

SYSTEMATIC REVIEW

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# Common criteria for evaluating cross-disciplinary research in global health: a scoping review

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## Abstract

**Background** Solutions to global health challenges depend on nations' capacity for cross-disciplinary research in global health. Despite longstanding demands for practical guidelines, published guidance and frameworks for evaluating cross-disciplinary research are scarce and scattered among disciplines. We aimed to bring together information on how cross-disciplinary research has been evaluated and collate the frameworks and tools that have been used to advance knowledge and practice about the design and evaluation of cross-disciplinary research in global health.

**Methods** We conducted a systematic scoping review by searching five databases (MEDLINE, CINAHL COMPLETE, Global Health, PubMed, Web of Science) for publications relevant for our objectives. These were to understand the characteristics of frameworks used to evaluate cross-disciplinary research, to describe how they had been used in practice, and to identify underlying common underpinning criteria. Our inclusion criteria were that the publications (a) focus on frameworks for cross-disciplinary research and (b) include aspects of evaluation or monitoring. The last search was conducted in July 2023.

**Results** Thirty-one of 2718 screened publications met our inclusion criteria. The intended users of the frameworks were cross-disciplinary researchers (31; 97%), funders (15; 48%), evaluators/reviewers (15; 48%) and practitioners/stakeholders (10; 32%). Eight frameworks (26%) were bespoke for a particular project and used a 'context-process-outcome' approach to incorporate the whole research pathway. Four frameworks (13%) focused on evaluating outcome/impact. Nineteen (61%) focused on other specific aspects of cross-disciplinary research. Seventeen frameworks (55%) provided evaluation tools and 14 (45%) included guidance about their use in practice. Twenty-four (77%) provided examples of how their frameworks were used in practice, and 21 (68%) stated that their frameworks were generalizable in different contexts. The criteria used for the evaluations across the publications fell into four categories: appropriate cross-disciplinary research approaches for the project goal; shared learning and integration; meeting disciplinary standards; and effective synthesis.

**Conclusions** Our collation and description of the heterogenous published guidance and frameworks for evaluating cross-disciplinary research, and our practical lessons for how to improve the robustness of such evaluations, will help funders, researchers and evaluators to make evidence-informed choices when they commission, design and evaluate cross-disciplinary research programmes in global health.

**Keywords** Cross-disciplinary research, Multidisciplinary research, Interdisciplinary research, Public Health research, Transdisciplinary research, Evaluation, Frameworks

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## Background

Finding solutions to complex global health problems depends on effective research collaborations between disciplines [1–3]. Cross-disciplinary research enables exchange of knowledge and experience [4–9], stimulates innovative responses to complex health challenges [10–17], and often incorporates disseminating accessible knowledge to influence practice and policy [18–20]. In recognition of these attributes, funders of global health research programmes are increasingly requiring cross-disciplinary research approaches to be incorporated into projects. However, they provide little guidance on how they define cross-disciplinary research and the metrics by which they will evaluate its use and impact across their global health programmes and projects.

Sourcing information on definitions, guidance and frameworks to help in the design and evaluation of cross-disciplinary research activities is challenging partly because cross-disciplinary research covers three typologies—multi-disciplinary, inter-disciplinary and trans-disciplinary research [21–28]. Although there are some relevant documents, they are heterogeneous in format, context and topic of variable quality and, by definition, are scattered among many different disciplines [29]. This means that funders, proposal reviewers, researchers and project evaluators for global health research—even if they do want to base their cross-disciplinary research approaches on evidence—are likely to have different views about what constitutes cross-disciplinary research and how they should assess the quality and success of cross-disciplinary research projects in global health [30–33]. This multiplicity of views and lack of pre-defined quality standards or success among those involved in cross-disciplinary research in global health may lead to tensions, misunderstandings about expectations and evaluation metrics, inability to demonstrate impact and value for money and ultimately wasted research efforts.

For over a decade, there has been a demand for overarching ‘practical guidelines’ and sets of ‘guiding questions’ for cross-disciplinary research [29], but these have not yet materialised. Given the diversity of global health research, it may not be possible or even desirable to have a single set of guidelines that can be applied to all cross-disciplinary research in global health. However, to improve the consistency, quality, evaluation and effectiveness of cross-disciplinary research in global health, it would be helpful to identify and collate these resources and provide a comparative synthesis to see if there are any underpinning commonalities that may be generically useful. The ability to access and use such collated resources to select guidelines and frameworks that best suit their needs would enable funders, reviewers, researchers and evaluators to better align their

understanding and expectations of cross-disciplinary research in global health in given contexts. This would make the whole process of commissioning and conducting cross-disciplinary research in global health more cost-effective and impactful.

We have therefore undertaken a scoping review of cross-disciplinary research evaluation frameworks based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses for Protocols extension for Scoping Reviews (PRISMA-ScR) [34] to systematically map published evidence concerning evaluations of cross-disciplinary research and to identify the key characteristics of existing cross-disciplinary research evaluation frameworks, their usage in practice and any common underpinning criteria. Our review encompassed literature across disciplines, including those beyond health, since solutions to global health problems often require inputs from non-health sectors. We applied a broad definition of frameworks in conducting this scoping review. A framework could be a system of rules, ideas or beliefs that is used to plan or decide something and in this case evaluation, and it could also be a guideline, which is information intended to advise people on how evaluation should be done.

Bringing together information about how to evaluate cross-disciplinary research efforts and clearly signposting the contexts and tools proposed or used in the various evaluations will enable funders, producers and evaluators of cross-disciplinary research in global health to better align their approaches and evaluation parameters. This will significantly advance knowledge and facilitate effective practice in this complex field.

## Methods

We applied the methodological framework of Arksey and O’Malley for scoping studies [35]. The process followed five stages: specification of the research question; identification of the relevant literature; selection of studies; charting the data; and summarising, synthesising and reporting the results [35]. We followed PRISMA-ScR checklist for reporting our findings (Additional file 1: Table S1) [34].

### Specification of the Review Question

This review aims to answer the following research questions:

- What are the key characteristics of existing cross-disciplinary research evaluation frameworks, including purpose, target users, the process of development and content?
- How have cross-disciplinary research evaluation frameworks been used in practice?

- What are the common underpinning criteria for cross-disciplinary research evaluation if there are any?

**Identification of the Relevant Literature**

We searched five electronic databases (MEDLINE, CINAHL COMPLETE, Global Health, PubMed, Web of Science) using keywords combined with the Boolean operators (AND, OR) (see terms used for the literature search in Additional file 2). We also manually scanned the reference lists of the eligible studies for relevant articles.

The search covered peer-reviewed original research, reviews, commentaries, project reports, institutional and government guidelines and tools published in English up to 31 December 2022, without a starting date. Our inclusion criteria were that the publications should focus on the following: (a) frameworks for cross-disciplinary research and (b) include aspects of evaluation or monitoring. For the purpose of this study, we defined cross-disciplinary research as research that combines or integrates concepts, methods and theories drawn from

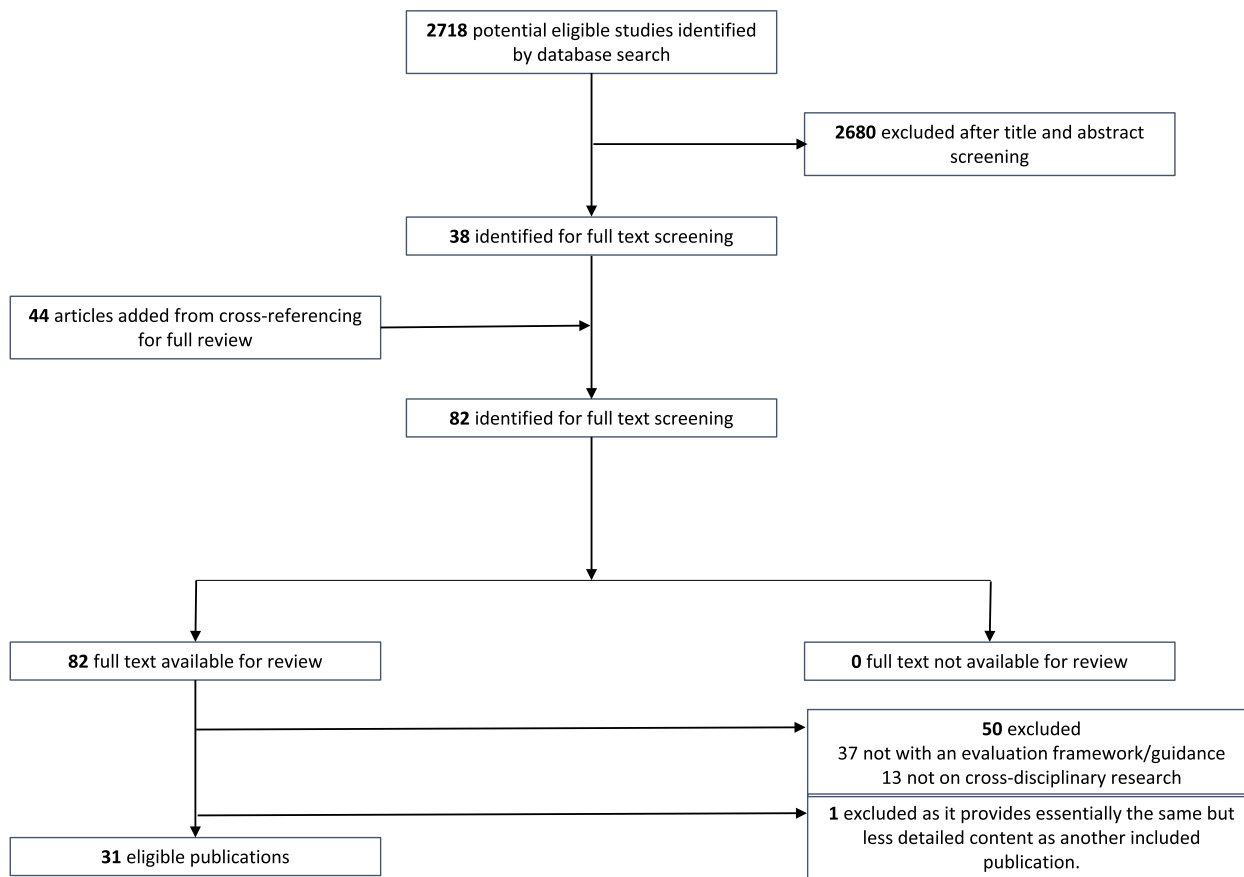
two or more disciplines [36]. We considered evaluation frameworks to be documents that provide a structure or guidance to evaluate the outputs, outcomes or impact of cross-disciplinary research activities [37]. These inclusion criteria were developed to be inclusive and cover the heterogeneity of the current guidance and frameworks for evaluating cross-disciplinary research activities.

**Selection of Studies**

The retrieved publications were imported into Endnote X8 (Clarivate), and duplicates were removed. The titles and abstracts of all potentially eligible studies were reviewed by two independent reviewers (YD and JH), and full-text screening was carried out if indicated. In case of disagreement after discussions between YD and JH, consensus was reached by involving a third person (IB).

**Charting the Data**

All eligible publications (Fig. 1) were read in full, and relevant frameworks were identified. A Microsoft Excel template was developed based on our research questions with reference to a published method for



**Fig. 1** Flow chart for the search and selection process for eligible publications

extracting information on evaluation frameworks [38]. The following data were extracted from included publications: author; year of publication; location of study; methods (study design, study population and settings); definitions of cross-disciplinary research and evaluation; purpose, aims and objectives of the framework; underlying principles or values; intended use and generalisability; framework development process and revisions; guidance on using the framework in practice; and framework content (Additional file 1: Table S2). Data extraction was performed by one reviewer (JH) and checked by a second reviewer (YD). Disagreements were resolved through discussions.

### Collating, summarising and reporting results

Data collation and summarisation was done in two steps: (1) a descriptive summary and (2) a narrative synthesis [35]. A descriptive summary consisted of the year of publication, location of study, methods and definitions of cross-disciplinary research and evaluation. Using thematic synthesis [39], we produced a narrative summary of the extracted information through an inductive approach using a ‘constant comparison’ method [40] to illuminate a heterogeneous topic area. This involved coding the data and identifying themes and sub-themes, which were then adjusted iteratively by constantly comparing among them through reflection and analyses, highlighting areas of convergence and divergence [40]. During the process, we continued reviewing the included publications for clarification. In this way, the themes and sub-themes were refined and integrated to form the basis of a coherent narrative.

## Results

### Search results and eligible publications

Initial screening identified 2718 potential publications. The full texts of 82 publications were reviewed, and 31 publications met our inclusion criteria and therefore underwent in-depth analysis (Fig. 1). The first authors of all the publications were affiliated to organisations in high-income countries (HIC) based on World Bank income categories [41]; one author was also affiliated to an organisation in a low- and middle-income country (LMIC) [42]. Three publications had co-authors affiliated to organisations in LMICs [42–44]. Eighteen publications covered cross-disciplinary research implemented in HICs in their analyses and two covered cross-disciplinary research in LMICs [43, 44]. Only one article was published before 2000 [45]. The eligible publications were very diverse, encompassing 17 peer-reviewed empirical articles, 5 project reports, 4 review articles, 3 guidelines, 1 graduate thesis and 1 book chapter. Fourteen publications addressed evaluations across multiple disciplines

and did not target specific research fields [17, 21, 30, 32, 43, 45–53], with five on tobacco research [20, 54–57]; three respectively on sustainability/social-ecological research [29, 44, 58] and landscape studies [59–61]; and one each on cancer research [62], clinical and translational sciences [63], health policy and systems research [42], global health [64], agriculture [65] and forestry [66].

### Definitions of ‘cross-disciplinary research’ and ‘evaluation’ used in the publications

Twenty-seven of the 31 publications (87%) provided explicit definitions that they used for cross-disciplinary research or they provided references to definitions. Only four publications (13%) provided a definition for evaluation in the context of cross-disciplinary research (Additional file 1: Table S3).

### Key characteristics of existing cross-disciplinary research evaluation frameworks

#### Purpose

Nine (29%) evaluation frameworks focused on cross-disciplinary research evaluation throughout the whole research processes, aiming to provide specific methodological approaches for the evaluation [21, 29, 42, 45, 52, 56–58, 60]; eight (26%) on process evaluation [20, 47, 49, 51, 53, 54, 56, 65]; seven (23%) respectively on knowledge integration [17, 43, 46, 50, 54, 59, 64] and on cross-disciplinary research quality [17, 30, 44, 47, 58, 60, 67]; six (19%) on (social) impact [45, 55, 57, 61–63]; and one each (3%) on the evaluation of cross-disciplinary research centres [55], collaborative readiness [62] and cross-disciplinary research teams [63]. Table 1 presents each framework’s purpose(s).

Many of the publications also aimed to standardise methods, approaches and tools (e.g. [21, 29, 52, 56–58, 60]) or to address gaps in the available evidence concerning different aspects of cross-disciplinary research evaluation. The aim of these studies included:

- describing the different forms of cross-disciplinary research to aid in analysing research documents [46, 48, 56];
- understanding how cross-disciplinary research processes (i.e. conception, design, implementation, evaluation) link to outcomes and policies [49, 52, 54, 55, 60, 66];
- improving and measuring the integration of different disciplines [54, 55, 64] and the quality of this integration [17, 30, 32, 44, 47, 58, 60];
- identifying indicators to assess cross-disciplinary research including its quality [42, 45, 47–49] and understanding dilemmas in assessing quality in practice [30, 67]; and

**Table 1** Purpose of each included cross-disciplinary research evaluation framework

First author, year [reference]	Evaluation in general	Process	Integration	Quality	(Social) impact	Collaborative readiness	Cross-disciplinary research centres	Cross-disciplinary research teams
Antrop and Rogge, 2006 [59]			√					
Bammer, 2013 [43]			√					
Belcher et al., 2016 [44]				√				
Bergmann et al., 2005 [58]				√				
Bruun et al., 2005 [48]	√							
Carr et al., 2018 [49]		√			√			
Defila and Di Giulio, 1999 [45]	√							
Dugle et al., 2020 [42]	√							
Edwards and Meagher, 2020 [66]					√			
Enengel et al., 2012 [61]								
Frescoln, 2015 [65]		√						
Fuqua et al., 2004 [20]		√			√			
Hall et al., 2008 [62]						√		
Huutoniemi et al., 2010 [46]			√					
Jahn and Keil, 2015 [30]				√				
Jahn et al. 2012 [50]			√					
Klein, 2008 [21]	√							
Mansilla et al., 2006 [32]		√		√				
Mansilla and Gardner, 2003 [47]				√				
Mascarenhas et al. 2021 [51]		√						
Måsse et al., 2008 [54]		√	√					
Mitchell et al., 2015 [52]	√							
Picard et al., 2011 [64]			√					
Pohl et al., 2011 [68]			√	√				
Späth, 2008 [29]	√							
Stokols et al., 2003 [56]	√	√			√			
Stokols et al., 2005 [55]							√	
Tress et al., 2003 [60]	√			√	√			
Trochim et al., 2008 [57]	√							
Walter et al., 2007 [53]		√			√			
Wooten et al., 2014 [63]								√

- understanding scientists' 'collaboration readiness' for cross-disciplinary research [62] and how to enhance participants' experience of cross-disciplinary research [65].

#### Intended users

The intended users of the frameworks were cross-disciplinary researchers (30; 97%), funders (15; 48%), evaluators/reviewers (15; 48%), practitioners/stakeholders (10; 32%), institutions hiring cross-disciplinary research researchers (5; 16%), programme managers (5; 16%) and policymakers (5; 16%). These categories are not mutually exclusive. Details are shown in Table 2.

#### The process of development

Seventeen (55%) studies reviewed published literature or project/programme documents to develop their frameworks for cross-disciplinary research [21, 30, 42, 44–50, 59, 61, 66], 14 (45%) collected primary data [29, 48, 51, 53–58, 60, 62, 63, 65, 67], 3 (10%) conducted an expert review [17, 45, 47], and 1 did not specify how they developed the framework (Additional file 1: Table S4) [43]. These categories are also not mutually exclusive.

#### Contents of the evaluation frameworks

The concept of 'frameworks' as described in the publications varied from frameworks (14; 45%) [17, 20, 42–44, 46, 49, 51–53, 58, 61, 64, 66], models (7; 23%) [50, 54–57, 63, 65], and criteria (3; 10%) [45, 47, 59] to

**Table 2** Intended users of the evaluation frameworks

First author, year [reference]	Cross-disciplinary research researchers	Funders	Evaluators/reviewers	Practitioners	Program managers	Institutions hiring cross-disciplinary research researchers	Policymakers
Antrop and Rogge, 2006 [59]	√			√			
Bammer, 2013 [43]	√	√		√		√	√
Belcher et al., 2016 [44]	√		√		√	√	
Bergmann et al., 2005 [58]	√		√				
Bruun et al., 2005 [48]	√	√					
Carr et al., 2018 [49]	√	√			√		
Defila and Di Giulio, 1999 [45]			√				
Dugle et al., 2020 [42]	√						√
Edwards and Meagher, 2020 [66]	√		√	√			
Enengel et al., 2012 [61]	√			√			√
Frescoln, 2015 [65]	√		√		√		
Fuqua et al., 2004 [20]	√	√		√		√	
Hall et al., 2008 [62]	√	√	√		√		
Huutoniemi et al., 2010 [46]	√	√	√	√		√	
Jahn and Keil, 2015 [30]	√	√		√	√		√
Jahn et al., 2012 [50]	√	√					
Klein, 2008 [21]	√		√				
Mansilla et al., 2006 [32]	√	√	√				
Mansilla and Gardner, 2003 [47]	√	√	√				
Mascarenhas et al., 2021 [51]	√			√			
Mässe et al., 2008 [54]	√		√				
Mitchell et al., 2015 [52]	√	√					
Picard et al., 2011 [64]	√						
Pohl et al., 2011 [68]	√			√			
Späth, 2008 [29]	√				√		
Stokols et al., 2003 [56]	√	√		√			√
Stokols et al., 2005 [55]	√	√				√	
Tress et al., 2003 [60]	√		√				
Trochim et al., 2008 [57]	√	√	√				
Walter et al., 2007 [53]	√		√				
Wooten et al., 2014 [63]	√	√	√				

guidelines (1; 3%) [30], principles (1; 3%) [21], questions (1; 3%) [29] and fundamental grounds (1) [67] and included 2 detailed logic models [54, 57]. Four (13%) frameworks were phrased as questions [43, 45, 51, 61], six (19%) provided their own set of questions to operationalise the evaluation [17, 29, 30, 58, 65, 66], and three (10%) listed practical steps to undertake the evaluation [50, 58, 60]. The amount of detail provided about the contents of the frameworks varied from little to extensive, largely depending on whether the study was

philosophical or conceptual [64, 65], whether it aimed to provide a high-level template or broad guidance [42] or whether it was to be implemented in practice [17, 53, 58, 60].

Specific aspects of cross-disciplinary research that were the foci of the evaluations proposed and/or used are summarised in Additional file 1: Table S5. Nineteen of the 31 evaluation frameworks (61%) incorporated specific aspects to evaluate cross-disciplinary research [17, 21, 29, 44–48, 50, 50, 51, 54, 59–62, 65]; eight

(26%) essentially created bespoke frameworks based on their understanding of cross-disciplinary research evaluation, using a 'context-process-outcome' approach [20, 30, 42, 43, 49, 55, 56, 58]; and 4 (13%) focused only on outcome/impact evaluation [52, 53, 57, 66].

Of the 19 evaluation frameworks that incorporated specific cross-disciplinary research aspects to be evaluated, twelve included integration/synthesis [17, 21, 29, 45–48, 50, 54, 59, 62, 65]; eleven assessed problem definition/justification for using cross-disciplinary research approaches or the goals of the cross-disciplinary research [17, 21, 44–47, 50, 51, 59–61]; five appraised knowledge generation/transformation or knowledge types [44, 45, 51, 59, 61]; four included either collaboration [21, 54, 62, 65], leadership and management [17, 21, 45, 59] or effectiveness [21, 44, 48, 67]; three included validity [48, 54, 65]; and two incorporated combinations of team competencies [45, 63], feedback opportunities [48, 59] and communication [54, 65]. These aspects were not mutually exclusive.

Some of those specific cross-disciplinary research aspects in different frameworks was interpreted in similar ways. For example, validity means consistency with multiple antecedent disciplinary knowledge, conform to disciplinary criteria of acceptability and relevance [47, 48]. Some aspects, although using the same/similar terminologies, had different focus. For example, integration/synthesis was assessed in three domains in one study (i.e. the spatial, the chronological and legal integration) [59], while in another two studies, it was evaluated in the methods index (e.g. development or refinement of methods for gathering data), the sciences-and-models index (e.g. understanding multiple determinants of the stages of nicotine addiction), improved interventions (e.g. progress in pharmacologic interventions) and the publications index (i.e. the sum of submitted and published articles and abstracts) [54, 65].

The eight frameworks that followed the context-process-outcome structure had tended to focus on specific elements that they identified as the most relevant/important. For example, context referred to influential circumstances [43] or study setting [42]; actors; project construction and project formulation [58]; institutional support; financial resources; history of collaboration [49]; or more specifically intrapersonal, social, physical environmental, organisational and institutional factors [20, 55, 56]. Process could be in terms of project execution and methodology [58], cross-disciplinary communication, conflict resolution [42], behavioural, affective, interpersonal, and intellectual [20, 55, 56]. Outcome could be results; products and publications in general [42, 58]; social or human capital outcomes [49]; or more concrete terms such as concepts, interventions, training

programmes, novel ideas, integrative models and institutional changes [20, 55, 56].

The four outcome and impact focused frameworks assessed outcomes such as improvement within the field of enquiry, knowledge generation and accessibility, mutual and transformational learning that would help to inform the research process [52] or different types of impact (e.g., changes to knowledges, attitudes, behaviours, skills, policies and culture) and causal factors to generate learning [66] or marked the achievement using short-, medium- and long-term markers, for example, collaboration, development of models and methods and changes on health outcomes [53, 57].

### Usage in practice

#### *Application, generalisability, evaluation tools and guidance for use*

Twenty-four publications (77%) provided practical examples of the application of their evaluation frameworks [17, 20, 29, 30, 43, 44, 46–53, 55–57, 59–63, 65, 66], twenty-one (68%) were said to be generalisable to cross-disciplinary research [17, 20, 21, 29, 42–47, 50–52, 56, 58, 61–67] with three specifically for the evaluation of cross-disciplinary research proposals [17, 46, 48], and one included a component for evaluating cross-disciplinary research proposals [62]. Among the 10 (32%) which the authors said they were not generalisable, two were for landscape studies [59, 60], two for large cross-disciplinary research initiatives [54, 57], and one each was for international science policies [49], policy issues relating to sustainable development [30] and transdisciplinary research centres rather than geographically dispersed research teams [55].

Eighteen publications (55%) provided evaluation tools together with their evaluation frameworks [17, 20, 21, 29, 30, 42, 44, 45, 48, 49, 51, 52, 54, 56, 58, 65, 66]. Evaluation tools here include instruments such as surveys/questionnaires, interview guides, checklists or a list of questions used to materialise the evaluation of cross-disciplinary research. A few tables with descriptors [49], key insights [21] for evaluation criteria or through definition and rubric scale to specific evaluation criteria [44] or as prompts to each aspect of the evaluation framework [43] were also included as evaluation tools.

Fourteen publications (45%) included guidance on how to use the framework in practice [17, 20, 21, 30, 42–45, 48, 50–52, 58, 62]. Only seven publications (23%) provided evaluation tools along with guidance on how to use them and examples of their use in practice. In five of these publications, the authors claimed that the evaluation process was generalisable to all types of cross-disciplinary research (Table 3). Table 4 presents description

**Table 3** Evaluation tools, guidance for use, practical examples and generalisability of the frameworks

First author, year [reference]	Evaluation tools provided	Guidance for use provided	Practical examples provided	Generalisability
Antrop and Rogge, 2006 [59]			√	
Bammer, 2013 [43]	√	√	√	√
Belcher et al., 2016 [44]	√	√	√	√
Bergmann et al., 2005 [58]	√	√		√
Bruun et al., 2005 [48]	√	√	√	
Carr et al., 2018 [49]			√	
Defila and Di Giulio, 1999 [45]	√	√		√
Dugle et al., 2020 [42]	√	√		√
Edwards and Meagher, 2020 [66]	√		√	√
Enengel et al., 2012 [61]			√	√
Frescoln, 2015 [65]	√		√	√
Fuqua et al., 2004 [20]	√	√	√	√
Hall et al., 2008 [62]		√	√	√
Huutoniemi et al., 2010 [46]			√	√
Jahn and Keil, 2015 [30]	√	√	√	
Jahn et al., 2012 [50]		√	√	√
Klein, 2008 [21]	√	√		√
Mansilla et al., 2006 [32]			√	√
Mansilla and Gardner, 2003 [47]				√
Mascarenhas et al., 2021 [51]	√	√	√	√
Mässe et al., 2008 [54]	√			
Mitchell et al., 2015 [52]	√	√	√	√
Picard et al., 2011 [64]				√
Pohl et al., 2011 [68]	√	√	√	√
Späth, 2008 [29]	√		√	√
Stokols et al., 2003 [56]	√		√	√
Stokols et al., 2005 [55]			√	
Tress et al., 2003 [60]			√	
Trochim et al., 2008 [57]			√	
Walter et al., 2007 [53]			√	
Wooten et al., 2014 [63]			√	√

of each available published evaluation tool alongside its associated publication for reference if needed.

### Indicators

Some studies provided indicators as measurable variables, with [17, 30, 42, 44, 50, 52, 54] or without [21, 43, 49] concrete evaluation tools to measure the indicators. Some studies developed tools to measure specific issues related to cross-disciplinary research evaluation without specifying indicators [20, 45, 51, 58, 63, 65, 66]. Some neither described specific indicators nor developed tools for measurement but provided broad outlines of what issues such indicators should measure [48], for example, evaluating the institutional capacity for interdisciplinary

research and identifying the type of interdisciplinarity in research [48].

Identified indicators and evaluation questions clustered around context [42–45, 58]; problem formulation [30, 45, 58, 66]; common research goal [43, 44, 58]; justification of the cross-disciplinary approach (e.g. additional use for research results) [45, 48, 58] alignment of context; research problem and approaches [43–45, 58]; project team/expertise/competences [43–45, 48, 58, 65]; research feasibility [44, 45, 48]; leveraging of integration [21, 29, 30, 42, 43, 45, 48, 54, 58]; social capacity [44]/social learning processes (e.g. individual leaning, shared cross-disciplinary research practices, project/programme features that generate cross-disciplinary



**Table 4** Available published evaluation tools for cross-disciplinary research evaluation

First author, year [reference]	Description of available published evaluation tools
Bammer, 2013 [43]	Five questions plus prompts to stimulate systematic consideration of specific expertise in each of the three domains of the framework to identify expertise
Belcher et al., 2016 [44]	A table describing criteria, definition and rubric scale for the transdisciplinary research quality assessment framework
Bergmann et al., 2005 [58]	One set of evaluation questions to assess research against the basic criteria for the evaluation of transdisciplinary research projects, and one set of questions against detailed criteria
Bruun et al., 2005 [48]	A table providing writing criteria for applicants of cross-disciplinary research projects
Carr et al., 2018 [49]	A table presenting criteria developed for cross-disciplinary research evaluation and their descriptors, and a table illustrating data sets and measurable variables against each evaluation criterium by taking a doctoral programme as a case study
Defila and Di Giulio, 1999 [45]	Four tables with questions to evaluate research proposals for inter and transdisciplinary research, including ex ante overarching project, ex ante sub-project, ex post overarching project and ex post sub-project, respectively
Dugle et al., 2020 [42]	A table presenting criteria for evaluating cross-disciplinarity in health policy and systems research, including domains, appraisal criteria, specific indicators and illustrative evaluation questions
Edwards and Meagher, 2020 [66]	A table with evaluation questions for the research impact evaluation framework
Frescoln, 2015 [65]	Five tables, respectively, on individual survey items on transdisciplinary attitude, individual survey items on collaborative behaviours, individual survey items on satisfaction with collaboration, individual survey items on impact of collaboration and individual survey items on trust and respect
Fuqua et al., 2004 [20]	Seven tables, respectively, on initial principal investigator interview and principal investigators perspectives scale, TTURC research outcomes checklist, behaviour change index, emergent themes survey, TTURC semantic differential scale, TTURC staff and university administration interviews and TTURC meeting observation form
Jahn and Keil, 2015 [30]	Four tables, respectively, presenting general quality dimensions of transdisciplinary sustainability research, requirements profile (with evaluation questions) for program managers or donors, requirements profile (with evaluation questions) for researchers, and requirements profile (with evaluation questions) for policymakers
Klein, 2008 [21]	A table summarising seven evaluation principles for cross-disciplinary research evaluation and key insights on each evaluation principle
Mansilla et al., 2006 [32]	A table presenting interview protocol to apply the analytical framework of assessing the learning process in transdisciplinary research in practice
Mässe et al., 2008 [54]	Two tables, respectively, providing a list of collaboration items and a list of transdisciplinary integration items
Mitchell et al., 2015 [52]	A table summarising core attributes of transdisciplinary researchers with description on the significance of each core attribute with evaluation questions
Pohl et al., 2011 [68]	A table providing suggested questions for evaluating inter- and transdisciplinary research
Späth, 2008 [29]	A table providing guiding Methodological Questions for Sustainability Research
Stokols et al., 2003 [56]	A table with questions asked of representatives from three transdisciplinary research centres about their experiences in developing and evaluating transdisciplinary science collaboration

research practices/collaboration) [42, 48, 51, 64, 66]; reflection and communication/interaction [21, 42, 49, 58, 64]; project management [21, 45, 58, 66]; research quality/credibility [44, 45, 54, 65, 66]; social capital outcomes (e.g. ability to interact, interpersonal connectivity, cross-disciplinary collaboration) [20, 44, 49, 54, 65, 66]; validity (e.g. cross-disciplinary balance was maintained as planned); [61] knowledge, results, products and publications [20, 30, 44, 45, 49, 58]; generalizability and application of results [30, 44, 45, 51, 58]; novelty/innovation [20, 45, 58]; variety of criteria and indicators for cross-disciplinary research [21]; and future expectations [20].

The details of indicators as measurable variables especially on integration, quality and collaboration were highly variable from one publication to another. For example, one publication focused all its six writing criteria for applicants of cross-disciplinary projects

on different aspects of integration [48], another used 15 items/short description to assess cross-disciplinary integration through surveys [54], and the third one applied three open-ended questions to assess integration [17]. Another example is that nine general quality dimensions of cross-disciplinary research were presented with detailed questions on each dimension for evaluation in one publication [50], while another publication's evaluation tool used one to four yes/no questions to assess scientific quality of cross-disciplinary research at different stages of research [45].

Identified indicators were qualitative, quantitative or a mix of both across the publications, for example, articulation of the problem [42]; processes described for developing cross-disciplinary research questions [49]; the worldview or orientation of the research team [52]; and changes to plans, decisions, behaviours, practices, actions and policies [65, 66] to name a few as

qualitative indicators. An example of quantitative indicators is the number of thesis proposals stating cross-disciplinary research questions [49].

#### **Common underpinning criteria**

The criteria predominantly fell into four categories covering evidence of: (i) the shared problem or goal of the project that required a cross-disciplinary research approach [30, 42, 46, 47]; (ii) promotion of cross-disciplinary participation, interactions, integration, sharing and learning [21, 29, 42, 48, 58, 63]; (iii) meeting disciplinary standards [42, 47, 48]; and (iv) effective synthesis of findings, explanations and solutions to meet the project's outcomes and goals [42, 49, 56]. Several authors proposed that the criteria for evaluating cross-disciplinary research should be additional to, rather than replace, those that have already existed for assessing within-discipline quality [67].

#### **Discussion**

Our review identified 31 eligible frameworks and guidance concerning how to evaluate cross-disciplinary research. It brings together information from these which can be used by funders, researchers and evaluators including those in global health. We summarised the key characteristics of these frameworks and their use in practice and provide a comparative synthesis on their commonalities and underpinning evaluation criteria.

The methods used to develop the cross-disciplinary research evaluation frameworks and guidance were highly variable but generally based on mixed-methods, including interviews, surveys, seminars/conferences, stakeholder discussions, literature reviews and 'expert' panels [29, 57]. There was much inconsistency in the definitions of cross-disciplinary research among the publications. This illustrates a lack of cohesion about what cross-disciplinary research is and means that standards against which it has been evaluated are highly variable [45, 46, 48, 49, 69]. Ideally, any definition needs to be narrow enough to distinguish cross-disciplinary research from other types of research, yet broad enough to encompass the diversity within cross-disciplinary research [48].

Many evaluation frameworks focused on evaluating the problem the cross-disciplinary research was addressing. Those frameworks argued the importance of formulating cross-disciplinary research problems [17, 21, 44–47, 50, 51, 59–61]. Evaluating the problem, however, was challenging because problem definition and positioning are conceptualised in varied ways by different disciplines [36], which hampers effective collective action [70]. The publications with indicators on context, research problem, or common goal or research approaches for cross-disciplinary research evaluation [30, 42–45, 58, 66] could

serve as references both for cross-disciplinary research design and evaluation.

Our review showed the content and identified indicators of the evaluation frameworks were very diversified and many frameworks focussed on different processes. It also showed that it is characterised by a diversity of indicators for societal relevance and accountability [18, 71, 72]. In addition, cross-disciplinary research has more uncertainties in the research processes and outcomes than single-disciplinary research [18, 71, 72]. It would be meaningful to explore the alignment of context, purposes, players, processes, outcomes and impacts in future analysis to guide the choice of appropriate evaluation frameworks and indicators. Also, future research could contribute to the evaluation of cross-disciplinary research in global health by exploring whether cross-disciplinary research in global health has its own patterns or characteristics in terms of context, purpose, players, processes, outcomes and impacts, and to develop a pool of indicators for the evaluation of cross-disciplinary research in global health informed by published evaluation frameworks, indicators and tools across disciplines.

In our review, examples of frameworks that had been improved through iterative lesson-learning from real life use were scarce, so it is unclear how robust these frameworks are in practice and if they can be applied in different contexts and in global health field. Furthermore, the purpose and potential users of the evaluation tools and processes were not always stated. Although cross-disciplinary integration was a central theme among the publications, there did not seem to be any agreement on what integration means [27, 73, 74] and an acknowledgement that there is limited evidence to guide such integration [27, 68, 75]. The lack of clarity on these key aspects of the evaluations makes it difficult for potential users to choose an appropriate evaluation framework.

Our review highlighted the importance of the availability of evaluation tools associated with published evaluation frameworks such as surveys, interview guide and a list of questions. This include making the tools that have been developed available and developing tools associated with each evaluation framework. Associated evaluation tools would be data set used for the evaluation according to the frameworks and would make the application of relevant evaluation frameworks in practice possible.

Our review found that the criteria that are normally associated with individual disciplines cannot necessarily be applied to cross-disciplinary research [47, 48, 60] and that cross-disciplinary research should still meet disciplinary standards [42, 47, 48] if we are to avoid good cross-disciplinary research being rejected by those from certain disciplines.

**Table 5** Practical ways to improve the robustness of evaluations of cross-disciplinary research

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**State the *definition of cross-disciplinary research that you are using in your evaluation*** – this will help to make sure the evaluation is aligned with the definition (e.g. is it the simple juxtaposition of various disciplines? Does it involve a cognitive effort to achieve a common goal? If so, is it from a disciplinary specific base or crossing disciplinary boundaries? Does the definition focus on ‘integration’ of methods? Does it include contributions from outside academia?).

**Specify the *purpose of the evaluation*** (e.g. does it aim to evaluate the whole ‘context-process-outcome’, or does it only concern the outcomes or impact? Or does it aim to evaluate the cross-disciplinary research team?).

**Be clear about the *potential users of the cross-disciplinary research evaluation*** (e.g. is it for researchers designing a project? For funders selecting a grant application?).

**Describe the *provenance of the evaluation framework*** (e.g. has it been adapted from a previously published framework used in a similar context? Is it based on a literature review? Is it informed by primary data?).

**Specify the *focus of the evaluation*** (e.g. does it focus on integration, collaboration or quality of the cross-disciplinary research?).

**Provide enough *detail about the evaluation tools and processes to enable others to replicate or adapt the evaluation for their own purposes*** (e.g. are the evaluation tools comprehensive and accessible? Is there guidance about how to do the evaluation in practice? Is there any application example?).

**Be clear about the *standards and indicators that are being used for the evaluation and how they align to the definition and purpose of the cross-disciplinary research*** (e.g. are they based on standards associated with the relevant single disciplines? Have additional indicators been used that are specific for cross-disciplinary research?).

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Although our review revealed that diverse approaches, epistemologies and methodologies are inherent to cross-disciplinary research, it also highlighted several areas where we could do better in developing a more robust approach to its evaluation. Table 5 summarises our recommendation on practical ways to improve the robustness of evaluations of cross-disciplinary research.

It is important to consider the trade-offs involved in evaluations—while in-depth, robust checklists or questionnaires combined with good qualitative methods may produce the best quality evaluations of cross-disciplinary research, their length and expense may discourage their use [17, 58]. A pragmatic way to achieve a workable balance between robustness and practicality may be to use the in-depth tools/measures such as the five questions plus prompts proposed by one publication [43] or a set of evaluation questions against basic criteria suggested by another publication [58] to inform ‘more reflexive and explicitly negotiated’ indicators and targets [29].

Our study has several limitations and strengths. Some of the data we extracted were subjective and therefore open to different interpretations. Several publications did not provide sufficient details or access to evaluation tools used for the cross-disciplinary research evaluations to enable us to extract information that was relevant for our objectives. We may have missed some publications that were not written in English and most publications were from high-income countries. Nevertheless, the breadth and diversity of evidence we synthesised from many different settings gives confidence that our general findings are widely applicable to different contexts, disciplines and research topics, including in global health. We also improved the robustness of the analyses by using two independent researchers and a third opinion to resolve discrepant results.

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## Conclusions

Our review has highlighted the heterogeneity of frameworks used for evaluating cross-disciplinary research in multiple contexts and disciplines. We have provided details of the characteristics, purpose and intended users and content of the frameworks along with details of the tools and processes used for the evaluations. This will enable funders, researchers and evaluators to make better, evidence-informed choices from among the different approaches when they commission, design, or evaluate cross-disciplinary research programmes, including in global health field. The evidence in the publications was too diverse for us to be able to generate a benchmark, or a single approach or a common toolkit, for evaluating cross-disciplinary research efforts. However, we have been able to identify key practical lessons from the literature that can help to improve the quality of such evaluations in the future.

**Abbreviations**

PRISMA-ScR	Preferred Items For Systematic Reviews and Meta-Analysis extension for Scoping Reviews
CINAHL	Cumulated Index in Nursing and Allied Health Literature
MEDLINE	Medical Literature Analysis and Retrieval System Online
HIC	High-income country
LMIC	Low- and middle-income country (LMIC)

**Supplementary Information**

The online version contains supplementary material available at <https://doi.org/10.1186/s44263-024-00113-x>.

Additional file 1. This file has five tables. Table S1 PRISMA-ScR checklist, Table S2 Data coding template, Table S3 Definitions, Table S4 Methods for the development of the evaluation frameworks and Table S5 Content of the evaluation frameworks.

Additional file 2. This file provides terms used to search literatures for this review.

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**Authors' contributions**

YD: Conceptualization, Methodology, Data Curation, Writing - Original draft preparation, Reviewing and Editing, Supervision. JH: Data Curation, Writing - Reviewing and Editing. IB: Conceptualization, Methodology, Writing - Original draft preparation, Supervision. All authors read and approved the final manuscript.

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**Data availability**

Data is provided within the manuscript or supplementary information files.

**Declarations****Ethics approval and consent to participate**

Not applicable.

**Consent for publication**

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**Competing interests**

The authors declare no competing interests.

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