SYSTEMATIC REVIEW

A scoping review of horizon scanning approaches used to identify emerging research methods

[version 1; peer review: 1 approved, 1 approved with reservations]

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Abstract

Background

Horizon scanning is an exploratory research method used to identify, select, and analyse information to detect signals and trends related to new and emerging innovations using pre-defined and explicit methods. It has the potential to play a role in anticipating methodological research trends and innovations, helping to deliver therapies to patients faster. However, the extent to which horizon scanning has been applied to identify emerging research methods is unclear.

Objectives

This scoping review explores if and how horizon scanning has been used to identify research methods in any field, setting or location.

Methods

Eligibility was based on the Population, Concept and Context framework: Any information source that used horizon scanning to identify research methods was eligible for inclusion. Two reviewers independently screened titles/abstracts and then full texts. Following a pilot phase, one reviewer extracted data, and three others performed data accuracy checks.

Results

Five studies published between 2017 and 2024 met the eligibility

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Any reports and responses or comments on the article can be found at the end of the article.

criteria, and a further 13 partially met the eligibility criteria and are summarised separately. The five fully included studies belonged to the environmental, ecological, and earth science disciplines. Using the horizon scanning system defined by the EuroScan network, the most reported was signal detection. A literature review was the most common method used to identify signals, other approaches included a combination of literature reviews with interviews and expert opinion. A range of methods were identified as priority areas for the future, including digitisation, computational techniques, genomics and statistical methods. There was heterogeneity in horizon scanning approaches and reporting.

Conclusions

This scoping review found limited systematic research using horizon scanning to identify research methods, which hinders preparation for evaluation and implementation. This highlights the need for further research to establish optimal horizon scanning approaches to identify research methods in health and social care.

Plain English Summary

Horizon scanning is a way of looking ahead to identify new ideas and trends. It helps researchers find out what might be coming next. In our case, we are interested in identifying new research methods, i.e., new ways of doing things. However, we don't know if other groups in health and social care and across different fields, like environmental sciences and military defence, have used horizon scanning to find new research methods.

Has horizon scanning been used to spot new research methods, and if so, how was it done?

We used a defined research method called a scoping review to answer our research question. Scoping reviews search for and examine a wide range of information to get a better understanding of a specific topic.

We found five studies published between 2017 and 2024 that used horizon scanning to find research methods. We also found 13 others that partly met our research question. The five main studies explored research methods in environmental and earth sciences. The way horizon scanning was done varied a lot between studies.

Not many studies have used horizon scanning to look for new research methods. Further work to optimise approaches could help prepare for future methods and facilitate timely implementation in health and social care.

Keywords

Horizon scanning, Research methods, Innovation, Emerging methods

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Introduction

Horizon scanning is an exploratory research method that identifies, selects, and analyses information to detect signals or trends related to emerging innovations (e.g., research methods) using predefined methods. This early intelligence provides foreknowledge about potential changes, facilitating proactive and well-informed decision-making and thereby increasing the likelihood of effective management of innovations that have the potential to disrupt current practices. Horizon scanning is a long-standing and important method predominantly used within and across public policy organisations to identify future areas of priority so resources can be appropriately allocated and policy decisions can be made with a longer-term focus[1]. For example, in health and social care, health technology assessment agencies worldwide use horizon scanning to identify medicines and medical devices that are in the clinical development pipeline and are likely to enter the healthcare market at some point in the future. This gives decision-makers time to plan for the timely evaluation of promising technologies most needed to address population health needs, ultimately accelerating their availability to patients[2]. Additionally, horizon scanning is used to answer a wide range of research questions, from identifying unmet needs to mapping research and funding landscapes[3].

Research methods have previously been defined as the systematic tools to identify, collect, analyse and interpret information[4]. Innovation and timely implementation of research methods that increase efficiency and effectiveness are essential to address the evolving health needs of the population, especially in the context of rapidly changing environments and complex health systems. Recent examples of methodological advancements to answer health-related priority research questions include the developments in and use of rapid evidence synthesis (RES), platform trials during the COVID-19 global pandemic, and the use of basket trials in rare diseases[5–8]. To ensure rigour, the broader methodological advancements mentioned above require developments in the component methods which underpin its use. To use RES as an example, the development of component methods includes the truncation or adaption of systematic review searching, screening, data extraction etc. These methodological advancements were necessary to accelerate patient access to safe and effective technologies by improving efficiency whilst maintaining scientific rigour. Increasing innovation in clinical research is a priority policy area in many countries; for example, in the UK, several national policy documents have set out strategic plans to make the United Kingdom a global leader. Notably, the UK Innovation Strategy, The Life Sciences Vision, and the NHS Long Term Plan highlight a commitment to accelerating innovative clinical research to treat or prevent ill-health and premature death[9–11].

Horizon scanning has the potential to play a vital role in generating early awareness of methodological research trends and innovations. It is well known that evidence-based interventions do not necessarily translate immediately into widescale implementation or adoption, and although the published literature on the implementation and adoption of research methods is less clear, we can expect similar challenges to apply[12]. Barriers to the dispersion and uptake may include limited awareness, funding, technical expertise, and perceived uncertainty about the method's validity in the absence of robust evaluation or unexplored ethical concerns. Having early awareness of upcoming research methods and disseminating this information to key stakeholders provides an opportunity to highlight and mitigate these barriers early on, helping to identify any unaddressed gaps, shape training, build capacity, and, where appropriate, encourage timely implementation. However, despite horizon scanning being used successfully in related areas, the extent to which horizon scanning has been applied to identify research methods in health and social care research and other research fields are unclear.

To address this gap, this scoping review explores if and how horizon scanning approaches are used to identify research methods across any field, setting or location.

Methods

The research question is exploratory and aimed to identify the breadth of existing research on a particular concept. As confirmed by the Right Review tool, a scoping review is the appropriate evidence synthesis for this work[13]. The scoping review was planned and conducted according to the JBI methodology for scoping reviews[14]. The protocol was registered on the Open Sciences Framework on August 01, 2024 (https://osf)[15]. The protocol and all appendices referred to throughout this article can be found on OSFHOME repository using the following DOI 10.17605/OSF.IO/4XQV6.

Patient and Public Involvement

Patients and the public were not involved during this project, but the findings from this piece of work will be used to inform future involvement and engagement days to shape the next stages.

Eligibility criteria

Appendix 1 provides full details of the eligibility criteria. In summary, the research question was formulated using the Population, Concept, and Context (PCC) framework, and any information source that used horizon scanning to identify research methods or methodologies was eligible for inclusion. There were no restrictions on the type of research field, place or setting where the research was conducted, or the research sponsor[14].

Types of evidence to be included

Peer-reviewed published articles, conference abstracts, and reports from grey literature were eligible for inclusion. Editorials, letters, comments, notes, erratum, economic evaluations, cost and resource use studies and trial protocols were excluded.

Search strategy

A pragmatic search strategy was developed by an experienced information specialist (CE) using concepts for 'horizon scan' and 'method'. The search strategy was developed in Embase (OVID) and peer-reviewed by a second information specialist (SGGM) prior to being translated to Scopus and

ProQuest (Social Science Premium Collection). Search results were combined and deduplicated using EndNote (version 20.2 *Clarivate Analytics, PA, USA)*. No limitations or restrictions were placed on the searches. The searches were conducted on the 6 June 2024, and the full search strategies can be found in Appendix 2.

Screening process

Two reviewers (NO'C or CE or JL) independently reviewed the title, abstracts, and then full-text articles for each record. Disagreements were resolved through discussion and consultation with a third reviewer, with a fourth reviewer (GN) consulted if needed. Reasons for exclusion at the full-text stage are in Appendix 3, and the search results and inclusion process are presented in Figure 1.

Data extraction

Following a pilot phase with two articles (NO'C, CE), one reviewer (NO'C) extracted data from the remaining articles. This data was comprehensively checked by one review team member (CE), with further accuracy checks by two other reviewers (GN and JL). Disagreements were resolved through discussion. In the interest of time, authors were not contacted for additional information.

The data extraction file can be viewed here https://osf.io/ (DOI 10.17605/OSF.IO/4XQV6). Appendix 4 (V1.1, 30.08.2024) provides a complete list of extracted data items. In brief, data was extracted across four categories: study characteristics, horizon scanning, methods and reporting. The EuroScan International Network's early awareness and alert system (also called horizon scanning systems) is an internationally agreed framework used in this study to categorise horizon scanning approaches[16]. There is variation in how the framework is described and applied, for the purposes of this study, we have considered all stages of the framework as the horizon scanning system. A brief description of this system, including its stages and processes for detecting healthcare technologies, is described in Table 1.

Critical appraisal

In line with methodological standards for scoping reviews, critical appraisal of the individual studies was not undertaken[14].

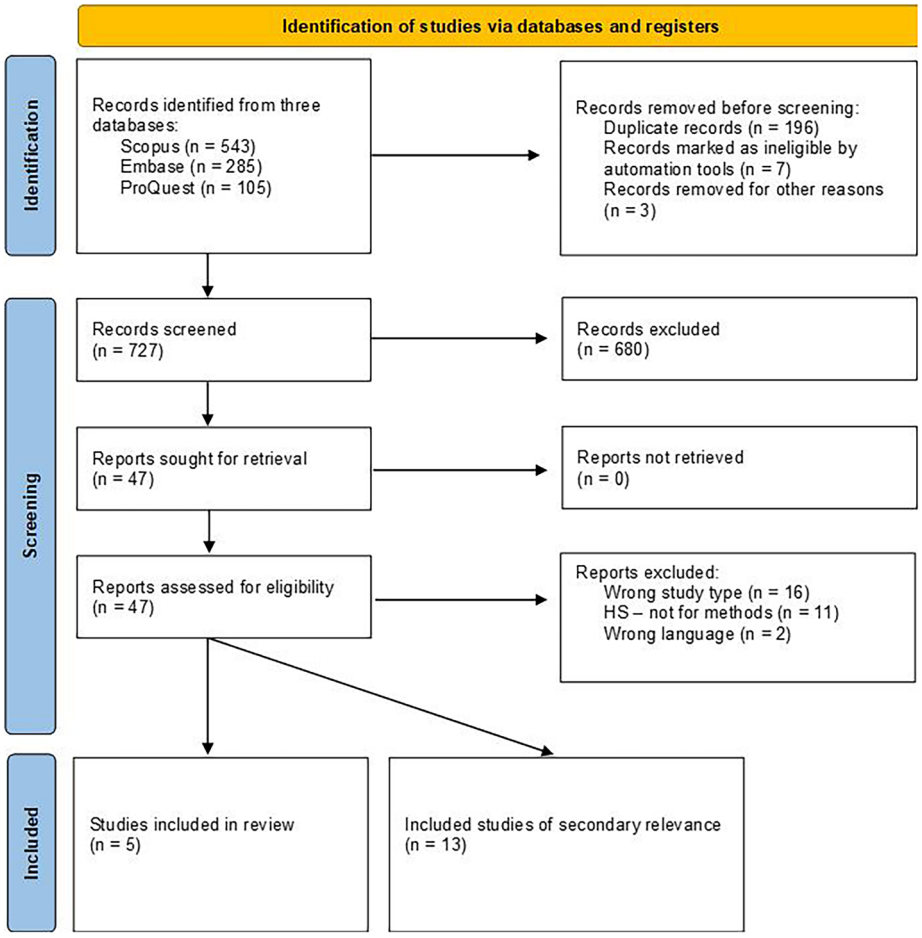

Figure 1. A PRISMA flowchart was created using the Shiny app. It details the number of studies identified, screened, and included in this scoping review[17].

Table 1. Horizon scanning stages described in the early awareness and alert system developed by the EuroScan network and later adopted by Hines *et al.*[18].

Stage	Identification	Filtration	Prioritisation	Assessment	Dissemination	Updating	Evaluation of process
Brief description	Proactive or reactive identification of technologies using specific search sources	Technologies are assessed using pre-determined eligibility criteria (i.e., time horizon, impact on the health system)	Eligible technologies are prioritised (e.g., burden, impact, diffusion, launch date, scoring tools, statistical methods (Best Worst Scaling))	Prediction of potential for impact (e.g., rapid, brief, or in-depth review, including information such as basic characteristics, evidence base, ongoing research, predictions of impact to health services (e.g., health, diffusion, costs, infrastructure, economic, ethical, legal, political and cultural impact, uncertainties))	Dissemination strategy so the correct target audience is aware of this early information.	Decision about whether the reports are going to be continuously updated as new evidence becomes available.	Process evaluation of the early alert system and process (e.g., to optimise resources, improve searching, screening, data extraction and reporting.)

Data analysis and presentation

Results are presented alongside a narrative summary. Reporting for this manuscript adheres to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis extension for Scoping Reviews (PRISMA-ScR) Checklist available in Appendix 5 on the Open Science Framework repository (https://doi.org/10.17605/OSF.IO/4XQV6)[15,19]. Deviations from the protocol are documented in Appendix 6.

Results

Selection

After duplicates were removed, 727 citations were identified. At the title and abstract stage, 680 records were excluded, with 47 full-text articles retrieved and assessed for eligibility. Of these, 29 were excluded for the following reasons: 16 did not present primary horizon scanning research; 11 used horizon scanning but not to identify research methods; and two were excluded because they were not written in English. A full list of excluded articles is available in Appendix 3 and Figure 1 shows the flow of records through the identification and eligibility assessment stages.

Characteristics of included evidence

Five studies fully met the eligibility criteria to be included in this review[20–24]. Thirteen additional studies partially met the eligibility criteria and have been categorised as included studies of secondary relevance because they aimed to identify emerging issues, opportunities, knowledge gaps, or challenges that are likely to be important in the future; while these studies did not use horizon scanning to identify research methods, all reported research methods as a finding[25–37]. This was considered an important secondary finding relevant to the aims of this scoping review, and these studies are discussed further under 'secondary findings'. Although consensus was reached on the full inclusion of the five studies and inclusion of the thirteen studies of secondary relevance, this was only achieved after extensive discussion and consultation between the review team. The difficulty in applying inclusion and exclusion criteria was primarily attributable to the limited reporting in identified studies and the scientific fields represented by the studies.

The five included studies were all peer reviewed studies that were published between 2017–2024, they all belonged to the environmental, ecological, and earth science disciplines. Two authors specified the remit of their research; one was relevant globally, and the other had a European focus. All authors reported funding information, details of this and other characteristics of the included studies are described below in Table 2.

1. Horizon scanning approaches used to identify methods

Horizon scanning was broadly conceptualised in the included studies as a methodology to gather emerging insights to address future challenges, see Table 3 for individual descriptions.

Table 4 presents the horizon scanning methods that were used to identify needed or emerging research methods in each of the included studies.

When mapped against the horizon scanning system, the most well-reported stage of horizon scanning was signal detection, which was reported in all studies. A literature review was the most common method (n=4) used to identify signals[20,21,23,24]. Two studies used a combination of approaches, such as expert consultation alongside online surveys, or interviews with experts together with a literature review[22,23]. The criteria and methods used for assessing eligibility of information (filtration) were not clearly reported in any study. Two authors reported prioritisation criteria; the methods used to prioritise the identified

Table 2. Characteristics of included studies (n=5).

First author (publication year)[citation(s)]	Title	Article Type	Place of research focus (e.g., city, country, continent)	Aims	Funder(s)
Abdelhady (2024)[20]	New and emerging technologies in paleontology and paleobiology: A horizon scanning review	Peer-reviewed article (primary research)	Not reported	To critically assess the state-of-the-art physical, chemical, and biological technologies used in paleontological research. In addition, the authors conducted horizon scanning to identify the current status and a way forward to provide a road map for their future use.	King Saud University
Novak (2020)[23,38]	Transforming Ocean Conservation: Applying the Genetic Rescue Toolkit	Peer-reviewed article (primary research) and website	Not reported	To highlight opportunities to bring genomic insight and biotechnology innovations to complement current and future marine conservation.	National Philanthropic Trust
Musche (2019)[22]	Research questions to facilitate the future development of European long-term ecosystem research infrastructures: A horizon scanning exercise	Peer-reviewed article (primary research)	Europe	To capture, classify and prioritise research questions that need to be considered for the future development of long-term ecosystem and socio-ecological research infrastructures, with a focus on research questions that are currently emerging, or address knowledge gaps.	European Union's Horizon 2020 research and innovation program European Regional Development Fund Czech Science Foundation and The Czech Academy of Sciences
Tomsett (2019)[24]	Remote sensing of river corridors: A review of current trends and future directions	Peer-reviewed article (literature review)	Not reported	To highlight the current and future methods that are employed to aid our understanding of the river corridor	Engineering and Physical Sciences Research Council Natural Environment Research Council
Hofmann (2017)[21]	Ecological Epigenetics in Marine Metazoans	Peer-reviewed article (literature review)	Global	To review key studies in ecological epigenetics and epigenomics, specifically in marine metazoans focusing on studies examining changes in DNA methylation.	U.S. National Science Foundation UC Climate Champion award from the University of California

Table 3. Summary of the descriptions of horizon scanning used by authors of the included studies.

Name of first author	Description of horizon scanning
Abdelhady	"A systematic horizon scanning analysis and literature review was done to identify current and potential future research directions in paleontology and paleobiology." (Abdelhady, 2024, p.8)[20]
Hoffman	"In this horizon scan article, I review the emerging area of ecological epigenetics in marine animals with studies of DNA methylation as the primary focus." (Hoffman, 2017, p.1)[21]
Musche	"Horizon scanning methods represent a common tool to detect emerging issues by consulting a large group of Individuals." (Musche, 2019, p.3)[22]
Novak	"The Horizon Scan identifies promising genomics applications for addressing marine conservation challenges, current technologies and leaders in the field, and gaps in our knowledge. (Novak, 2020, p.28)[38]
Tomsett	"We also seek to highlight studies that combine multiple remote sensing techniques, such that they are developing new insight into river corridors before "horizon scanning" to try and suggest a future agenda for the remote sensing of river corridors. Finally, we outline the key challenges that will need to be addressed in order for the techniques and methods identified to progress to a point where they can be broadly applied" (Tomsett, 2019, p.2)[24]

Table 4. Horizon scanning approaches used in the included articles categorized against the horizon scanning system developed by the EuroScan network and later adopted by Hines *et al.*[18].

Horizon scanning							
Author (date)[citation]	**Detection**	**Filtration**	**Prioritisation**	**Assessment**	**Dissemination**	**Updating**	**Evaluation of process**
Abdelhady (2024)[20]	**Time Horizon:** NR **Eligibility Criteria:** NR **Method(s):** Systematic literature review Restrictions: Field: Earth Science; Date: 2000–2022. Database: Scopus. Journals: Paleontology.	NR	Bibliometric analysis: Topics were ranked based on keyword frequency over time to highlight historical trends using AntConc v4.2. Four groups of emerging techniques were assessed but the methods to determine are unclear	Narrative /opinion piece	Not formally reported/ publication	NR	NR
Novak (2020)[23,38]	**Time Horizon:** NR **Eligibility Criteria:** NR **Method(s):** Interviews with multi-disciplinary experts (n100 from 60 institutions) and a Literature review (>250 articles).	NR	NR	Narrative/ opinion piece Qualitative framework to display technological maturity and socio-political/ economic factors which influence readiness, deployment and acceptability of applications.	Not formally reported/ website/ publication	NR	NR
Musche (2019)[22]	**Time Horizon:** NR **Eligibility Criteria:** NR **Method(s):** Multi-disciplinary expert consultation (n=6) was conducted with a random sample (n=28) to generate initial questions. Following this, online surveys were distributed using snowball sampling to the core groups personal networks in order to collect emerging research questions.	Methods and criteria are unclearly reported; however, questions were consolidated, de-duplicated, and eliminated by the leading team (n4).	Questions grouped into four themes and ranked by the core team for relevance to future research infrastructure. The top four questions from each theme (16 total) were selected for discussion and refined through re-formulation, merging, reinstating, or scope adjustment. Final mean scores were calculated and alternative questions presented, the five highest-ranking questions per theme formed a list of 20 priority research questions.	Narrative and visual/opinion piece A conceptual visualisation to demonstrate the increasing complexity of research infrastructure, themes and ecosystems alongside policy relevance.	Not formally reported/ publication	NR	NR

Horizon scanning							
Author (date)[citation]	**Detection**	**Filtration**	**Prioritisation**	**Assessment**	**Dissemination**	**Updating**	**Evaluation of process**
Tomsett (2019)[24]	**Time Horizon:** Near future **Eligibility Criteria:** NR **Method(s):** Literature review	NR	NR	Narrative/ opinion piece	Not formally reported/ publication	NR	NR
Hofmann (2017)[21]	**Time Horizon:** NR **Eligibility Criteria:** NR **Method(s):** Literature review	NR	NR	Narrative/ opinion piece	Not formally reported/ publication	NR	NR

Abbreviations: NR, not reported.

signals included expert engagement for consensus-deriving ranking and quantitative ranking techniques using bibliometric analysis. Assessment methods included author opinion, which was reported narratively, and qualitative frameworks to indicate wider determinants of readiness such as socio-political and economic factors. No studies conducted formal assessments of the prioritised innovations to ascertain the potential for impact, for example to examine the existing and ongoing evidence base and related areas of uncertainty, costs, ethical, political, legal or cultural impact (such formal methods may include rapid evidence synthesis, driver analysis, scenario planning or modified-Delphi study[18]). Although a dissemination plan was not explicitly reported by any of the studies, the publications themselves are a form of dissemination and are classified under this category. Additionally, none of the studies or related materials document any intention to update or evaluate the horizon scanning process or findings. There was no reported public involvement in the planning or conduct of these studies. Overall, there was heterogeneity in the reporting of horizon scanning methodology used and its presentation across the studies.

2. Methods identified

All five studies reported using horizon scanning to identify research methods within the environmental, ecological, and earth science disciplines. Table 5 provides a summary of the methods identified across different fields.

Identified methods or techniques included digitisation, computational techniques, genomics, next-generation sequencing, statistical methods to facilitate dataset comparability and the harmonisation of measurements and methods across sites.

3. Reporting

Only two studies cited references to support their horizon scanning method, and none referenced the use of any reporting guidance. Abdelhady cited guidance on conducting bibliographic analysis[20,39], while Musche referenced previously published work to justify the use of a modified Delphi method and the omission of a workshop[22,40–42].

In addition to narrative reporting, a range of visualisations (n=19) were presented across the five included studies (see Box 1 for a description of visualisation types and examples). Two studies used visualisations in their assessment stages as conceptual tools to illustrate awareness of technologies or methods in relation to broader considerations, such as sociopolitical and economic acceptability[22,23].

Box 1. Types of visualisations included in the five studies.

- Pie charts (n=6) (e.g., temporal change in use of techniques relevant to paleontology)[20,23].
- Doughnut chart (n=1)[20].
- Line graph (n=4) (e.g., Publication trends (method field) over time)[20,24].
- Geospatial analysis map with insets (n=1)[24].
- Global thematic map with insets (place) and time series chart (n=1)[23].
- Conceptual framework to categorise research infrastructure, themes, ecosystem and disciplinarity requirements against complexity and policy relevance (n=1)[22].
- Qualitative framework (n1) (e.g., technological readiness according to acceptability)[23].
- Sunburst chart (n1)[20].
- Dual axis bar chart (n1) (e.g., frequencies of publications and occurrences in the Paleobiology Database (PBDB) according to taxonomic groups)[20].
- Horizontal bar chart (n1) (e.g., frequencies of topics in research filed over five years)[20].
- Composite comparative chart - spatial resolution chart alongside a bar chart (n1)[24].

Table 5. Research methods identified during horizon scanning.

Author	Research field	Research focus	Method(s) identified
Abdelhady[20]	Earth sciences/ Geology	Paleontology and paleobiology	1. Digitisation (e.g., Laser and computed tomography scan) 2. Molecular analysis (e.g., Paleogenomics/DNA and biomarkers for diagnostics) 3. Computational/statistical techniques (e.g., Quantitative biostratigraphy, modelling and machine learning) 4. Sclerochronology
Hofmann[21]	Ecology	Ecological epigenetics and epigenomics in marine metazoans	1. Methylation-sensitive amplification polymorphism method 2. Kit based quantitative tools (e.g.,ELIZA) 3. Genomic sequencing (e.g., bisulfite sequencing to profile genomic-scale methylation patterns)
Musche[22]	Biology/Ecology	Ecosystems	1. Detection of critical thresholds in ecosystem response (e.g., analysis of long-term data to improve false positives, using simultaneous data sets from multiple sources) 2. Comparability of heterogeneous datasets through development of statistical tools, harmonization of methodologies across research sites, and, joint analysis of big data coming from citizen science. 3. Reduce uncertainties in global and regional climate change projections provided by earth system models through harmonisation of field methods and measurement standards to enable use of data and modelling opportunities from different networks (e.g., Improve parameterization of processes for climate simulations). 4. Emerging technological developments with greatest potential and consideration of scaling issues when transferring local data to decision making. Open software solutions to facilitate sampling, management and analysis of data with a focus on standard configurations. 5. Molecular high-throughput technologies to analyse link between genetic and functional diversity with ecosystem processes and infrastructure development which relies on existing initiatives.
Novak[23]	Conservation biology	Ocean conservation	1. Genetic insight guided captive breeding 2. Genetic diversity augmentation via genomic guided translocation/ reintroduction 3. Genetic diversity augmentation via genomic-guided advanced reproductive technologies 4. Facilitated adaption via genetic guided translocation/reintroduction. 5. eDNA for monitoring invasive species 6. Synthetic alternatives 7. Cellular alternatives 8. *ex situ* bioremediation 9. Engineered/edited whole organism alternatives 10. *In situ* bioremediation 11. Genomic biocontrols for invasive/irruptive species 12. De-extinction via precise hybridization (gene editing)
Tomsett[24]	Geography and environmental science	Remote sensing methods	1. Unmanned aerial vehicles. 2. Autonomous underwater vehicles 3. Unmanned surface vehicle 4. Real time monitoring using internet of things 5. Satellite remote sensing

4. Secondary finding

The thirteen studies that partially met the eligibility criteria are summarised below and in Table 6. They used horizon scanning approaches to explore broad aspects of future importance, such as issues or opportunities, and then discussed research methods as a finding. A full list of references is available in Appendix 7[25–37].

Six of the studies were interested in emerging issues related to health and social care, specifically in relation to genomics,

Table 6. A summary of the thirteen studies that partially met the eligibility criteria describing briefly their characteristics, horizon scanning approaches and research methods identified.

Author (date of publication)[citation] Article type	Title	Horizon scanning approach	Methods identified
Health and social care related studies (n=6)			
Otsuka (2023)[29] Full text	Horizon Scanning in Tissue Engineering Using Citation Network Analysis	Citation network analysis	3D bio-printing for use in tissue engineering
Bockhold (2022)[25] Abstract	Future technologies and projected innovations for medical radiation applications and radiation protection: the euramed rocc-n-roll horizon scanning survey	Cross-sectional online survey following a Delphi study	Artificial intelligence solutions Dose reduction technology and techniques Cardiovascular and neurological applications of diagnostic and interventional medical imaging
Provencher (2020)[33] Full text	A Horizon Scan of research priorities to inform policies aimed at reducing the harm of plastic pollution to biota	Survey	Methods to implement standardized sampling and reporting of ingested plastics. Methods for non-lethal sampling to assess plastic ingestion
Giuffre (2020)[28] Abstract	FRESHER and RARE 2030: scanning the horizon emerging trends in health and healthcare	Four step foresight methodology: horizon scanning, trends identification and ranking, scenarios building, backcasting and policy elaboration using participatory approaches	Big data Artificial Intelligence applications
Fennessy (2019)[26] Abstract	Genomics: From Horizon Scanning To National Health Policy	Adapted horizon scanning followed by extensive stakeholder consultation	Infrastructure Data
Parker (2014)[30] Full text	Identifying the Science and Technology Dimensions of Emerging Public Policy Issues through Horizon Scanning	modified-Delphi and a workshop	Developing capabilities in interdisciplinary whole systems energy science, including new methods, approaches and analytical tools Integrated land-use planning: Developing and testing methods to support resource allocation conflict resolution Meeting long-term skills requirements: Improving methods for anticipating demand Public sector capacity to be an intelligent customer of scientific advice: Developing methods for assessing the value and validity of, and for valorising, non-scientific evidence in policy making Antimicrobial resistance and infectious diseases: Identifying methods to incentivise the development of novel therapies
Non health and social care related studies (n=7)			
Tew (2024)[36] Full text	A horizon scan of issues affecting UK forest management within 50 years	Modified Delphi	Efficient and effective methods of storing roundwood

Author (date of publication)[citation] Article type	Title	Horizon scanning approach	Methods identified
Robison (2023)[35] Full text	Shifts in the smart research agenda? 100 priority questions to accelerate sustainable energy futures	Delphi method	Participatory methods to engage diverse and marginalized groups (e.g., co-design, speculative design)
Pustkowiak (2021)[34] Full text	Small things are important: the value of singular point elements for birds in agricultural landscapes	Literature review followed by assessment of results by survey	Singular point elements as a tool to increase bird diversity
Trofimova (2020)[37] Full text	Fundamental questions and applications of sclerochronology: Community-defined research priorities	Workshop (initial list and ranking) followed by Survey	Methods to assess the leads, lags, and synchronicities in sclerochronological records across large spatial regions.
Bharucha (2020)[32] Full text	The Top 100 questions for the sustainable intensification of agriculture in India's rainfed drylands	Modified Delphi	Monitoring of soil moisture and crop water demand combined with more efficient irrigation methods and increased wastewater reuse
Fitak (2019)[27] Full text	The Expectations and Challenges of Wildlife Disease Research in the Era of Genomics: Forecasting with a Horizon Scan-like Exercise	Workshop	Methodological and analytical advancements in sequencing, sample processing, best practices and accessibility
Patino (2017)[31] Full text	A roadmap for island biology: 50 fundamental questions after 50 years of The Theory of Island Biogeography	Survey (Following expert opinion to generate initial list of priority questions)	Methods for responding to the anthropogenic extinction crisis on island Methods to identify islands most susceptible to biodiversity loss in the next decade Efficient and cost-effective methods (i.e. policy; education; research; management) for safeguarding biodiversity in island biology.

rare diseases, ionizing radiation, and health policy, one of these studies explored plastic pollution and had a transdisciplinary remit that included health[25,26,28–30,33]. The remaining seven studies contained research relevant to environmental and ecological sciences.

To summarise the horizon scanning approaches used, seven of the thirteen studies used a combination of approaches. The reported approaches, either in isolation or combination, include: one case study on the utility of citation network analysis, five used the Delphi method or a modified version, five used surveys, and three reported workshops. One article described a four-step foresight approach with horizon scanning as the identification stage, although reporting was limited due to it being an abstract. The horizon scanning approach in a second abstract is also unclear, but it appeared to involve expert consultation.

To highlight some of the methods identified as an area of focus in health and social care, Provencher *et al.*, used survey-based horizon scanning to prioritise research questions for plastic pollution policies, ultimately highlighting the need for standardised sampling and reporting methods[33]. Similarly, Giuffre *et al.*, used foresight methodology to identify emerging trends in rare diseases to guide future policy development, they identified trends in 1) citizen empowerment 2) leveraging big data and artificial intelligence to improve data standardisation and interoperability, automated data extraction techniques, and the creation of disease registries using existing clinical data[28,43]. Other research methods and tools identified as a need include artificial intelligence (AI) solutions for medical radiation applications and the requirement for further work to effectively implement genomics into health and social care via national policies[25,26].

Examples of emerging areas where focus should be given includes improving methods for predicting skills demand, improving scientific literacy, and developing tools to assess national metrics such as population health[30]. Additionally, emerging areas include diversifying policy evaluation methodologies and incorporating public opinion into early policy development by using crowdsourcing and social media. Methods for assessing the value of non-scientific evidence in policy-making were also identified as well as a need for methods to determine when public engagement is appropriate, how best to monitor social intelligence and identify emerging diseases[30].

Discussion

Summary of evidence

In this scoping review, five studies were identified that reported using horizon scanning to identify research methods. While the search did not have date limits applied and was broad enough to identify literature from multiple disciplines, all the studies included belonged to the environmental, ecological, and earth science disciplines and were published relatively recently between 2017 and 2024. Horizon scan methodology used research approaches, such as literature reviews, interviews, and surveys, highlighting 29 research methods that are likely important for the future advancement of research in those areas.

It has been previously reported that there is variation in the aims of horizon scanning, the methods used to conduct it, and the terminology used to describe it. This variation likely reflects the wide-ranging disciplines that rely on its use to generate early intelligence to answer different policy and research questions, together with a lack of agreed standardised methodology for the planning, conducting and reporting of horizon scanning. As described in the methods section, the stages outlined in the historical 2014 EuroScan horizon scanning system were used as a framework to map the horizon-scanning findings. As far as can be determined, it is the only internationally agreed framework that describes the stages of horizon scanning, and using it helped to categorise and present the results. However, there are major drawbacks to taking this approach, it was originally developed for a specific use in the healthcare and biomedical fields as an early awareness system to support the health technology assessment of medicines, and this may have limited its applicability to other disciplines and where the use of horizon scanning is for different aims and purposes. Additionally, none of the authors appear to have followed pre-defined, systematic methods nor reported them explicitly. Considering this, best judgment and consensus were used to categorise the identified horizon scanning methods.

Within the findings, variability in the definitions and aims of horizon scanning was noted. While the EuroScan early awareness and alert system is referred to as a horizon scanning system by both EuroScan and Hines *et al*., they also highlight one stage of the process (i.e., detection), as horizon scanning and consider separate subsequent stages (i.e., filtration, prioritisation, assessment, dissemination, updating and evaluation) under foresight methodology. There is also variation in the definitions used in the EUnetHTA 2020 recommendations, where the authors describe the later stages (topic identification, selection and prioritisation) as horizon scanning only if it is proactive. This variation suggests a lack of consensus on whether horizon scanning should be regarded as a systematic method solely to identify emerging signals, with subsequent stages (filtration, prioritisation, assessment, dissemination, updating and evaluation) considered separately as foresight methodology. In practice, horizon scanning centres take a tailored approach to meet the needs of individual research question and often consider stages beyond detection as part of the horizon scanning process[44]. There are ongoing efforts to make the planning, conduct and reporting of horizon scanning more methodologically robust[45]; variation or ambiguity in how expansive the definition of horizon scanning should be, means that careful delineation is required to determine the scope and reach of all considerations of horizon scanning activity.

As previously mentioned, many studies were poorly reported. This, combined with the varying norms across different research areas, broadly defined aims (e.g., horizon scanning to identify issues, threats, or opportunities), and terminology for findings that could be considered methods (e.g., AI and big data), made several scoping review stages challenging. One particularly difficult aspect was identifying research methods due to the lack of a cross-disciplinary classification framework. The Methods Map developed by Sage may be a useful framework for organising various research methods, approaches, and techniques for researchers looking to undertake similar work, but it is limited in its applicability to transdisciplinary areas and also in some areas of evidence-based medicine, like systematic review and health economics[4].

Using horizon scanning as a scientific method to explore emerging trends and research likely to impact the future can increase early awareness, evaluation, and the subsequent adoption of the most promising and innovative methods. Similarly, using horizon scanning or demand signalling to identify a need for research methods, rather than identifying emerging ones, could drive innovation by encouraging cross-pollination of ideas and adoption of approaches from adjacent fields, ultimately accelerating patient access and improving patient outcomes.

Limitations

The search strategy was designed to be targeted, aiming for specificity using the keyword ‘horizon scanning’. Horizon scanning is often described as a methodology that falls under the broader umbrella term ‘foresight’, and so it is possible that by omitting this, some relevant records may not have been identified. However, testing the impact of this during an earlier search development stage found that the term foresight generated many irrelevant records, which would not be considered at the full-text stage. As the aim of this work was to map what has been conducted and reported in this area rather than exhaustively identify detailed information relating to each data item, authors were not contacted for additional information. Lastly, only studies written in English were eligible for inclusion, studies excluded based on language are transparently reported in Appendix 3. It is difficult to assess the impact of excluding both articles on the results given translation issues; However, it appears one was relevant to National security in the Netherlands, and the other appears to be a review of horizon scanning methods used for HTA worldwide and in Germany.

The lack of standardised reporting led to difficulties in assessing eligibility, extracting data, and categorising the results. To mitigate this, multiple team discussions to derive consensus were relied upon. To ensure robust data extraction, one person extracted the data, and three other reviewers checked each data item for agreement. As mentioned, reporting standards are being developed and this should support future mapping work[45].

Despite following current guidance for conducting a scoping review, including the use of recognised measures to reduce bias and error, as with any secondary research, it is possible that relevant studies may not have been identifiable in the databases searched or were indexed in ways that our search would not have detected.

Conclusions

The purpose of this scoping review was to explore if and how horizon scanning is being used to identify research methods. Our findings suggest there is limited horizon scanning work being undertaken to systematically identify emerging research methods that may be important in the future. Of particular note, dedicated horizon scanning for research methods in health and social care is lacking and may be occurring as an incidental finding to horizon scanning for other aspects. Additionally, interdisciplinary recommendations to plan, conduct and report horizon scanning studies are lacking or poorly cited. A lack of awareness about emerging methods limits the ability of relevant stakeholders to be prepared for evaluation and implementation. Further work is required to establish optimal horizon scanning approaches to identify research methods in health and social care and to understand better what type of information is useful to which key stakeholders and when.

Ethics

As this project is secondary methodological research, using available data in the published or grey literature, no ethical approval was sought.

Data availability statement

Open Sciences Framework (OSF): Horizon scanning approaches to identify emerging research methods. https://doi.org/10.17605/OSF.IO/4XQV6.

The project contains the following data:

- Data extraction 03092024 (Data extraction file)[46]
- Horizon scanning approaches to identify emerging research methods: scoping review protocol (Protocol)[15]
- A scoping review of horizon scanning appoaches used to idenitfy emerging research methods APPENDICES V1.0 (Appendices)

Reporting guidelines

- Open Sciences Framework: PRISMA-ScR checklist for 'A scoping review of horizon scanning approaches used to identify emerging research methods'. DOI 10.17605/OSF.IO/4XQV6[47].

Acknowledgements

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Open Peer Review

Current Peer Review Status: ? ✓

Version 1

Reviewer Report 28 October 2025

https://doi.org/10.3310/nihropenres.15198.r37642

✓ **Alice Kelen Soper**
McMaster University, Hamilton, Canada

This scoping review focused on horizons scanning to identify emerging methods across disciplines, finding an overall lack of horizons scanning, particularly in health and social care. The writing is very clear and concise. I have a few minor comments to consider in the following sections:

Methods:
Patient and Public Involvement: Consider including a sentence about how this work can inform future involvement and engagement of knowledge users (patients and public) and why that's important. There also appears to be a typo: "days", likely instead of "ways".

Discussion:
Limitations: Another limitation may be the small number of included studies. Consider commenting on this limitation and the implications to generalizability.

Acknowledgements:
Consider adding a period after 'Dr': Dr. Gurdeep Sagoo.

Are the rationale for, and objectives of, the Systematic Review clearly stated?
Yes

Are sufficient details of the methods and analysis provided to allow replication by others?
Yes

Is the statistical analysis and its interpretation appropriate?
Yes

Are the conclusions drawn adequately supported by the results presented in the review?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: patient and public involvement in research, childhood disability, implementation science, qualitative research, inclusive education

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 08 October 2025

https://doi.org/10.3310/nihropenres.15198.r37409

?

Federica Zennaro
Ca' Foscari University of Venice, Venice, Italy

The paper is well written and clearly presented. The topic is of interest and the overall structure is coherent. However, I believe that several minor revisions could further improve the quality and clarity of the manuscript. My specific suggestions are as follows:

1. **Abstract**
   The main focus of the paper is not entirely evident from the abstract. While the abstract mentions results in the field of medicine, the body of the paper also extends to environmental science and other related areas. Please revise the abstract to better reflect the overall scope and main contribution of the study.
2. **Methods**
   It would be beneficial to include the key terms or keywords of the research within the *Methods* section, in order to improve transparency and facilitate understanding of the study design.
3. **Structure and Indexing**
   Please check the numbering and indexing of the sections (e.g., 1; 1.1; 1.1.1) to ensure consistency throughout the manuscript.
4. **Discussion**
   - As the original topic relates to health science and social care, I suggest adding a subsection in the *Discussion* that addresses the potential and lessons learned from the use of horizon scanning in health science and social care.
   - In the *Limitations* subsection, please highlight that the inclusion of only five papers limits the statistical strength and generalizability of the findings.

Are the rationale for, and objectives of, the Systematic Review clearly stated?
Partly

Are sufficient details of the methods and analysis provided to allow replication by others?
Yes

Is the statistical analysis and its interpretation appropriate?
Partly

Are the conclusions drawn adequately supported by the results presented in the review?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: climate change, environmental science

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.