplinary work with these communities, and the need to include local stakeholders. This can be more important for One Health compared to other research because cultural beliefs can change how humans interact with the other domains.

Survey of Experts

Demographics of Experts:

There were 30 participants that completed the survey, and all participants provided some demographic information.

Out of the respondents, ⅓ have been in the field for 1-4 years, ⅓ for 5-10 years, and ⅓ have been in the field for more than 10 years. No respondents have been in the field for less than 1 year.

Of the participants who chose to identify the country where their institution is based: 10 participants are based in the United States, 4 are based in Latin America, 3 based in Europe, 3 based in Africa, 2 based in the UK, and 2 based in Australia.

Of the participants who chose to identify the countries that they work in: 9 work in Africa, 9 work in Latin America, 6 work in Asia, 6 work in the US, 3 work in Europe, 2 work in Oceania, and 1 works in the Middle East. Participants could identify more than one country where they worked, and many participants work on projects in more than one country or geographic area. 15 participants work on at least one project in the country that they are based in.

The majority of respondents (15) listed the Animal domain as the domain where they have the most expertise, followed by the Human domain (10). Only 5 respondents listed the Environment domain as their highest level of expertise. The most common ranking of expertise was Animal - Human - Environment, with 11 respondents. The second most common ranking, with 6 respondents, was Human - Animal - Environment. Only 5 participants selected the environment as the domain that they have the most expertise in.

23 of the respondents are primarily affiliated with academic institutions, 5 are primarily affiliated with non-profit organizations.

For experience with the COHERE Guidelines: 11 participants were in the Never Heard Of, 3 were in Don't Use, 7 were in Some Use, 7 were in Full Use groups.

2 participants are excluded from the numerical calculations because they did not answer over 50% of the scoring questions. 1 is from the Never Heard Of group, and 1 is from the Don't Use group. The written feedback they provided is included in the results.

Individual Criteria

Guideline	Never Heard Of	Don't Use	Partial Use	Full Use	All Participants
1	0.50	0.63	0.43	0.57	0.53
2	0.40	0.88	0.57	0.57	0.60
3	0.40	0.50	0.29	0.86	0.51
4	0.40	0.14	0.00	0.43	0.24
5	0.50	0.14	0.00	0.57	0.30
6	0.50	0.86	1.00	0.86	0.80
7	0.30	0.88	0.57	0.57	0.58
8	0.60	1.13	1.00	0.57	0.82
9	0.30	0.57	0.33	0.43	0.41
10	0.20	0.57	0.33	0.43	0.38
11	0.50	0.63	0.29	0.43	0.46
12	0.40	0.38	0.00	0.43	0.30
13	0.50	0.63	0.57	0.57	0.57
14	0.40	1.00	0.86	0.57	0.71
15	0.30	0.75	0.57	0.71	0.58
16	0.22	0.50	0.29	0.57	0.39
17	0.40	0.88	0.57	0.57	0.60
18	0.30	0.50	0.29	0.43	0.38
19	0.20	0.13	0.14	0.14	0.15

Table 4. Averaged scores of perceived need for improvement for individual COHERE guidelines. The guidelines that crossed the 0.5 average threshold into "Minor improvement" are in light red, and those that crossed the 0.75 average threshold into "Major Improvement" are in dark red.

The participant evaluation of the level of improvement needed for each guideline was translated into a numerical scale and averaged for each group and all participants. Participants who had heard of COHERE before but chose not to use it saw the most need for improvement, with 7 guidelines rating as "Major improvement needed" when the scores were averaged. The participants who had never heard of COHERE before rated the fewest guidelines as needing improvement. The participants who fully implement COHERE rated more guidelines as needing improvement compared to participants who only partially use COHERE. Guidelines 6 and 13 which focus on the Environment domain were rated by all groups as needing improvement, as well as Guideline 8 which guides data analysis.

Individual Criteria Response and Feedback

The following is the response to each individual guideline. The response is the level of improvement needed based on the thresholds and average for all participants presented

above. “Feedback” is a summary of all responses gathered in the free text section. Any comments that were repeated are summarized, so multiple people may have provided the same comment.

1. Background

Response: Minor Improvement needed

Feedback: Clarity is needed about what is included in the Environment domain - does that include plants or are plants a fourth domain? Is One Health more of a methodology or a study design?

2. Rationale

Response: Minor improvement needed

Feedback: Does a One Health study have to include all three domains, versus using a One Health approach where all three domains do not need to be equally represented? Describe how the domains are interrelated, not just that they are represented. Researchers should provide information about their philosophy and research paradigm to provide context for their approach.

3. Study Design

Response: Minor improvement needed

Feedback: Add clarification about what part of the environment domain is included, considering the built environment if applicable. These guidelines do not fit qualitative epidemiological studies.

4. Human Participants

Response: No improvements needed

Feedback: Caution must be exercised to avoid any potentially identifying information, and sensitivity of researchers when working with communities.

5. Animal Participants

Response: Minor improvements needed

Feedback: Clarity needed about whether vectors are part of the animal or environment domain, and how that is defined. Clarity of difference between captive populations of wild animals versus truly wild species. Captive populations of wildlife are also not always exotic

to that location. Ethical standards for animals are different, and not as stringent, as ethical standards for humans. Animal “use” does not always have an ethical or scientific justification that needs to be demonstrated for research to be performed.

6. Environment

Response: Minor improvements needed

Feedback: Consider splitting the environment domain into a plant domain and environment domain or specify that plants are included in the environment domain. Create ethical standards for environmental sampling, such as an environmental impact statement to ensure that environmental sampling is also done with consideration and does not have a negative impact on the study subject. Land use changes over time are also an important factor of the environment. The definition or classification of vectors is confusing.

7. Measurement

Response: Minor improvement needed

Feedback: More guidance on expectations should be provided about what is acceptable - they may be too broad to be useful and worth implementing. This is very focused on infectious disease studies but is less applicable to other studies. Methodologies used should be more explicitly described so that others can understand the data collection process.

8. Analysis

Response: Major improvement needed

Feedback: Reassess any hierarchical relationships - the spirit of One Health is that all three domains are treated equally, and clearer guidance should be provided about how any difference should be treated. Methodology for analysis should be explicitly stated to allow others to understand what was done.

9. Study Team

Response: No improvement needed

Feedback: Study teams should provide information about the positionality, domains, fields, perspectives, etc. that they contributed to the team. The guidelines should be expanded to include more emphasis on what stakeholders are included or excluded, including governmental and community participants. As One Health research starts to include more involvement from community collaborators, these people must be given credit for their involvement and listed as co-authors if appropriate. All stakeholders should

be included at all steps of the research process, including study design and review of the final publication. It is not possible to include all stakeholders in each project, so a discussion of what stakeholders were excluded is also valuable for understanding the context.

10. Ethics

Response: No improvement needed

Attention to ethical considerations should be given to all domains equally. Ethical standards for the animal domain could be increased. There should be ethical standards for environmental samples, such as an environmental impact statement, and careful consideration of how samples are collected. Mention could be given to the local community and native populations where environmental sampling occurs. The order within COHERE could be shifted as most journals include ethics statements and study team information at the end of the paper.

Is the current ethical standard sufficient: 74.1 % yes, 25.9 % no

11. Human Participants

Response: No improvement needed

Feedback: Extreme caution should be exercised with what demographic information is provided in publications, particularly if the research is focused in a specific community or tribal group, to avoid potentially identifying information. Researchers should also be extremely sensitive to the history of research on different groups (prisoners, race, ethnicity), and ensure that they avoid causing any harm.

12. Animal Participants

Response: No improvement needed

Feedback: Does animal husbandry fall into the animal domain or the environment?

13. Environment

Response: Minor improvements needed

Feedback: More clarity is needed about how plants are included in this domain, or potentially a fourth domain should be created to specifically address plants versus other factors that are included in the environment domain, such as the built environment, climate change, and land use changes. If plants are measured, they should be correctly identified with taxonomic information. Geographic references for the area should be

included.

14. Measurement

Response: Major improvements needed

Feedback: This criterion is very limited and directed at quantitative infectious disease studies, and therefore cannot be applied to other One Health studies. It is not always appropriate to identify data down to the same taxonomic level in all domains. Section B is the more important one - the idea is to increase data standardization and make it applicable or allow analysis of data in other projects.

15. Analysis

Response: Minor improvements needed

Feedback: Increase the clarity and usability of guidelines.

16. Overall

Response: Minor improvements needed

Feedback: A brief overview should be included before the discussion goes into detail. Encourage more discussion to focus on ecosystem factors and interactions and disaggregate Environment data into different factors.

17. Limitations

Response: Minor improvements needed

Feedback: Include more information about what populations (human, animal, and plant) were excluded and why. Allow for explanations of why a study is still a One Health study even if one domain was not directly measured. Emphasize the need for equal community involvement and participation, as well as the integration of indigenous knowledge as equally important to traditional scientific methods. Include recommendations for the direction of future research - what is needed and recommended approaches.

18. One Health Contribution

Response: No improvements needed

Feedback: The One Health Approach should include integration between the three domains, details on how they interact with each other, not just their inclusion in the study. Consider the inclusion of Ecohealth and Planetary Health platforms. The term “One

Health" should only be used in the title or keywords of a manuscript if the study is truly a One Health Study. One Health as a field is more than zoonotic diseases.

19. Acknowledgement

Response: No improvement needed

Feedback: Include additional stakeholders and contributors beyond the authors in the acknowledgements.

Opinions on COHERE Overall

Participant responses on a five point scale were averaged in their groups and overall. The closer to 5, the more positive the opinion of COHERE, and 3 is neutral, and closer to 1 is a more negative opinion.

	Never Heard Of	Don't Use	Some Use	Full Use	All Participants
What is your general opinion of the COHERE guidelines?	3.91	3.00	4.00	4.57	4.00
How easy are the COHERE guidelines to understand?	4.00	3.67	3.86	4.00	3.93
How easy are the COHERE guidelines to implement?	3.45	2.67	3.29	3.71	3.39
How likely are you to use the COHERE guidelines in study design?	3.64	2.33	4.17	4.57	3.85
How likely are you to use the COHERE guidelines in data analysis or discussions?	3.55	2.67	4.29	4.43	3.86
How likely are you to use COHERE guidelines when evaluating papers?	3.64	2.67	4.29	4.29	3.86
The COHERE guidelines be promoted as a useful tool for One Health research	4.00	3.00	4.43	4.29	4.07
Increased implementation of the COHERE guidelines would improve data standardization in the field of One Health	4.00	3.33	4.00	4.43	4.04

A majority of the participants have a positive opinion of COHERE and found them easy to understand. The majority of participants responded relatively neutrally regarding the potential ease of implementation. A small majority of participants are likely to use the guidelines in study design, although many respondents were neutral.

A majority of participants would use the guidelines in data analysis or discussions and for evaluating papers.

The majority of respondents agreed that COHERE should be promoted as a useful tool for One Health research, and that increased implementation would improve data standardization.

Overall Feedback

The following were collected from the free response section provided at the end of the overall questions about the guidelines, as well as feedback on the individual guidelines that was repeated for multiple guidelines or is part of a broader idea than a single guideline.

Benefits of Increased Implementation of COHERE

Participants responded to the idea that increased implementation of the COHERE Guidelines could lead to the following:

- better data standardization between projects,
- more clarity and consistency about what is included vs excluded as a One Health study, and provide guidance about what should be included in a One Health study.
- The COHERE Guidelines could potentially be used as a tool by journals and reviewers when evaluating papers.

Improvements That Could Increase Implementation of COHERE

Participants provided the following ideas about how the guidelines could be improved:

- The guidelines should be reorganized to be less repetitive in the methods and analysis sections and follow the layout of many journals and put the study team information at the end of the paper.
- To expand the implementation, the guidelines should be translated into other languages, and adapted to apply to other study types, such as qualitative and non-epidemiological studies.
- Examples of studies that have implemented the COHERE Guidelines should be provided and promoted as resources.
- The Environment Domain should be clarified or split into a Plant Domain and other domain. The plant domain would include: a) describe the species and pathosystems studied b) provide appropriate statistics for plant variables studied c) provide geographic references for the area studied. The current guidelines are overly zoocentric, and do not place enough emphasis on plants, microbes, etc.
- Ethical standards for the environment domain regarding sampling should be created. The appropriate classification and analysis of vectors is unclear.
- As the field of One Health increases the amount of community involvement and participation, the guidelines should be expanded to include guidance on indigenous, community, and other stakeholder involvement in the study design, implementation, and writing processes.

Discussion

Overall, this study found evidence that COHERE is supported and accepted in the field and promoted as a helpful tool for researchers. The scoring comparison suggests that implementing COHERE is possible, and that it could help researchers meet the goal of high-quality papers. The qualitative analysis revealed that COHERE is supported as a tool, and that there are several potential benefits to increased use. The survey showed that researchers have an overall positive impression of the guidelines, and there is interest in using them, and expanding how they can be used.

Future versions of COHERE can be improved by creating clearer definitions of each domain, continuing to expand the guidelines related to ethical standards, and increasing the accessibility and applicability to other study types.

COHERE Accepted

All three sections of this project support the conclusion that COHERE can be helpful when designing, writing, and evaluating One Health studies and projects. There is a general expectation in citations and survey responses that increased implementation of COHERE would improve the quality of One Health papers. Under the premise that meeting the criteria in COHERE makes a paper a higher quality One Health study, the papers that implemented COHERE did do better at meeting that goal compared to papers that did not. The recommendations presented in the guidelines match the priorities and interpretation of people in the field of what should be included in a One Health paper, indicated by the overall positive response in the survey, and the discussion in the citations.

The scored comparison showed that the majority of the recommendations provided in COHERE can be successfully implemented when writing One Health papers and suggests that using COHERE can lead to better papers. Using COHERE could improve discussion sections and data integration, which was the category with the most significant difference in scores.

The qualitative analysis showed that COHERE can work with a variety of frameworks and guidelines, in a variety of areas, indicating that there is interest in expanding the use. The use of COHERE in a journal club, as well as support for considering the guidelines even when they cannot be fully implemented, indicates that the guidelines provide even greater benefit than solely as a tool to support project design and reporting.

COHERE was positively received in the survey by the participants overall, including people who had never heard of it before, and the majority agreed that it should be promoted as a useful tool. There is also support for using COHERE when evaluating papers, such as in journal club as previously discussed.

Helpful Tool for Collaboration

Respondents and the published literature indicated that COHERE provides a framework for collaboration and integration of different expertise and provides common definitions and criteria to reduce confusion and miscommunication. A distinguishing factor of One Health projects is the emphasis on collaboration between people with different expertise and COHERE provides some guidance to form a diverse team. The qualitative analysis and the survey included discussion of how to work on teams with diverse expertise. This is an area that can be expanded in future versions of the guidelines, to provide greater guidance on inclusion of additional stakeholders.

Multiple publications as well as survey respondents indicated that the guidelines work with other tools, and were supported as addressing a need in the field for a tool like COHERE. The guidelines provide a common structure and definitions that are important for collaboration across disciplines, where terms could be used in different ways. The definition of One Health can vary depending on the priorities of that stakeholder, so using a shared definition and tool like COHERE can support clear communication.

Tool for Standardization

One of the most discussed needs in the field of One Health is the creation of standardized methods and data presentation that would allow data from different sources to be harmonized. COHERE is supported as a tool for increasing method and data standardization, as well as the greater inclusion of metadata with data sets. Both factors will increase the ability to integrate data from different sources which is a significant challenge in the field. While COHERE doesn't address data standardization between studies or in the field overall, standardization within a study to the same taxonomic level, as well as describing any differences in how data was collected, could make integration between projects more feasible. Most survey respondents agreed that increased use of COHERE would improve data standardization, agreeing with the citations of COHERE. Supporting the integration of data from multiple domains also leads to metadata being included in the data from each domain, which is often missing from studies that do not include more than one domain.

One of the largest barriers to One Health projects, including the development of surveillance systems, is the separation between the domains, and between data collectors. These barriers can be due to funding as well as technological barriers that prevent data sharing. As the Davis 2018[16] study found, combining what would have been two to three separate studies into one project led to valuable savings of time, resources, and led to a more comprehensive study than each project could have done individually. As discussed in a few of the papers that cited COHERE, using COHERE and a One Health Approach when collecting data, which would include ensuring that relevant metadata is collected and properly associated, as well as standardizing how the data is presented, could generate data sets that can be combined with other sources. This is one way to

increase the availability and accessibility of data within the restrictions of the current funding and publication structures. The integration and standardization of data from multiple sources is a particular concern in the development of surveillance systems and increasing the use of the COHERE guidelines as reporting standards is expected to reduce the challenge of integration.

Environment Domain

There is no unifying definition of what is included or excluded in each domain, and this makes the environment domain particularly challenging. The assumptions made about what is included in the human domain are the most consistent, and researchers are familiar with the goal of human health. The animal domain is also easier to define, given that there is a standard definition of an animal. However, the environment domain is defined differently between projects, and there is no guidance on what is sufficient to consider measuring the environment domain, which is an important criteria if applying the COHERE definition that a One Health study must include all three domains.

There are up to four different groups of potential factors that are included in the "Environment domain", depending on the definitions and priorities of the group doing the research. The first group is the biotic factors of the environment – primarily plants and microbes, although this category could be expanded to include viruses. The second group is the inert physical environment, both built and natural – buildings, roads, water sources, forest, geography, etc. The third group is the human environment – the political, historical, cultural, and socioeconomic surroundings of a project. The fourth group is the large scale environmental factors – land use change, climate change, weather patterns, etc. that have a larger scale than the limited time or area of a study.

The first group of biotic environment is the only group that can be considered a "health bearer"[23] where the health outcomes should be considered, and ethics should be considered. The papers in the qualitative section, as well as the survey respondents, included responses supporting the creation of a plant domain separate from the environment to capture this, and supported the development of ethical standards.

This is also where the difference between "ecosystem" and "environment" could be more than a language choice, and the potential impacts should be considered. "Environment" can refer to the inert physical surroundings, and does not imply the same level of connection, where "Ecosystem" inherently brings attention to interactions and change over time.

COHERE classifies vectors as belonging to the environment domain when the biological processes are not included in the analysis, which created a challenge during the scored comparison, and led to a likely overestimation of the integration of the environment in these studies. There are several papers included in the analysis where the environment domain was fulfilled by the vector, yet the presence or absence of the vector was also the

outcome being studied. This suggests that other environmental factors that could be important or related to the study topic are not being included fully, or at all in the analysis. The current version of COHERE does not specify what type of environmental data is sufficient to meet the criteria, which was raised as a concern by some survey respondents. The classification and definition of vectors was also identified as an area of improvement in the survey.

For the next version of COHERE, the environment domain should be clearly defined, and potentially split into criteria for the biotic and abiotic factors of the environment. The human sociocultural environment, and larger scale environmental changes are important, and should be included in models, but should potentially be a layer on top, rather than directly included in the environment domain. It may not be appropriate to include plants or the physical environment in a study, depending on the context, but the guidelines should encourage clearly stating the logic for inclusion and exclusion.

The human factors are important because all those factors can have significant impacts on how humans interact with the other domains, and what decisions are made. However, they should be treated more as an additional layer, rather than included in a domain. COHERE already has Guidelines 9 and 10, for guidance on ethics and working with diverse teams. These guidelines could be expanded to support consideration of the larger context of work, rather than supporting their inclusion in the environment domain.

Creation of specific criteria for the biotic environment could also create more space for ecologists and environmental science, which is a recognized gap in the current research. While the environment domain is included in One Health research now, when the environment is a vector or is not explored beyond shared proximity, it is often not investigated as thoroughly as the other domains.

Expansion of Ethics

COHERE can also play a role in the evolving discussion of ethical standards, and provide guidance on involving stakeholders, working with indigenous and community groups, and sharing data and knowledge. COHERE describes all three domains as equal priorities, however does not include any ethical guidance for the environment.

Discussion of ethics appeared in the qualitative analysis and the survey, with the overall conclusion that the current guidelines are acceptable, but there are areas for improvement. The primary ethical concern regarding humans was the need to involve and appropriately acknowledge communities, particularly indigenous communities, that are involved in research and ensure that the community that provides the data receives the data back in a useful way. The ethical concerns about animals related to raising the standards to be closer to what is currently in place for humans and going beyond current standards of care to consider a more holistic view of health. There are no ethical standards

in place for environmental samples, and this was seen as one area where the domains are not being prioritized equally.

The concerns around ethics raised in this project had two distinct priorities. The first priority was the treatment of all three domains as equal in priority and emphasizing that the health of each is of the same importance, countering the prevailing hierarchy that places human health as the most important. The second aspect of ethical considerations was more focused on how projects are done and working to ensure that as many stakeholders as possible are included, and that groups that have not been represented are included.

In the first aspect, the equivalent treatment of all three domains, one of the main concerns raised in both the qualitative analysis and the survey is that there are currently no ethical standards for sample collection of the biotic environment domain, and no clear instructions for consideration of the health of the environment as one of the key outcomes. One suggestion to solve this is to support environmental impact statements as part of the ethical approval process. There is also need for guidance on including the health of the environment in the discussion of outcomes. There was also frustration that the outcome of health of the environment is not included, or not given the same importance in discussions and conclusions. A couple of papers raised this point, that the different definitions of One Health can indicate a hierarchy when the definition used places human or human and animal health as the priority, and the environment or ecosystem is included in the way it supports human and animal health.

For the second aspect, there are several different aspects of the ethics relating to how a study is performed that need to be considered. The historical, political, socioeconomic, etc. context of a study location and subject need to be considered and the study leaders should make sure that everything is being done in the most balanced manner possible. The cultural context can have a large impact on how interactions between domains are interpreted, and how results are interpreted.

COHERE was developed within the existing academic and institutional power structures, which have a history of colonialism and power imbalance. Ongoing efforts to create more balance are important, and future iterations of COHERE should reach out and try to involve previously underrepresented groups. The analysis in this project also relied heavily on the existing publication and academic structures, and therefore does not include input from a wide range of potential stakeholders outside of those systems. This was a critique raised by one of the survey respondents, in relation to the development of COHERE, and is an area where future efforts should improve. Although a wide audience was attempted for the survey, the respondents are still biased towards academic institutions in the global north, which traditionally have more power. Future efforts should also expand the geographic range included and increase the participation from researchers in the Global South.

In particular, the efforts of the One Health field to increase the inclusion of indigenous knowledge and groups into research projects, should be navigated carefully. The next

version of COHERE could be a primary source of guidance about how knowledge sharing, data ownership, and collaboration, should be done when working with these communities. This particular concern appeared in both the qualitative analysis and the survey.

Future efforts at outreach should also include people who may be using COHERE in different ways, such as for journal club or paper analysis, and people who are reading One Health research, but are not writing papers.

Potential Areas for Expansion

The support for COHERE in reviews and opinion papers does not appear to have increased the implementation of the guidelines in practice yet, although it could have increased awareness of them. The inclusion of COHERE in papers about method development is promising, and that could lead to increased implementation in future publications, but that has yet to be shown. There was a bias towards papers focusing on zoonoses and other medical topics that cited COHERE, and those discussing aspects of the field overall. This suggests that there is room to increase the implementation of COHERE in other areas of One Health research, such as AMR.

There was also a desire to expand COHERE to include other paper types, such as qualitative studies, and to adapt it to have a wider focus beyond zoonotic disease research. There is also interest in translating the guidelines into other languages to make them even more accessible around the world. These expansions could be included in future efforts to increase awareness of the guidelines, which was suggested in survey responses as one of the current barriers to wider implementation.

Limitations

This is a pilot project and was limited by a small sample size in all the analyses performed. Future efforts should try to increase the sample sizes, as well as add additional reviewers. The scored comparison and survey are limited in their power by the sample size, and potentially more significantly impacted by biases.

The primary technical challenge in the scored comparison analysis is the lack of common definitions of what the boundaries of each domain are, particularly regarding the environment domain. This likely led to overestimation of the inclusion of the environment domain in the scored comparison analysis, based on the classification of vectors. The scoring comparison is also impacted by the issue of multiple comparisons, increasing the likelihood that some of them would reach significant values. The scoring comparison is also limited by a single comparison group from one journal, which does not represent the diversity of One Health publications. There is also circular logic when scoring papers that intended to meet certain criteria versus papers that did not try to meet those criteria, and this bias should be considered when evaluating the results.

The qualitative analysis is biased towards authors that have a favorable opinion of the guidelines, and therefore chose to include it in their work. There is also a potential bias or selection towards authors in terms of knowledge of the guidelines, or performance of searches with specific criteria that would include COHERE. There is also potential for other uses of COHERE to not be reported in publications, such as other journal clubs beyond the one described in the MOOC.

The survey is limited by small sample size and limited questions, and the lack of follow-up to investigate ideas raised. The information was only provided in English, which reduced the accessibility of the survey to people who speak other languages. It also required people to be accessible via email, and it was difficult to find email addresses for people outside of the US or European academic systems. Low awareness of the guidelines could contribute to the low response rate, as people may be more hesitant to fill out a survey when they are unfamiliar with the subject. The feedback of participants who had not heard of the guidelines before is based on their initial reading of the guidelines, and the difference in scores and responses compared to those who were more familiar with the guidelines indicate that there may be some challenges to implementation that are not apparent when reading them for the first time. It is also not clear how many participants that were unfamiliar with the guidelines referenced the original paper or relied solely on the text of the guidelines as provided in the survey.

One important critique of COHERE is that it was developed within existing academic, publishing, and financial power structures, which bias towards the Global North, and institutions with a history of colonialism. This was raised by one survey respondent, but is echoed by other survey respondents, as well as in the qualitative analysis, in the discussions about the ethical and appropriate way to include indigenous groups and knowledge as the field moves towards a more collaborative and inclusive approach. The survey attempted to gather a more global perspective and include other groups, but the demographic data suggests that the responses were still biased towards the global north and researchers working within academic systems. Future efforts should include more outreach to stakeholders that have not been included in the discussions so far.

Conclusion

COHERE is generally accepted and supported by researchers in One Health as a helpful, high-quality tool that can be used to improve One Health research in a variety of ways. The guidelines presented are accepted and supported by experts as appropriate goals for One Health papers to reach, and the expectation is that meeting the guidelines should lead to high quality papers. One very important use of COHERE is to provide common definitions and a framework for collaboration.

As part of this, COHERE could play an important role in defining the scope of each domain, and provide critical guidance about the extent that data from each domain should be represented in One Health studies. The lack of common definitions of each domain, particularly the environment, have led to confusion and over and under representation of the different domains within research projects. Shared definitions are a crucial tool when bringing together interdisciplinary teams, which is a core component of One Health. A more detailed and rigorous definition of the environment domain could reduce confusion in the field about what is included, and what is sufficient to consider the domain as included in One Health studies. Division of the domain into the sub-domains of biotic and abiotic factors, or the creation of a plant domain, would increase the attention on the environment and ecosystem, and could increase the inclusion of environmental scientists and ecologists, which is currently lacking. This project used a very broad definition, which likely led to an overestimation of the inclusion of the environment domain. Future analyses should use a more narrow and specific definition to better understand whether the environment domain is being equally included in relation to the human and animal domains.

While specific, detailed guidelines for standardized presentation of data across studies is beyond the scope of COHERE, these standards should be included as complementary tools to COHERE, and their use should be encouraged within the recommendations presented as they are developed. This also applies to the linking of metadata to datasets, and their sharing between silos. Tools like OH-CRAC, EMBRACE-WATERS, and others should be supported by COHERE as tools that address different types of data and data sources.

Another set of complementary tools that COHERE can support would be those relating to best practices of community participation and involvement in research. Although a few survey respondents and papers suggested that COHERE could play a role in guiding this process, these concerns would be better addressed in separate tools that can be tailored to different types of research and stakeholders. COHERE, and the field of One Health, should support specific guidelines for working with indigenous communities that are developed by or with those communities.

Similarly, it is beyond the scope of COHERE to develop independent ethical standards and guidelines, but each iteration of COHERE should align with the current and highest available standards for each domain. Supporting an environmental impact statement for the collection of plant sampling is one way to promote ethical standards being applied to all three domains, which is one way to ensure that all domains receive equivalent emphasis.

There are a few different ways that future iterations of COHERE can be more available to researchers. COHERE can be translated into other languages and made more widely available that way. The recommendations in COHERE can be expanded to be slightly more inclusive of other study types, and be less zoocentric, but separate tools should be developed for more diverse study types such as meta-analyses and review papers.

COHERE has the potential to become a widespread tool and could provide valuable guidance for One Health research in the future. This preliminary project provides suggestions of what is working well and where improvements could increase implementation.

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Appendix 1 – COHERE Guidelines

	Standard Number	Recommendation
Introduction		
Background	1	Review the human, animal, and environmental context of the problem and justify why a One Health study is appropriate to address the scientific question
Rationale	2	Clearly state the research aims and/or hypotheses in the context of the relationship among the three domains (human, animal and environment), or state and defend the nature of the study if it is not hypothesis-driven
Methods		
Study design	3	a. Explain or describe the relationship/interaction (epidemiologic, biological, ecological, spatial/temporal, etc.) of the collection of the human, animal, and environmental specimens and/or data b. Provide inclusion and exclusion criteria for all domains c. According to study design, follow other guidance, e.g. STROBE and its extensions (STROBE-VET, STROME-ID), CONSORT, PRISMA, etc., as indicated
Human participants	4	a. Provide qualitative and/or quantitative description of the human population or human data, including characteristics related to inclusion or exclusion from the study, sample size (at all relevant population levels), and sample size justification, as appropriate b. Ensure human subject assurances adhere to the highest standards of ethics governing human subjects research
Animal participants	5	a. Provide qualitative and/or quantitative description of the animal population (domestic, captive exotic, or free-ranging wild), including characteristics related to inclusion or exclusion from the study, sample size (at all relevant population levels), and sample size justification b. Include, at minimum, the common or generic name for the species of animal or animals studied, and provide the taxonomic Genus species if indicated (i.e. for less common species) if the species chosen is dependent on study design c. Ensure animal subject assurances adhere to the highest standards of ethics governing animal subjects research

Environment	6	a. Identify environmental (abiotic) and/or ecosystem (biotic) factors including vector characteristics if appropriate, that are under investigation b. Describe the type and purpose of any environmental samples or data collected c. Provide qualitative and/or quantitative description of the study location, including geographic locale (e.g. region and country, latitude/longitude or a centralized point if the location of the site is sensitive information), ecosystem type (e.g. mangrove forest) and/or land use description (e.g. urban, agricultural, etc.), and number and description of where samples were obtained
Measurement	7	a. If indicated, include the frequency of sampling (i.e. sample interval) and calendar timing (i.e. date, month, season, year) b. Describe the relationships/interactions (epidemiologic, biological, ecological, spatial/temporal, etc.) among human, animal, and environmental samples and data, as well as other significant differences in data collection methods between domains c. Describe and justify testing or analysis measures used, and indicate the validity for such measurements for use among human, animal and environmental domains
Analysis	8	a. Identify how data among the three domains were collected b. Explain how any hierarchical relationships within and between domains (e.g. at the individual or group level) were handled c. If data were handled differentially among the three domains (e.g. collection of data from one domain at a different time interval than from another domain), describe this in sufficient detail to allow assessment of potential bias introduced by this decision
Study team	9	a. If applicable, describe the involvement of study team members, stakeholders and community members (e.g. farmer participant stakeholders, industry, etc.) b. Indicate how study team members representing all three domains contributed to development of the research question and study design
Ethics	10	a. Report animal (IACUC/ACUC) and human ethics (IRB) approvals, as well as other relevant permissions that were obtained b. If applicable, describe the framework for adhering to community based research standards (e.g. community approval, cultural respect, knowledge translation)

Results		
Human participants	11	a. Report recruitment data, provide study population percentages and describe generalizability of study population to underlying population b. Describe demographics (i.e. sex, age, race/ethnicity, etc.) or case characteristics, as well as exposure factors and behavioral characteristics evaluated, of human subjects
Animal participants	12	a. Report study population percentages and describe generalizability of study population and study species to the underlying animal population of interest b. Describe demographics (i.e. sex, age, breed, etc.) or signalment, as well as exposure factors, of animal subjects c. If applicable, describe animal management characteristics (i.e. housing, diet, other environmental factors)
Environment	13	a. Report findings from collected samples and/or measurements, including measures of heterogeneity that could impact generalizability of findings b. Provide descriptive statistics for all appropriate environmental/ecosystem variables c. If appropriate, provide geographic referencing for all samples or data submitted to public databases
Measurement	14	a. Identify populations, pathogens and/or vectors to the same taxonomic level across all three domains b. Report findings in a way that is standardized or equivalent across all three domains
Analysis	15	a. Provide comparative statistics, qualitative comparisons or integrated analyses among human, animal, and environmental variables, including (as appropriate) measures or descriptions of uncertainty (e.g. variance, confidence intervals, qualitative limitations) b. Consider the potential for lack of independence or group effects that may impact statistical inference (e.g. at the household or building level, pen or other animal cohort level, and community level) c. If indicated, provide geospatial comparisons or illustrations of spatial relationships (e.g. maps) to describe the distribution between human and animal populations
Discussion		
Overall	16	a. Provide a comprehensive discussion that integrates the human, animal and environmental aspects of the results b. Indicate generalizability of findings to local, national, and/or international levels

Limitations	17	a. Discuss any discordance in acquisition, analysis or interpretation of data among the three domains (e.g. identify problems with application of different methods among the domains) b. Identify where methods lack validation (e.g. animal methods used in human populations or vice versa) c. Identify any methods that may not have been optimal to address research aims and suggest how future studies could overcome such limitations d. Comment on issues that may impact the reproducibility of the study, as appropriate e. Identify and discuss potential sources of bias f. Discuss species-specific differences that may impact the results or the interpretation of the results g. Identify other potential populations of humans or animals that could be involved in the problem and were not measured or addressed in the study
One Health Contribution	18	a. Describe how a One Health approach to the study—specifically incorporation of expertise among the disciplines and integration of findings from human, animal and environmental domains—furthered the understanding of the data/ research problem b. If appropriate, describe lessons learned from the One Health interdisciplinary study team approach, e.g. successes and challenges identified as part of the process of conducting the study, methods for operationalizing participation among the disciplines, and cost-benefit analyses of the resource efficiencies of One Health studies c. Identify how the conclusions relate to promotion of human, animal and ecosystem health d. Include “One Health” as a keyword and, if appropriate, also in the title of the manuscript
Acknowledgment	19	Indicate funding source(s) and potential conflicts of interest

Appendix 2 – Citations of COHERE

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6. Dalton, K. R., Rock, C., Carroll, K. C. & Davis, M. F. One Health in hospitals: how understanding the dynamics of people, animals, and the hospital built-environment can be used to better inform interventions for antimicrobial-resistant gram-positive infections. *ANTIMICROBIAL RESISTANCE AND INFECTION CONTROL* **9**, (2020).
7. Davis, M. F. *et al.* Occurrence of Staphylococcus aureus in swine and swine workplace environments on industrial and antibiotic-free hog operations in North Carolina, USA: A One Health pilot study. *ENVIRONMENTAL RESEARCH* **163**, 88–96 (2018).
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10. Falzon, L. C. *et al.* Quantitative Outcomes of a One Health approach to Study Global Health Challenges. *ECOHEALTH* **15**, 209–227 (2018).
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12. Gass Jr, J. D. *et al.* A standardized instrument quantifying risk factors associated with bi-directional transmission of SARS-CoV-2 and other zoonotic pathogens: The COVID-19 human-animal interactions survey (CHAIS). *ONE HEALTH* **15**, (2022).
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18. Huber, R. I. *et al.* Symposium report: emerging threats for human health - impact of socioeconomic and climate change on zooanthroponosis in the Republic of Sakha (Yakutia), Russia. *INTERNATIONAL JOURNAL OF CIRCUMPOLAR HEALTH* **79**, (2020).
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Levin, R. *et al.* The urban lead (Pb) burden in humans, animals and the natural environment. *ENVIRONMENTAL RESEARCH* **193**, (2021).
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30. Machalaba, C. *et al.* Applying a One Health Approach in Global Health and Medicine: Enhancing Involvement of Medical Schools and Global Health Centers. *ANNALS OF GLOBAL HEALTH* **87**, (2021).
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34. Nouws, S. *et al.* The Benefits of Whole Genome Sequencing for Foodborne Outbreak Investigation from the Perspective of a National Reference Laboratory in a Smaller Country. *FOODS* **9**, (2020).
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Appendix 3 – Table of Scored Comparison Papers

Group	Paper Title	Author	Human Domain	Animal Domain	Environment Domain	Vector as Environment Domain?
1	Occurrence of Staphylococcus aureus in swine and swine workplace environments on industrial and antibiotic-free hog operations in North Carolina, USA: A One Health pilot study	Davis	Workers at swine facilities	Swine at hog production facilities	Dust, ambient air in hog production facilities	no
1	Fecal microbiota dysbiosis in macaques and humans within a shared environment	Grant	Workers with elevated macaque exposure	Macaques living in park vs	Gut microbiome of humans	no

				isolated forest	and macaques	
1	Household Transmission of SARS-CoV-2 from Humans to Pets, Washington and Idaho, USA	Meisner	Pet owners	Pets (dog, cat, ferret, hamster)	COVID-19, shared household	yes
1	Human Colonization with Extended-Spectrum Beta-Lactamase-Producing E. coli in Relation to Animal and Environmental Exposures in Bangladesh: An Observational One Health Study	Rousham	Humans with high exposure to poultry	Poultry in villages, farms, urban markets	Water supply, wastewater outlet	no
1	Distribution of Staphylococcus species in dairy cows, workers and shared farm environments	Roberts	Dairy workers	Cows on dairy farms	Dairy farm surfaces	no
1	Long-Tailed Macaques (Macaca fascicularis) in Urban Landscapes: Gastrointestinal Parasitism and Barriers for Healthy Coexistence in Northeast Thailand	Schurer	People living near macaques	Macaques living near people	Built environment shared by humans and macaques	no
2	Risk factors and Molecular genotyping of Brucella melitensis strains recovered from humans and their owned cattle in Upper Egypt	Abdel-Hamid	People at risk of brucellosis	Household cattle	*Brucella melitensis* presence	yes
2	A One Health approach to study the circulation of tick-borne pathogens: A preliminary study	Banovic	Family with history of tick exposure	Household dogs and goats	Ticks	yes
2	One health approach on serosurvey of anti-Leptospira spp. in homeless persons and their dogs in South Brazil	do Couto	Homeless persons who own dogs	Dogs owned by homeless people	Shared living environment of owners and dogs	no
2	Prevalence and zoonotic transmission of colistin-resistant and carbapenemase-producing Enterobacterales on German pig farms	Effelsberg	Workers on pig farms	Pigs on pig farms	Gut microbiome of workers and pigs	no
2	Impacts of small-scale chicken farming activity on antimicrobial-resistant Escherichia coli carriage in backyard chickens and children in rural Ecuador	Hedman	Children in homes with backyard chickens	Backyard chickens	Gut microbiome of children and chickens	no
2	Simian adenoviruses: Molecular and serological survey in monkeys and humans in Thailand	Kosoltanapiwat	Humans with potential monkey exposure	Wild monkeys	Viruses	yes
2	Antimicrobial resistance and genetic diversity of Staphylococcus aureus collected from livestock, poultry and humans	Rao	Humans with potential exposure to resistant bacteria	Swine, dairy cattle, beef cattle, poultry	AMR genes	yes
2	Genetic relatedness of third-generation cephalosporin-resistant Escherichia coli among livestock, farmers, and patients in Japan	Nakano	Livestock farmers	Healthy livestock (cattle, swine)	E. coli strains in fecal microbiome	yes
2	Association between seroprevalence of measles virus in monkeys and degree of human-monkey contact in Bangladesh	Ortiz-cam	Humans exposed to macaques	Macaques exposed to humans	Measles virus, monkey-human proximity	yes

2	Spatial relationships between small-holder farms coupled with livestock management practices are correlated with the distribution of antibiotic resistant bacteria in northern Tanzania	Rosenkrantz	Humans with different livestock practices	Livestock (cattle, goats, sheep)	Livestock practices	no
2	Prevalence and genetic diversity of Giardia duodenalis in pet dogs from Zhengzhou, central China and the association between gut microbiota and fecal characteristics during infection	Sui	Dog owners	Pet dogs	*G. duodenalis* presence	yes

Citations:

1. Abdel-Hamid, N. H. *et al.* Risk factors and Molecular genotyping of Brucella melitensis strains recovered from humans and their owned cattle in Upper Egypt. *One Health* **13**, 100281 (2021).
2. Banović, P. *et al.* A One Health approach to study the circulation of tick-borne pathogens: A preliminary study. *One Health* **13**, 100270 (2021).
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4. do Couto, A. C. *et al.* One health approach on serosurvey of anti-Leptospira spp. in homeless persons and their dogs in South Brazil. *One Health* **15**, 100421 (2022).
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Appendix 4 – Scoring Rubric

Group	Area	Standard #	0	1	2	3
1) Study Design	Introduction	1	No or very minimal mention of OH as concept, does not describe more than one domain	Includes at least two domains, but no discussion about why OH approach is valid for this topic.	Defines OH, discusses at least 2 domains, no to minimal discussion of One Health approach	Explicit, clear discussion of OH as concept, explicit justification for approach and how domains fit together
	Rationale	2	unclear study aims, unclear relationship between domains	clear aim(s) or hypothesis that involve a connection between 2-3 domains, but not in OH context, does not justify why study method chosen	clear aim/hypothesis including 2-3 domains, in a OH context, but does not justify study design OR clear aim/hypothesis including 2-3 domains, with justification of study design, but not in OH context	fully meets criteria
	Study Design	3	no explanation of data collection, no criteria for inclusion/exclusion, does not follow published guidance	describes data collection but does not integrate, provides limited criteria for some domains	explains at least one relationship, provides full inclusion/exclusion criteria for at least one domain but not others,	explanation of relationship/interaction of the collection of specimens or data, clear and explicit inclusion/exclusion criteria for all domains, follows guidance
2) Participants	Human Participants	4	does not provide any information about human participants, no inclusion/exclusion criteria, no information about sample size and justification, no discussion of ethical standards	very limited information about human participants, limited information about sample size and justification, very limited discussion	provides most relevant descriptions, but maybe not full breakdown, or missing key pieces of information. may not include sample size justification. IRB approval included,	provides full and clear descriptions including inclusion/exclusion, and includes sample size justification, Full IRB approval and any other ethical considerations mentioned, or clear explanation of why IRB approval not needed

				of ethical standards		
	Animal Participants	5	no or very limited signalment of animal participants, no sample size justification, no species information, no ethical approvals included	minimal information of signalment, missing sample size and justification, only common name of species provided, some amount of ethical approval obtained, but not IACUC standard	most requirements met, but missing some information, most information about species included, IACUC approval, but no other ethical justification	full descriptions of animal participants, including sample size justification, included species information, clear approvals and ethical consideration, including IACUC approval, or why approval not required
	Environment	6	No information about environment or ecosystem factors, no description of environmental samples collected, no geographic information, ecosystem type, etc. provided	Limited information about either abiotic or biotic factors provided, limited to no description of environmental samples collected, very broad and nonspecific information about study location	Environmental or ecosystem factors included, some description of environmental data collected, some description of study location	Clear identification of all environment and ecosystem factors included, detailed information about environmental samples collected, clear description of study location, easy to locate and combine with other data sources
3) Study Execution ?	Measurement	7	No information about sampling frequency, no information about relationships and interactions between domains, no information about diffrences in data	Minimal information about sampling frequency, limited information about relationships and interactions, no	Sampling frequency described but not justified, incomplete description of relationships and interactions between domains, limited	Full description of sampling frequency and justification, full description of relationships and interactions between domains, justification for difference in data collection or measurement

			collection, no description or justification for different measurements	description of differences in data collection, no justification for different measurements	justification for difference in sampling or measurements	
	Analysis	8	no information about data collection, no explanation of hierarchical relationships, no explanation of difference in data handling	minimal information about data collection, minimal information about any hierarchical relationships, minimal explanation of any difference in data handling	full information about data collection, some information about hierarchical relationships, some explanation of difference in data handling	full information about data collection, full description of any hierarchical relationships, full explanation of differences in data handling
	Study Team	9	No information about study team or stakeholders, no information about study team and contributions	Minimal information about study team or other stakeholders, minimal information about study team and contributions	Some information about study team, stakeholders, community members, some information about study team and contribution	Detailed information about study team, stakeholders, community members, detailed information about study team and contributions
	Ethics	10	No ethical approvals reported, no framework described	Incomplete ethical approvals provided, no framework described	Ethical approvals obtained, minimal or no description of framework	Ethical approvals and other permissions obtained, framework described
4) Results	Human Participants	11	No information about recruitment, study population, no demographic information, no exposure factors, no behavior	Minimal information about recruitment, study population, demographics, exposure, behavior	Most information about recruitment, study population, demographics, exposure, behavior provided, but no justification	Full information about recruitment, study population, demographics, exposure, behavior, provided, or justification for exclusion provided

					for any missing information	
	Animal Participants	12	no signalment provided, no information about study species, population, no animal management characteristics	Minimal signalment information provided, minimal description of study population and general population, minimal description of animal managemen t	Study population described, some information about general population, some signalment provided, some animal management described	Full description of study and general population, detailed signalment provided, details about animal management included
	Environment	13	No information about sample collection, no measurement of heterogeneity, no descriptive statistics, no geographic referencing	minimal information about sample collection, heterogeneit y, minimal descriptive statistics, limited geographic referencing	information about sample collection, heterogeneity, some descriptive statistics, some geographic referencing	Detailed information about samples collected, including heterogeneity, complete descriptive statistics, appropriate geographic referencing
	Measurement	14	Reporting not consistent across any domains, missing data, data not standardized across domains	Only some data identified to the same level, only some standardize d	Most data identified to the same level, reporting mostly consistent but not fully across domains	All identified to the same taxonomic level, all data reported in standardized/equiv alent
	Analysis	15	No comparative statistics or comparisons, no measurement of uncertainty, no consideration of indepence, no description of spatial relationships	Minimal comparative statistics or comparison, minimal measureme nt of uncertainty, minimal consideratio n of indepence factors, minimal information	Some comparative statistics, comparison, integration, variation, some measurement of uncertainty, some information about spatial relationships	Full comparative statistics, comparisons, and fully integrated analysis, detailed consideration of independence, description of geospatial relationships

				about spatial relationships		
5) Discussion	Overall	16	No comprehensive discussion - discussed independently, no generalization beyond study	Minimal comprehensive discussion - only some domains integrated, minimal generalization beyond study	Detailed comprehensive discussion including at least 2 domains, some generalization	Detailed, comprehensive discussion including all three domains, generalization to scale
	Limitations	17	No discussion of any limitations	Minimal discussion of limitations, missing important discussion points	Full discussion of some limitations, but missing a few of the listed criteria	Full discussion of all relevant limitations
	One Health Contribution	18	No discussion of One Health approach, no discussion of study team, no One Health context	Minimal discussion of One Health, One Health approach	Discussion of One Health approach, missing part of discussion or conclusion	Detailed discussion of One Health approach, clear identification of One Health conclusion
	Acknowledgement	19	not included	x	x	included

Appendix 5 – Codebook

Code	Description
Animal Domain	Specific mention of what is included/excluded in the animal domain
Collaboration Benefit	Quotes relating to collaboration - importance, working across disciplines, etc.
Data Standardization	Discussion of metrics, standards, etc for increasing data standardization, presentation of data, etc.
Environment Domain	Specific mention of what is included/excluded in the environment domain
Ethics	Discussion of ethics and ethical considerations in research
Exact Citation	The specific citation of COHERE
Guidelines and Frameworks	Discussion of other guidelines and frameworks other than COHERE being used in the study or discussed
Human Domain	Specific mention of what is included/excluded in the human domain
One Health Approach Benefit	Discussion of how using a One Health Approach improved the research, what benefits it could provide
One Health Definition	The definition of One Health used in the paper, what parameters they are including
One Health Field Need	Needs or future direction of the field
One Health Inclusion/Exclusion	Discussion or criteria being used to determine what is part of a One Health Study and what is not
Other Barriers	Identification of barriers other than silos and data standardization
Silos	Mention of silos/barriers between disciplines, lack of collaboration

Appendix 6 –Survey Text

One Health Guidelines Survey

Thank you for participating in this survey! It is designed to take 10-15 minutes.

As the field of One Health expands, there has been a need for tools that are specific to One Health to guide study design and data analysis to include all three domains. This survey is intended to gather expert opinions about the Checklist for One Health Epidemiological Reporting of Evidence (COHERE) Guidelines that were published in 2017 in the journal of One Health. COHERE was modeled after STROBE to provide this tool for epidemiology studies, although many of the guidelines can be applied to other study types as well. Please click here if you would like to read the original paper, with more detailed explanation about the process and methods used to develop these standards. There is also additional information at the Center for One Health Research (COHR), at University of Washington linked here. You do not need to read this paper in order to complete the survey, the standards are listed in the first section.

There are 3 sections of the survey.
1. Feedback on each of the guidelines individually (this is the longest section)
2. Overall thoughts about the COHERE guidelines and implementation
3. Brief demographic information

I am interested in identifying barriers to implementation and adoption, with the goal of better understanding why the COHERE guidelines have not been more widely used.

This survey is intended for people who are involved in research in the field of One Health, who have a basic familiarity with the topic. The COHERE guidelines are intended for observational and interventional epidemiology studies, but you do not have to participate in epidemiology studies to provide your expertise.

All of the questions are voluntary, no identifying information is collected, and this survey is only seeking opinions as an expert. There is an option at the end to provide your email if you are willing to participate in future discussions, or would like to be notified of any publications resulting from this work.

This project is run by Elizabeth Traylor, a 3rd year Masters of Public Health in One Health candidate at University of Washington as part of my thesis project. Please send any questions about this survey to trayle@uw.edu. I am receiving support from the Center for One Health Research at the University of Washington.

By continuing with this survey, you consent to your responses being collected and analyzed.

COHR

COHERE Guidelines

One of the concerns as the field of One Health develops is the need to have guidelines that encourage fully integrating the data from all 3 domains. The COHERE guidelines were published in 2017, modeled after STROBE, to provide a One Health specific tool. COHERE was created specifically for epidemiology studies, but many of the guidelines can be applied to multiple study types. These are guidelines rather than standards, and some may be more or less applicable depending on study design and research question.

Here is a link to the original paper, with more detailed explanation about the process and methods used to develop these guidelines. There is also additional information hosted at the Center for One Health Research (COHR), at University of Washington linked here.

This section is about the COHERE guidelines individually. The next section will include questions about the guidelines as a whole.

1. How familiar are you with the COHERE guidelines?

Mark only one oval.

- ◯ Have implemented them in the study design, data analysis, or paper writing of my work
- ◯ Have used them to analyze published papers, not implemented in my work
- ◯ Have heard of them, choose not to use
- ◯ Never heard of them before

The COHERE Guidelines

Below are COHERE guidelines in sections. The standards are presented as they are written in the original paper.

Please read each standard and indicate the usability - if the standard can be used and applied to a study, and whether you think it is acceptable as it is, needs minor improvement, or needs major improvement. If the standard needs improvement, please provide your thoughts in the section below about how it should be improved, or what the errors are.

Introduction

1. Background:
Review the human, animal, and environmental context of the problem and justify why a One Health study is appropriate to address the scientific question

2. Rationale:
Clearly states the research aims and/or hypothesis in the context of the relationship among the three domains (human, animal, and environment), or state and defend the nature of the study if it is not hypothesis-driven

2. Rate the usability of each guideline

Mark only one oval per row.

	No improvement needed	Minor improvement needed	Major improvement needed
Introduction	◯	◯	◯
Rationale	◯	◯	◯

3. How could these guidelines be improved?

_____

Methods (Part 1)

3. Study Design:
(a) Explain or describe the relationship/interaction (epidemiologic, biological, ecological, spatial/temporal, etc.) of the collection of the human, animal, and environmental specimens and/or data
(b) Provide inclusion and exclusion criteria for all domains
(c) According to study design, follow other guidance, e.g. STROBE and its extensions (STROBE-VET, STROME-ID), CONSORT, PRISMA, etc., as indicated

4. Human Participants:
(a) Provide qualitative and/or quantitative description of the human population or human data, including characteristics related to inclusion or exclusion from the study, sample size (at all relevant population levels), and sample size justification, as appropriate
(b) Ensure human subject assurances adhere to the highest standards of ethics governing human subjects research

5. Animal Participants:
(a) Provide qualitative and/or quantitative description of the animal population (domestic, captive exotic, or free-ranging wild), including characteristics related to inclusion or exclusion from the study, sample size (at all relevant population levels), and sample size justification
(b) Include, at minimum, the common or generic name for the species of animal or animals studied, and provide the taxonomic Genus species if indicated (i.e. for less common species) if the species chosen is dependent on study design
(c) Ensure animal subject assurances adhere to the highest standards of ethics governing animal subjects research

6. Environment
(a) Identify environmental (abiotic) and/or ecosystem (biotic) factors including vector characteristics if appropriate, that are under investigation
(b) Describe the type and purpose of any environmental samples or data collected
(c) Provide qualitative and/or quantitative description of the study location, including geographic locale (e.g. region and country, latitude/longitude or a centralized point if the location of the site is sensitive information), ecosystem type (e.g. mangrove forest) and/or land use description (e.g. urban, agricultural, etc.), and number and description of where samples were obtained

4. Rate the usability of each guideline

Mark only one oval per row.

	No improvement needed	Minor improvement needed	Major improvement needed
Study Design	⬭	⬭	⬭
Human Participants	⬭	⬭	⬭
Animal Participants	⬭	⬭	⬭
Environment	⬭	⬭	⬭

5. How could these guidelines be improved?

Methods (Part 2)

7. Measurement:

(a) If indicated, include the frequency of sampling (i.e. sample interval) and calendar timing (i.e. date, month, season, year)

(b) Describe the relationships/interactions (epidemiologic, biological, ecological, spatial/temporal, etc.) among human, animal, and environmental samples and data, as well as other significant differences in data collection methods between domains

(c) Describe and justify testing or analysis measures used, and indicate the validity for such measurements for use among human, animal and environmental domains

8. Analysis:

(a) Identify how data among the three domains were collected

(b) Explain how any hierarchical relationships within and between domains (e.g. at the individual or group level) were handled

(c) If data were handled differentially among the three domains (e.g. collection of data from one domain at a different time interval than from another domain), describe this in sufficient detail to allow assessment of potential bias introduced by this decision

6. Rate the usability of each guideline

Mark only one oval per row.

	No improvement needed	Minor improvement needed	Major improvement needed
Measurement	◯	◯	◯
Analysis	◯	◯	◯

7. How could these guidelines be improved?

Methods (Part 3)

9. Study Team:
(a) If applicable, describe the involvement of study team members, stakeholders and community members (e.g. farmer participant stakeholders, industry, etc.)
(b) Indicate how study team members representing all three domains contributed to development of the research question and study design

10. Ethics:
(a) Report animal (IACUC/ACUC) and human ethics (IRB) approvals, as well as other relevant permissions that were obtained
(b) If applicable, describe the framework for adhering to community based research standards (e.g. community approval, cultural respect, knowledge translation)

8. Rate the usability of each guideline

Mark only one oval per row.

	No improvement needed	Minor improvement needed	Major improvement needed
Study Team	◯	◯	◯
Ethics	◯	◯	◯

9. Are the current ethical standards of IRB, IACUC, etc. approval sufficient?

Mark only one oval.

- ◯ Yes
- ◯ No

10. How could these guidelines be improved?

_____

Results (Part 1)

11. Human Participants
(a) Report recruitment data, provide study population percentages and describe generalizability of study population to underlying population
(b) Describe demographics (i.e. sex, age, race/ethnicity, etc.) or case characteristics, as well as exposure factors and behavioral characteristics evaluated, of human subjects

12. Animal Participants
(a) Report study population percentages and describe generalizability of study population and study species to the underlying animal population of interest
(b) Describe demographics (i.e. sex, age, breed, etc.) or signalment, as well as exposure factors, of animal subjects
(c) If applicable, describe animal management characteristics (i.e. housing, diet, other environmental factors)

13. Environment
(a) Report findings from collected samples and/or measurements, including measures of heterogeneity that could impact generalizability of findings
(b) Provide descriptive statistics for all appropriate environmental/ecosystem variables
(c) If appropriate, provide geographic referencing for all samples or data submitted to public databases

11. Rate the usability of each guideline

Mark only one oval per row.

	No improvement needed	Minor improvement needed	Major improvement needed
Human Participants	◯	◯	◯
Animal Participants	◯	◯	◯
Environment	◯	◯	◯

12. How could these guidelines be improved?

Results (Part 2)

14. Measurement

(a) Identify populations, pathogens and/or vectors to the same taxonomic level across all three domains
(b) Report findings in a way that is standardized or equivalent across all three domains

15. Analysis:

(a) Provide comparative statistics, qualitative comparisons or integrated analyses among human, animal, and environmental variables, including (as appropriate) measures or descriptions of uncertainty (e.g. variance, confidence intervals, qualitative limitations)
(b) Consider the potential for lack of independence or group effects that may impact statistical inference (e.g. at the household or building level, pen or other animal cohort level, and community level)
(c) If indicated, provide geospatial comparisons or illustrations of spatial relationships (e.g. maps) to describe the distribution between human and animal populations

13. Rate the usability of each guideline

Mark only one oval per row.

	No improvement needed	Minor improvement needed	Major improvement needed
Measurement	◯	◯	◯
Analysis	◯	◯	◯

14. How could these guidelines be improved?

Discussion

16. Overall

(a) Provide a comprehensive discussion that integrates the human, animal and environmental aspects of the results
(b) Indicate generalizability of findings to local, national, and/or international levels

17. Limitations

(a) Discuss any discordance in acquisition, analysis or interpretation of data among the three domains (e.g. identify problems with application of different methods among the domains)
(b) Identify where methods lack validation (e.g. animal methods used in human populations or vice versa)
(c) Identify any methods that may not have been optimal to address research aims and suggest how future studies could overcome such limitations
(d) Comment on issues that may impact the reproducibility of the study, as appropriate
(e) Identify and discuss potential sources of bias
(f) Discuss species-specific differences that may impact the results or the interpretation of the results
(g) Identify other potential populations of humans or animals that could be involved in the problem and were not measured or addressed in the study

15. Rate the usability of each guideline

Mark only one oval per row.

	No improvement needed	Minor improvement needed	Major improvement needed
Overall	◯	◯	◯
Limitations	◯	◯	◯

16. How could these guidelines be improved?

_____

One Health Contribution and Acknowledgement

18. One Health Contribution

(a) Describe how a One Health approach to the study specifically incorporation of expertise among the discipline and integration of findings from human, animal and environmental domains—furthered the understanding of the data/research problem
(b) If appropriate, describe lessons learned from the One Health interdisciplinary study team approach, e.g. successes and challenges identified as part of the process of conducting the study, methods for operationalizing participation among the disciplines, and cost-benefit analyses of the resource efficiencies of One Health studies
(c) Identify how the conclusions relate to promotion of human, animal and ecosystem health
(d) Include “One Health” as a keyword and, if appropriate, also in the title of the manuscript

19. Acknowledgement

Indicate funding source(s) and potential conflicts of interest

17. Rate the usability of each guideline

Mark only one oval per row.

	No improvement needed	Minor improvement needed	Major improvement needed
One Health Contribuition	◯	◯	◯
Acknowledgement	◯	◯	◯

18. How could these guidelines be improved?

_____

Thank you. The next section will ask about your opinions of COHERE as a whole.

The COHERE Guidelines

The following are questions about the COHERE Guidelines overall, as they are currently written. This section is about how comprehensive the guidelines are, and identifying if there are any holes.

19. What is your general opinion of the COHERE guidelines?

Mark only one oval.

	1	2	3	4	5	
Very	◯	◯	◯	◯	◯	Very Positive

20. How easy are the COHERE guidelines to understand?

Mark only one oval.

	1	2	3	4	5	
Very	◯	◯	◯	◯	◯	Very easy

21. How easy are the COHERE guidelines to implement?

Mark only one oval.

	1	2	3	4	5	
Very	◯	◯	◯	◯	◯	Very easy

22. How likely are you to use the COHERE guidelines in study design?

Mark only one oval.

	1	2	3	4	5	
Not	◯	◯	◯	◯	◯	Very likely

23. How likely are you to use the COHERE guidelines in data analysis or discussions?

Mark only one oval.

	1	2	3	4	5	
Not	◯	◯	◯	◯	◯	Very likely

24. How likely are you to use COHERE guidelines when evaluating papers?

Mark only one oval.

	1	2	3	4	5	
Not	◯	◯	◯	◯	◯	Very likely

25. The COHERE guidelines be promoted as a useful tool for One Health research

Mark only one oval.

	1	2	3	4	5	
Stro	◯	◯	◯	◯	◯	Strongly agree

26. Increased implementation of the COHERE guidelines would improve data standardization in the field of One Health

Mark only one oval.

	1	2	3	4	5	
Stro	◯	◯	◯	◯	◯	Strongly Agree

27. What would be a benefit to increased implementation of the guidelines?

28. What are the guidelines missing?

Demographics

This section is general information about your experience, training, and where you are based. Please only provide information at the level of detail you are comfortable with.

29. How long have you been involved in the field of One Health?

Mark only one oval.

- ◯ Less than 1 year
- ◯ 1-4 years
- ◯ 5-10 years
- ◯ Over 10 years

30. What country is your institution based in?

31. What country/countries are your research projects based in?

32. How would you rank your expertise in each of the One Health domains?

Mark only one oval per row.

	Most expertise	Middle expertise	Least expertise
Human	◯	◯	◯
Animal	◯	◯	◯
Environment	◯	◯	◯

33. What is your primary affiliation?

Mark only one oval.

- ◯ Academic institution
- ◯ Industry
- ◯ Non-Profit
- ◯ Governmental
- ◯ Other: _____

Skip to question 34

Conclusion

Thank you for participating in this survey. Your responses and time are valuable, and your effort is much appreciated.

Please contact Elizabeth at trayle@uw.edu if you have any questions or feedback about this survey.

34. Are you interested in being contacted in the future for further discussion about the COHERE guidelines?

Mark only one oval.

- ◯ Yes
- ◯ No

35. Would you like to be notified about any publications that come from this project?

Mark only one oval.

- ◯ Yes
- ◯ No

36. Please provide your email address if you answered yes to either question above.

_____

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