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Scoping review on research data in Spain: Academic output and developing trends

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ABSTRACT

Research data have become a central pillar of Open Science, yet in Spain the study of this topic remains fragmented and relatively recent. This scoping review provides a systematic overview of academic output on research data in Spain, examining publication trends, thematic categories, and methodological approaches. Using the Arksey and O'Malley framework, searches were conducted in Scopus and Web of Science, retrieving 26 publications (23 journal articles, two conference papers, and one documentary review) published between 2011 and 2024 in Spanish, English, and Portuguese. Screening was performed with Rayyan software and summarized with a PRISMA diagram. Eight thematic categories were identified: Open Science and Research Data, Research Data Sharing, Editorial Management and Research Data, FAIR Principles, Research Data Projects, Research Data Services in Libraries, Research Data Repositories, and Multidisciplinary Studies on Research Data. Results indicate growing interest in the last five years, though with uneven thematic and methodological development. Greater emphasis has been placed on Open Science frameworks, library services, and repositories, whereas editorial management and FAIR principles remain underexplored. Methodologically, surveys dominate across six categories, limiting depth. Future studies should diversify methods using qualitative, longitudinal and mixed approaches to analyze institutional, cultural and behavioral dynamics shaping research data practices.

Introduction

In April 2016, the European Commission announced that, beginning in January 2017, research data would become open access through the creation of a European space for open science, now known as the European Open Science Cloud (EOSC). In 2018, the Open Science Action Plan established that, whenever possible, research data from publicly funded projects should be made available for reuse. The following year, the European Union (EU) approved funding to launch Horizon Europe 2021–2027, a program designed to strengthen open access to research results through open science practices. As a mandatory requirement, beneficiaries of EU-funded projects must submit a Data Management Plans (DMPs) aligned with the FAIR principles. These initiatives have increased the prominence of "research data" as a recognized research output, contributing to its integration into funding requirements and research evaluation frameworks.

Aligned with EU policies, Spain has progressively incorporated open science and research data into its legal framework. Research data were first indirectly mentioned as research results in Law 14/2011 on Science, Technology and Innovation (Boletín Oficial del Estado [BOE], 2011), which laid the foundation for promoting open access to research outputs. Later, Law 17/2022, amending Law 14/2011 (BOE, 2022), explicitly introduced concepts such as data management and the FAIR principles. Article 37 on Open Science promotes free access to and management of research data (open data) in accordance with the international FAIR principles (Findability, Accessibility, Interoperability, and Reusability) and encourages the use of open infrastructures and platforms for publishing scientific results. Researchers whose activities are publicly funded must deposit both the final accepted version of their publications and the associated data in institutional or thematic open access repositories upon publication.

Similar provisions are found in Organic Law 2/2023 on the University System (BOE, 2023), which regulates Spanish universities. Article 12 emphasizes the promotion of Open Science and Citizen Science, requiring libraries and other university units to provide training and support for the dissemination of open science practices within universities and society at large. In Spain's legal hierarchy, an Organic Law (Ley Orgánica) governs fundamental rights and institutional structures

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and requires an absolute parliamentary majority for approval, while an ordinary Law (Ley) regulates general matters with a simple majority, underscoring the stronger constitutional authority of the former.

In line with this, the Conference of Rectors of Spanish Universities (CRUE) adopted in February 2019 the Commitment of Spanish Universities to Open Science (CRUE, 2019). Point 7 of the declaration promotes collaboration with national entities to develop a shared national infrastructure, federated with EOSC, for the storage, management, and publication of scientific data across disciplines not yet covered by existing European infrastructures.

The Horizon Europe Strategic Plan 2025–2027 (European Commission, 2024) further reinforces mandatory Open Science practices, including open access to scientific publications and responsible research data management in accordance with the FAIR principles. It requires the development of DMPs and the provision of open access to research data, while also promoting data sharing, reproducibility, and the development of skills that support open science adoption.

In parallel, the Spanish Strategy for Science, Technology and Innovation 2021–2027 (Ministerio de Ciencia e Innovación, 2021) aligns national R&D&I policy with the Horizon Europe framework, supporting open science and open access to data under the FAIR principles. Among its objectives is the creation of public data repositories to enhance Spain's participation in EOSC.

The National Open Science Strategy (ENCA) 2023–2027 (Ministerio de Ciencia e Innovación, 2023) consolidates these national commitments to open science under several strategic axes. Axis B focuses on research data, aiming to establish a methodology that ensures FAIR-aligned data management through three measures: (i) the creation of professional data stewardship roles; (ii) the mandatory submission of DMPs for publicly funded projects; and (iii) coordination among state agencies to monitor national regulations on open data and the reuse of public sector information.

Regarding research data initiatives in Spain, several projects have played a key role in developing the national open data infrastructure, including MareData, Curator-e, and Datasea, which promote FAIR data practices, repository standardization, and institutional collaboration (CSIC, 2024a, 2024b; Universidad Carlos III de Madrid, 2024; Universitat de Barcelona, 2024).

Despite this solid regulatory and strategic framework, the actual implementation of open science and research data practices in Spain remains fragmented and uneven across institutions. While European and national policies have established strong mandates for open access and data sharing, there is limited empirical evidence on how these policies are reflected in academic and institutional practices. This gap highlights the need for a systematic mapping of the existing literature to understand how research data has been addressed, the main areas of focus, and the extent to which Spanish research aligns with international open science standards. Therefore, conducting a scoping review is particularly appropriate, as it enables the identification of trends, challenges, and opportunities within a rapidly evolving policy environment.

In addition to identifying thematic and policy trends, this review also examines the methodological approaches employed in the literature on research data in Spain. Understanding how this body of research has been conducted, whether through surveys, case studies, or mixed methods, provides valuable insight into the maturity of the field and the types of evidence currently supporting decision-making. Examining these methodological patterns helps reveal both strengths and gaps in the existing knowledge base and guides the design of future studies capable of producing deeper, context-sensitive evidence about research data practices.

The aim of this scoping review is to examine the volume, thematic categories, and methodological approaches of publications addressing research data within the Spanish context. Specifically, we identify the extent to which different aspects have been studied and analyze the available evidence to highlight emerging methodologies and best practices in this field, in order to identify existing research gaps and assess how national practices align with international Open Science policies and FAIR data principles.

Since 2017, seven scoping reviews have examined research data in various contexts academic institutions (Perrier et al., 2017), academic libraries (Xu et al., 2022), data-sharing incentives (Woods & Pinfield, 2022), health data (Inau et al., 2023), citizen science (Hansen et al., 2021), cancer research (Chen et al., 2024), and social work (Kuorikoski, 2024)—at the international level. However, no prior scoping review has focused on the Spanish context, underscoring the need and relevance of this study. This work therefore aims to systematically map the current landscape and provide a comprehensive overview of research on data in Spain.

Methodology

Scoping reviews are a useful tool for determining the scope and coverage of existing literature on a given topic. They provide an overview, broad or detailed, of the volume, range, and focus of studies (Munn et al., 2018). Such reviews explore the extent (size), range (variety), and nature (characteristics) of research, thereby informing decision-making and identifying directions for future investigation based on a comprehensive synthesis of the available evidence (Peters et al., 2020; Tricco et al., 2018).

Research data is a relatively recent subject in the Spanish context, which justifies the use of a scoping review. This methodological approach allows for a broad and flexible exploration of the current landscape, as opposed to a systematic review, which typically focuses on narrowly defined questions and assesses the quality of evidence. Accordingly, a scoping review was selected to identify how research data is developing in Spain, the theoretical and methodological frameworks employed, and to establish a baseline for future, more focused studies. The findings also aim to inform public decision-making and institutional strategies based on empirical evidence.

This review follows the methodological framework proposed by Arksey and O'Malley (2005), which comprises five stages: (S1) Identifying the research question, (S2) Identifying relevant studies, (S3) Study selection, (S4) Charting the data, (S5) Collating, summarizing, and reporting the results.

Stage 1: identifying the research question

The research questions were formulated in alignment with the objectives of the study:

Q1. How many articles have been published on research data in the Spanish context?
Q2. What are the thematic categories of published articles on research data in the Spanish context?
Q3. What are the methodological approaches employed in these publications?

Stage 2: identifying relevant studies

The search strategy was designed around two core concepts derived from the research questions: *research data* and *Spanish context*. Initial search terms included “research data,” “open research data,” “Spain,” and “Spanish.” Additionally, the Open Science Taxonomy: Revised and Extended proposed by da Silveira et al. (2023) was used to expand the conceptual coverage. This taxonomy organizes Open Science into ten components and ninety-six tags; the second component, open data, includes tags such as FAIR principles, policies, data management, preservation, data journals, and data repositories. Incorporating these tags broadened the search scope and enhanced relevance.

Boolean operators were applied consistently to structure the search logic. The operator OR was used within each block to include synonyms and related terms, while AND was used between blocks to combine the

main conceptual elements of the research questions.

Searches were conducted in Scopus and the Web of Science Core Collection (WoS) using equivalent conceptual structures, with only minor syntactic adjustments required by each database's search field configurations. In both databases, three conceptual blocks were used:

- **Block 1:** "research data" OR "open research data"
- **Block 2:** related terms such as "management," "sharing," "policies," "reproducibility," "profiles"
- **Block 3:** geographical context terms such as "Spain," "Spanish institutions," "Spanish research," "Spanish universities," and "Spanish libraries."

The overall logical combination was therefore: (Block 1 OR Block 2) AND Block 3, ensuring comprehensive retrieval of records addressing research data within the Spanish context. Although the search syntax varied slightly between databases for example, WoS allows topic searches using the field tag TS=, the conceptual structure and scope remained equivalent across both platforms.

The detailed search configuration for each database, including search fields, Boolean logic, and the number of results retrieved, is summarized in Table 1.

Search query in Web of Science Core Collection (Clarivate)

TS = ("research data" OR "open research data" OR "management of research data" OR "preservation of research data" OR "data journals" OR "data repositories" OR "data repositories" OR "data management plan" OR "data sharing" OR "reproducibility of research data" OR "FAIR principles" OR "research data policies" OR "data librarian" OR "data stewards" OR "data curator") AND TS = ("spain" OR "spanish" OR "spanish institutions" OR "spanish research" OR "spanish universities" OR "spanish libraries").

Search query in Scopus (Elsevier)

TITLE-ABS-KEY ("research data" OR "open research data") AND ("research data management" OR "research data preservation" OR "data journals" OR "data repositories" OR "data management plan" OR "data sharing" OR "research data reproducibility" OR "FAIR principles" OR "research data policies" OR "data librarian" OR "data stewards" OR "data curator") AND ("Spain" OR "spanish" OR "spanish" OR "spanish institutions" OR "spanish research" OR "spanish universities" OR "spanish libraries").

Table 1
Search strategy and parameters applied in Scopus and Web of Science (WoS).

Element	Scopus	Web of Science (WoS)
Search field	TITLE-ABS-KEY (title, abstract, author keywords)	TS = (Topic Search: title, abstract, author keywords, and *Keywords Plus*)
Block 1: Research data	"research data" OR "open research data"	"research data" OR "open research data"
Block 2: Management, sharing, policies, reproducibility, profiling	"research data management" OR "research data preservation" OR "data journals" OR "data repositories" OR "data management plan" OR "data sharing" OR "research data reproducibility" OR "FAIR principles" OR "research data policies" OR "data librarian" OR "data stewards" OR "data curator"	"management of research data" OR "preservation of research data" OR "data journals" OR "data repositories" OR "data management plan" OR "data sharing" OR "reproducibility of research data" OR "FAIR principles" OR "research data policies" OR "data librarian" OR "data stewards" OR "data curator"
Block 3: Spain	"Spain" OR "Spanish" OR "Spanish institutions" OR "Spanish research" OR "Spanish universities" OR "Spanish libraries"	"Spain" OR "Spanish" OR "Spanish institutions" OR "Spanish research" OR "Spanish universities" OR "Spanish libraries"
Operators used	OR within blocks, AND between blocks	OR within blocks, AND between blocks
Number of results	408	420

Stage 3: study selection

All retrieved records from Scopus and WoS were imported into Rayyan. Duplicates were removed prior to screening. The selection process involved two stages: (1) an initial screening of titles and abstracts, followed by (2) full-text review.

To ensure methodological transparency, eligibility criteria were defined a priori and are described below.

Inclusion criteria:

- Publications explicitly addressing research data in the Spanish context, including empirical studies, policy analyses, or institutional case studies.
- Focus on Spanish universities, repositories, national or regional initiatives, or research policies.
- Examination of at least one aspect of research data (e.g., application of FAIR principles, data sharing, editorial or institutional policies, DMPs, library-based Research Data Services (RDS), or national/European data projects).
- Scholarly sources (peer-reviewed journal articles, conference papers, or documentary reviews) providing methodological or conceptual depth.
- No restrictions on publication year or language.

Exclusion criteria:

- Studies not pertaining to the Spanish context.
- Works addressing open government or administrative data instead of research data.
- Publications on open access to articles without any research data dimension.
- Research focused exclusively on data analytics, software tools, or discipline-specific results unrelated to data management.
- Non-scholarly materials (editorials, news, book reviews).
- One full-text record was excluded due to restricted access.

A total of 828 records were retrieved across both databases. After deduplication, 725 unique records remained for screening. Of these, 698 were excluded during the title and abstract stage as not relevant according to the established criteria. The remaining 27 full texts were examined in detail, and one was excluded due to limited access, resulting in a final sample of 26 publications included in the synthesis.

The study selection process and results are summarized using the PRISMA flow diagram (Fig. 1).

Results

Step 4: charting the data

The final corpus included 26 records: 23 journal articles, 2 conference papers, and 1 documentary review published between 2011 and 2024 in Spanish, English, and Portuguese. No time restrictions were applied during the database searches; 2011 corresponds to the earliest record identified. This temporal coincidence aligns with the enactment of Spain's Science, Technology and Innovation Act (Law 14/2011), which introduced the first national open-access mandate and likely influenced the initial emergence of research on data management in Spain.

A temporal analysis of publication trends (Fig. 2) reveals that the first

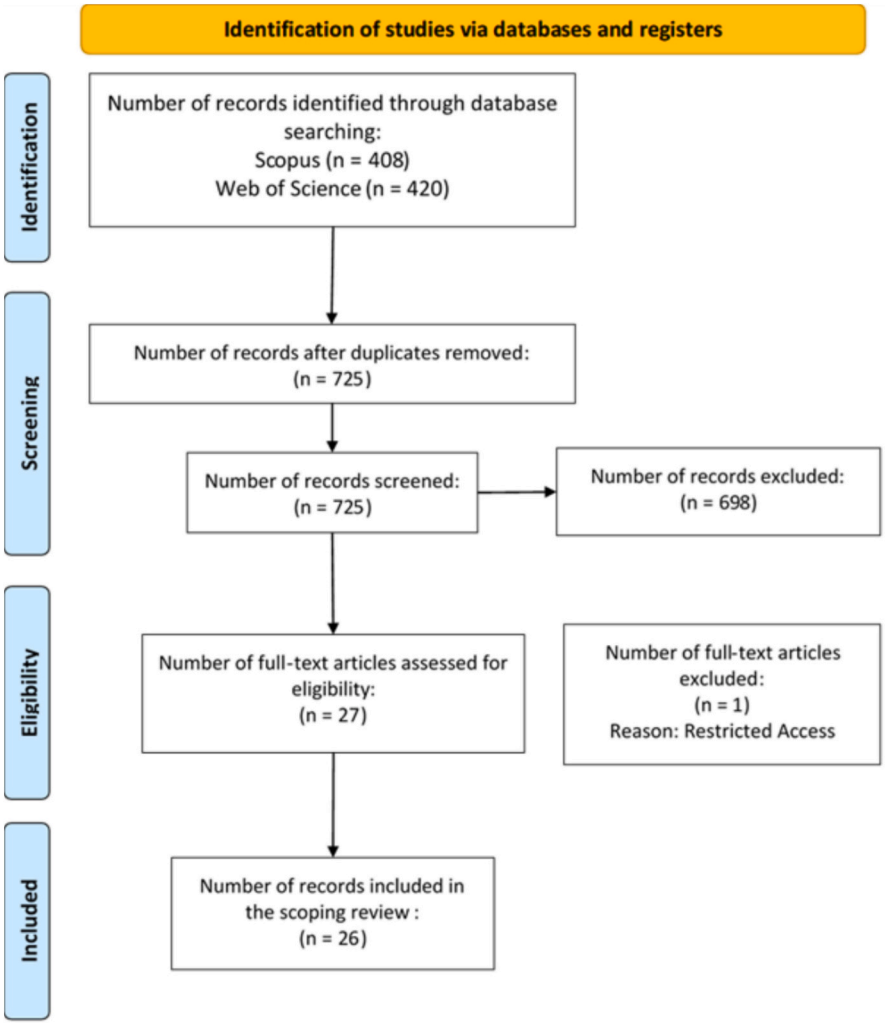

Fig. 1. PRISMA diagram of search and selection of scope review.

and only article of the decade was published in 2011. Similar isolated outputs appeared in 2012 and 2015, followed by a gradual rise in productivity: two publications in 2013; three each in 2020 and 2022; five in 2018; six in 2023; and four in 2024. Despite this upward trend, growth has been irregular, with publication gaps in 2014, 2016, 2017, 2019, and 2021.

The recent increase in publications coincides temporally with new policy requirements for publicly funded research, such as the 2020 mandate requiring a DMP as part of final project reporting. Although this measure does not directly explain the increase in scientific output, it has likely heightened institutional and researcher awareness of research data, contributing to a more diverse and visible body of literature in the Spanish context.

The analysis of the reviewed articles revealed recurring conceptual and thematic patterns, which were examined inductively to define eight overarching categories:

C1. Open Science and Research Data
C2. Research Data Sharing
C3. Editorial Management and Research Data
C4. FAIR Principles
C5. Research Data Projects
C6. Research Data Services in Libraries
C7. Research Data Repositories
C8. Multidisciplinary Studies on Research Data.

The categorization process followed an iterative, qualitative approach. Titles, abstracts, and keywords were analyzed to determine each article's dominant thematic focus. When thematic overlaps occurred, the article was assigned to the category most representative of its primary objective, ensuring analytical consistency. While the categories were derived inductively, their conceptual definition was informed by the Open Science Taxonomy: Revised and Extended (da Silveira et al., 2023), which also guided the search strategy and ensured terminological coherence throughout the review.

A detailed summary of the categories, representative studies, methodological approaches, and application contexts is provided in Appendix 1, supporting transparency and reproducibility of the review.

The temporal distribution of thematic categories (Fig. 3) shows that the earliest study, published in 2011, addressed Research Data Services in Libraries (C6). In 2018, 2023, and 2024, publications expanded across multiple categories, indicating thematic diversification. Emerging areas in recent years include FAIR Principles (C4) and Multidisciplinary Research Data Studies (C8). Sustained activity is observed in Research Data Repositories (C7) and Open Science and Research Data (C1), reflecting continuous academic engagement.

Methodologically (Fig. 4), online surveys dominate six of the eight categories, confirming their transversal use. The Open Science and Research Data (C1) category exhibits greater methodological diversity—including case studies and mixed designs—suggesting a more consolidated field. Conversely, FAIR Principles (C4) display a narrower profile dominated by comparative and mixed-method approaches.

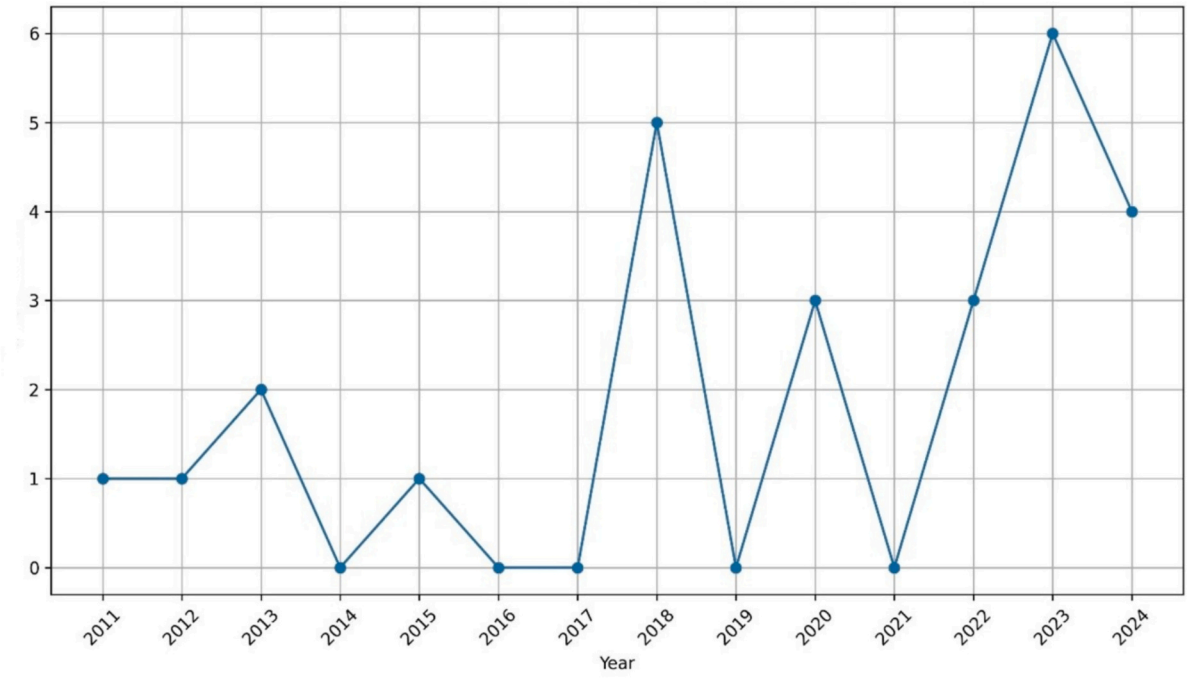

Fig. 2. Temporal distribution of publications on research data in Spain (2011–2024).

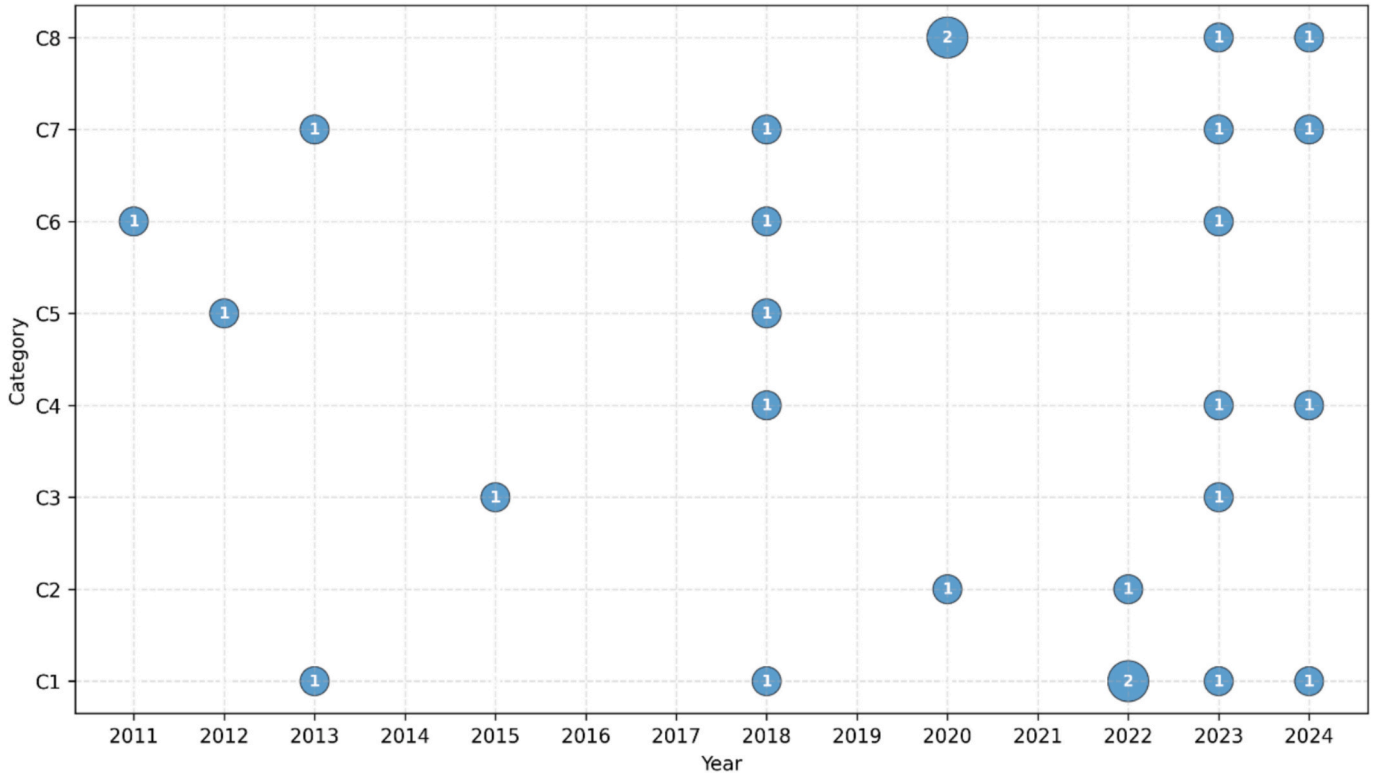

Fig. 3. Thematic categories of research data publications by year (C1–C8).

Overall, some areas show methodological maturity, while others remain exploratory and less structured.

Step 5: collating, summarizing, and reporting the results

The results are presented below as a narrative synthesis (Woods & Pinfield, 2022), organized around the eight thematic categories and interpreted within the Spanish research context.

C1. Open science and research data

Over the past decade, the development of Open Science and Research Data in Spain has been gradual. González et al. (2013) identify the starting point as Law 14/2011 on Science, which promoted open access to publications but made no explicit reference to research data. In these

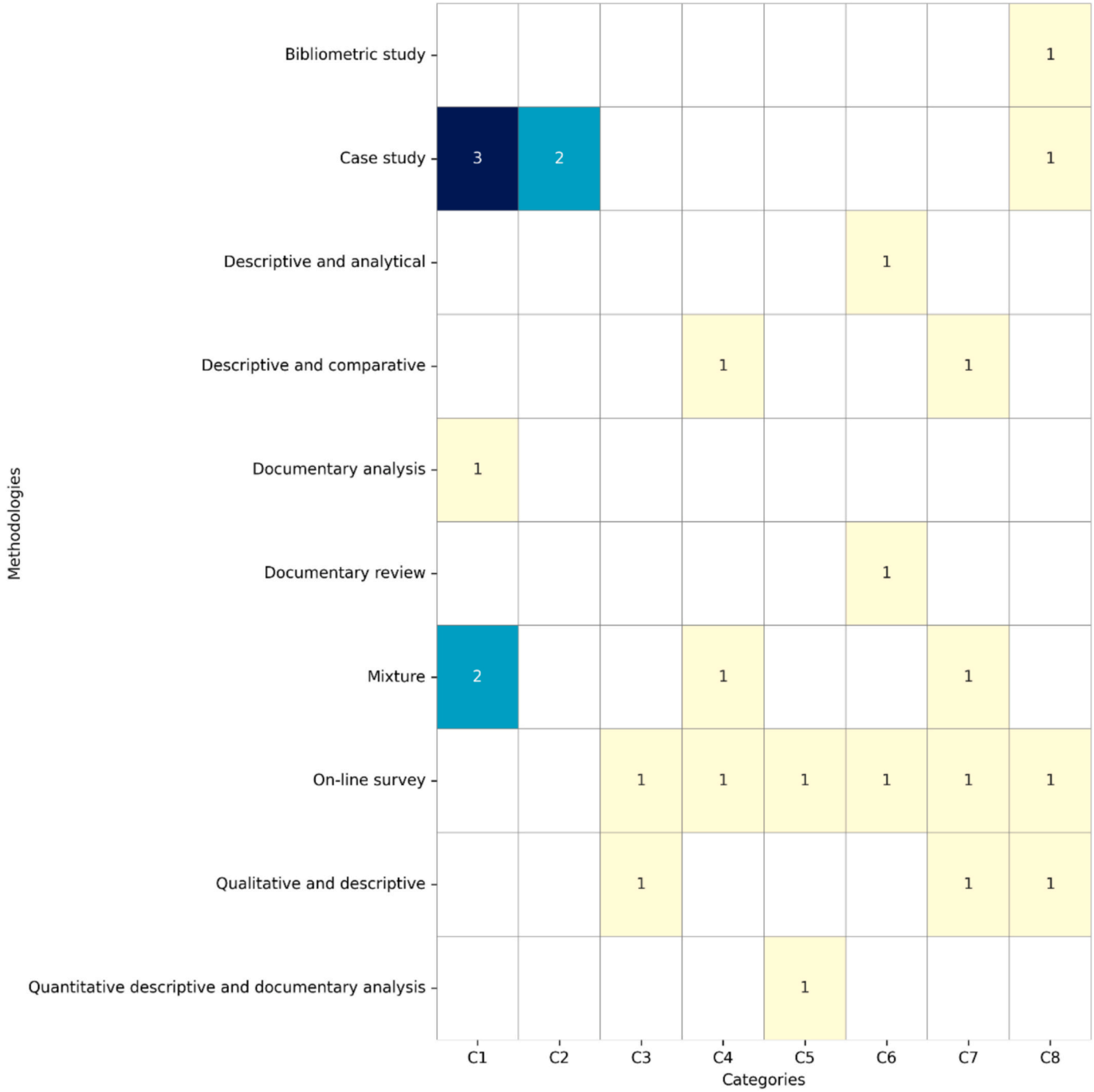

Fig. 4. Methodological distribution across thematic categories (C1–C8).

early years, researchers mainly relied on repositories (green OA) and publishing platforms (gold OA) to store their data. Until 2012, Spanish researchers had only Digital.CSIC (Consejo Superior de Investigaciones Científicas [CSIC], 2024a, 2024b) available for dataset deposit, in contrast with the diversity of international repositories.

Five years later, Arias-Coello et al. (2018) reported limited technical literacy among academics and doctoral students: most stored data on personal devices, were unfamiliar with DMPs, and made minimal use of metadata, though interest in training was growing. A qualitative shift emerged in González-Teruel et al. (2022), who observed that debate had moved from the relevance of Open Science to its implementation. Trust, academic recognition, and career advancement were identified as key motivators for data sharing.

From an institutional perspective, Abad García et al. (2022) found significant progress: more than 78 % of Spanish universities had appointed Open Science managers and were adapting their repositories. Nonetheless, a lack of consensus persisted regarding the inclusion of Open Science criteria in research-career evaluation. Administrative rigidity and workload continued to hinder deeper institutional engagement.

More recent evidence from Ollé et al. (2023) shows that one-third of researchers were unaware of whether their institutions required data sharing or application of the FAIR principles, and that only one-third used institutional repositories. Main incentives remained extrinsic citations (67 %), visibility (61 %), and journal mandates (56 %). Even so, 77 % requested greater technical support, revealing ongoing organizational barriers despite heightened awareness. This apparent disconnect between institutional readiness and researchers' needs suggests that the

establishment of Open Science structures has not yet translated into effective operational support. Fragmented responsibilities, limited coordination between administrative and research units, and insufficient training for technical and library staff may explain the gap between policy implementation and everyday practice.

From a library standpoint, Santos-Hermosa and Boté-Vericad (2024) highlight the absence of systematic Research Data Management (RDM) training for librarians despite their central role in promoting Open Science. Training remains fragmented, and library-school curricula still fall short of the competencies required for data-management challenges.

C2. Sharing research data

Research-data sharing in Spain has advanced modestly, characterized by a persistent gap between institutional recommendations and researcher practices. Aleixandre-Benavent et al. (2020) exposed this contradiction: although more than half of researchers regarded repositories as the ideal medium for preserving data, 81.5 % stored them on personal computers, and only 45 % had a DMP. Furthermore, 87 % were unaware of institutional infrastructures, indicating structural deficiencies that hinder an open-data culture. Legal concerns, loss of authorship, and fear of data misuse remain major barriers. Nevertheless, 90 % expressed willingness to reuse other researchers' data, indicating a generally positive attitude toward sharing once technical and regulatory barriers are mitigated.

Evidence from Sixto-Costoya et al. (2022) at the University of Valencia confirms low repository usage for data sharing: only 6 % of analyzed papers included data deposited in platforms such as Figshare. Non-reusable formats (mainly PDF, 83.6 %) predominated, limiting reproducibility. The study also notes that funding and journal impact positively influence the availability of supplementary material, suggesting that editorial policies and funder mandates are beginning to shape researcher behavior.

C3. Editorial management and research data

Editorial management of research data has evolved slowly, with progress still limited. Aleixandre-Benavent et al. (2015) described an editorial landscape among Spanish pediatric journals that remained largely unreceptive to data management: while some mentioned data reuse or submission to websites, none explicitly promoted dataset or supplementary-material deposition, reflecting a publication culture centered exclusively on the article as the final research product.

Eight years later, Melero et al. (2023) reported moderate improvement: open access extended to 92 % of journals, yet only 16 % had explicit data-policy statements. In most cases, data continued to appear merely as supplementary material within journals, reducing visibility and reusability. Good editorial practices, assigning DOIs to datasets, applying clear licenses, and providing citation guidelines, remained rare (below 10 %).

Cultural resistance persists as well. Many publishers consider research data of limited value to third parties, thereby deprioritizing them in editorial policies. Frequently cited obstacles include metadata management, data-protection concerns, and a lack of time or specialized staff. Data-sharing practices are more established in experimental and life sciences but remain exceptional in social sciences and humanities.

C4. FAIR principles

The adoption of the FAIR principles in Spain has progressed from isolated institutional initiatives to more structured integration into academic and research practices. An early example is the Carlos III University of Madrid Library, documented by Fernández-del-Pino Torres et al. (2018). Since 2006, its e-Archivo repository has been designed in alignment with FAIR criteria, implementing persistent identifiers, standardized metadata, and interoperability through networks such as OpenAIRE. This infrastructure has since been strengthened with integrations such as CRIS, ORCID, and VIVO, as well as through collaborative initiatives like PGDonline (a platform for creating and managing Data Management Plans) and e-ScienceData, both developed in partnership with the Madroño Consortium.

At the national level, CSIC has advanced FAIR assessment through the FAIR EVA tool (Aguilar Gómez & Bernal, 2023), which evaluates compliance with FAIR principles across institutional repositories. The tool provides tailored feedback and has revealed substantial variation among datasets, often linked to limited technical expertise and insufficient awareness of disciplinary standards.

More recently, the integration of FAIR principles has extended to higher education curricula. González Soltero et al. (2024) describe an educational initiative at the European University of Madrid, where graduate biomedical students received practical training in data literacy and FAIR data management. Activities such as creating management plans and using assessment checklists effectively bridged the gap between theoretical understanding and practical implementation, fostering a culture of transparency and data reuse from the early stages of research training.

C5. Research data projects

The development of research data projects in Spain reflects a gradual shift from early exploratory initiatives to more coordinated and collaborative frameworks. The first milestone dates back to 2008, with a project led by the University of Barcelona and CSIC-IATA (Instituto de Agroquímica y Tecnología de Alimentos, Consejo Superior de Investigaciones Científicas), which although focused on open access already recognized the importance of scientific data as a distinct research output.

Subsequent efforts such as ODASCI (Universitat de València et al., 2012), coordinated by the Universitat de València, CSIC, and Universidad Politécnica de València, examined researcher behavior and developed tools for dataset discovery. Later, national initiatives including MareData (CSIC), Curator-e (Custodia y Gestión Digital de Datos de Investigación; Universidad Carlos III de Madrid), and Datasea (Datos de Investigación en Abierto; Universitat de Barcelona) consolidated best practices for implementing FAIR principles and established standardized repository management protocols.

Other projects, such as KIMO (Knowledge and Information Management in Open Science; Universitat Oberta de Catalunya, 2006) and WaKe (Web Knowledge for Open Science; Universidad de Alicante, 2012), expanded the focus to Big Science contexts and the development of institutional data portals. Collectively, these initiatives illustrate the progressive institutionalization of research data across Spain.

Among early examples of international coordination, the ODiSEA project (García García et al., 2012) stands out for mapping disciplinary data repositories to facilitate discovery and access through interoperability standards such as OAI-PMH. This effort anticipated the openness and interoperability later formalized through the FAIR framework.

A key turning point came with MareData (Melero-Melero & Abadal-Falgueras, 2018), which brought together seven research groups in a national thematic network funded by the Ministry of Economy and Competitiveness. The project promoted interdisciplinary collaboration and proposed 17 recommendations for responsible data management aligned with FAIR principles, contributing significantly to the consolidation of Spain's open data ecosystem.

C6. Research data services in libraries

The involvement of libraries in Research Data Services (RDS) in Spain has evolved from early isolated initiatives to increasingly structured and cooperative models. A pioneering example is described by Arano et al. (2011), who documented the establishment of a primary-data community within the Pompeu Fabra University repository. This initiative, which used persistent identifiers (Handle), represented an early step toward integrating datasets into institutional research ecosystems. Similarly, in 2010, the CSIC launched the Datasets Collection in Digital.CSIC, hosting resources such as SPEIbase, a climate database that exemplified libraries' expanding role in data dissemination.

A significant advance occurred with the Consorci de Serveis Universitaris de Catalunya (CSUC), analyzed by De León and De Ferrer (2018). Since 2014, its Research Support Working Group (RSWG) has promoted a cooperative framework focusing on DMPs, the adaptation of DMPOnline, and the creation of FAIR-aligned guidelines. The group also introduced monitoring indicators for human resources, training, and service use, consolidating libraries as key training agents and institutional coordinators.

More recently, Martin-Melón et al. (2023) provided an updated overview of RDS implementation in Spanish public universities. The study found that 58 % of institutions offered data-management advice, mostly related to DMPs, repositories, and dataset discovery, while 75 % provided guides or tutorials. However, only 10.4 % had a dedicated institutional plan, and most integrated data management into broader open-access policies. Service quality remains uneven, and training opportunities are scarce (23 %), concentrated mainly on postgraduate students and researchers.

C7. Research data repositories

The development of research data repositories in Spain has advanced from exploratory initiatives to a phase of early consolidation, though challenges persist. Early analyses by Nina-Alcocer et al. (2013) revealed that data sharing lacked formal policies and relied on fragmented practices such as supplementary publications, personal storage, or institutional repositories poorly suited to data preservation. International repositories like Dryad, Zenodo, Figshare, and Dataverse offered more structured alternatives.

Five years later, Moreno (2018) documented continued heterogeneity: many Spanish repositories registered in re3data.org lacked technical details, primarily used DSpace or Dataverse software, and included basic metadata (mainly Dublin Core). Most collections contained documents rather than structured datasets, exposing both technical and conceptual inconsistencies.

Recent work by Martínez Méndez et al. (2023) indicates increasing institutional engagement. Among 24 public universities and two consortia, data publication has grown, particularly in the arts and sciences. Dataverse emerged as the platform most compatible with FAIR principles, although DSpace remains predominant. Persistent challenges include a reliance on self-archiving and limited technical support.

Monteagudo-Haro and Prieto-Gutiérrez (2024) expanded on these findings, examining 32 repositories across the REBIUN network. They reported six times higher data presence in public versus private universities, with Andalusia, Catalonia, and Madrid as the most active regions. Despite good accessibility and clear licensing, 91 % of institutions still lacked specific data-management policies, and only 9 % had formal guidelines, though 65 % maintained general open-access policies. These findings underline a continuing disconnect between open-access adoption and research-data-management implementation.

C8. Multidisciplinary research-data studies

Research on research data from a multidisciplinary perspective reveals a fragmented reality marked by limited knowledge, inconsistent standards, and a weak culture of openness. In oceanographic science, Wulff (2020) identified low Spanish participation in European ocean-data spaces. Although Open Geospatial Consortium (OGC) standards were adopted, implementation remained partial and poorly adapted to marine data needs.

In food science and technology, Melero and Navarro-Molina (2020) found that over 50 % of researchers were unaware of the FAIR principles and DMP requirements. Although 66 % shared data as publication appendices, only 24 % reused third-party data, indicating a research culture still hesitant toward openness.

Cerda-Cosme and Méndez (2023) analyzed Spanish COVID-19 research, revealing that only 2.1 % of publications deposited data in repositories, while 5.2 % included them as supplementary materials. Low adherence to accessibility, licensing, and format standards underscored persistent uncertainty about what constitutes a dataset and how to share it properly.

Finally, Lucas-Domínguez et al. (2024) examined oncology research, specifically cancer stem cell (CSC) studies, finding that 47 % of articles contained data, but only 0.7 % deposited them in repositories. Supplementary materials predominated, even in high-impact journals, often in non-FAIR formats lacking identifiers or formal licenses.

Overall, research on research data in Spain addresses multiple dimensions from the regulatory and cultural evolution of Open Science to disciplinary practices. The studies reveal significant progress in infrastructure development, institutional support, and training, yet also highlight persistent limitations in FAIR adoption, editorial management, and data sharing. A sustained gap between policy and practice remains, particularly regarding repository use and data reuse. Moving toward a robust open-science culture will depend not only on infrastructure and policy but also on a cultural shift among researchers toward collaboration, transparency, and responsible data stewardship.

Discussion

The discussion interprets and contextualizes the main findings of this scoping review within the broader landscape of research data in Spain and internationally. While the results section outlined publication trends, thematic categories, and methodological patterns, this discussion examines their implications specifically, how Spain's regulatory, institutional, and cultural contexts influence the development of research data practices.

This section is organized around five core discussion points, each synthesizing recurrent issues identified across multiple studies and connecting them to the eight thematic categories presented in the results. Together, they provide a critical reflection on the current state of research data in Spain, the challenges that persist, and the opportunities for advancement. In doing so, the discussion highlights how policy frameworks, institutional initiatives, and researcher practices intersect to shape the implementation of Open Science principles.

The lack of a precise definition of research data creates confusion for authors

A recurring issue across the Open Science and Research Data and Multidisciplinary Studies categories concerns the very definition and conceptual understanding of what constitutes research data.

Melero and Navarro-Molina (2020) observe that confusion frequently arises among authors regarding what qualifies as research data. Many equate data with tables, figures, or images rather than with the underlying raw data those elements represent. A clear conceptualization is essential for proper data management, dissemination, and reuse. Yet, ambiguity surrounding the term continues to generate inconsistencies in how research results are reported and how data policies are implemented.

Institutions such as the European Commission (2018), the Spanish Ministry of Science and Innovation (2021), OECD (2007), Science Europe (2018), and UNESCO (2021), along with scholars including Piwowar and Vision (2013), Tenopir et al. (2011), Wilkinson et al. (2016), Borgman (2012), and Peters et al. (2020), have proposed definitions emphasizing different dimensions of research data from their empirical nature to their role in validation and reproducibility.

Gómez-Diaz and Recio (2022) offer one of the most comprehensive formulations, identifying three essential features: (1) data must be produced through systematic processes of collection, processing, analysis, sharing, and dissemination explicitly aimed at answering a scientific question; (2) they must be generated by a research team; and.

(3) they must yield results that are published or disseminated in a scientific contribution.

This definition underscores the importance of distinguishing genuine research data from supplementary materials such as extended tables,

figures, or code that may not meet these criteria.

It is also crucial to differentiate open data (produced by public institutions for transparency and administrative purposes) from open research data, which emerge directly from the scientific process and underpin knowledge production. Regardless of openness, research data constitute the empirical foundation of scientific validation. As Monteagudo-Haro and Prieto-Gutiérrez (2024) argue, open research data are an integral component of Open Science when supported by clear dissemination and reuse policies.

Limited understanding of data ownership and licensing hinders responsible data sharing

A second recurring challenge, evident in the Research Data Sharing and Editorial Management categories, concerns widespread uncertainty about data ownership and licensing.

Many researchers remain unaware that transferring copyright for an article to a publisher does not automatically transfer rights to the underlying raw data. As Carroll (2015) explains, raw observational or experimental data are factual and therefore not subject to copyright protection, which applies only to creative expressions. Within the European Union, data themselves are not protected by copyright, although databases may receive sui generis protection when substantial investment in their creation or verification can be demonstrated (Labastida & Margoni, 2020). This legal nuance underscores the need for appropriate licensing, consistent with the FAIR principle of Reusability.

Creative Commons (CC) licenses are widely recommended for research data, yet restrictive variants such as CC BY-NC or CC BY-NC-ND considerably reduce their reuse potential. Melero and Navarro-Molina (2020) found that only 8 % of surveyed researchers used the open CC BY license, while 46 % opted for restrictive ones and 39 % were unsure which license applied. Such uncertainty undermines a core Open Science objective: enabling lawful and meaningful data reuse.

Licensing choices are often shaped more by editorial or institutional norms than by informed legal understanding (Melero et al., 2023). Misconceptions persist for instance, some researchers wrongly assume that funding agencies own the data, when in fact grants typically focus on dissemination rather than ownership (Melero & Navarro-Molina, 2020).

Compounding the issue, publishers frequently provide vague or inconsistent information: Vasilevsky et al. (2017) found that few biomedical journals clearly stated ownership or licensing terms. As a result, both regulatory ambiguity and researcher misinformation remain significant barriers to responsible and transparent data management.

A persistent gap remains between willingness to reuse and to share research data

A third major finding, spanning Research Data Sharing, Library Services, and Open Science, is the persistent asymmetry between researchers' willingness to reuse others' data and their reluctance to share their own.

Data sharing yields collective benefits for the research community but often entails perceived personal risks (Pronk et al., 2015). Several studies confirm this imbalance: 60 % of researchers express willingness to reuse others' data, compared with only 40 % willing to share their own (González et al., 2013). Most Spanish researchers share data only within existing collaborations 62 % with project colleagues, 22 % with partners, and just 3 % with unrelated peers (Aleixandre-Benavent et al., 2020). Such patterns reflect a culture of control and mistrust around data sharing.

Common deterrents include concerns over data misuse, potential contradictions with published findings, and limited personal incentives (Aleixandre-Benavent et al., 2015; González-Teruel et al., 2022). While Open Science ideals enjoy wide support, genuine openness remains constrained by cultural norms and weak structural incentives. The Horizon 2020 program, mandating DMPs and open access for EU-funded projects, has begun to institutionalize these practices (Arias-Coello et al., 2018), but its influence across Spanish institutions remains uneven.

Researchers cite visibility and validation as key motivators for sharing, whereas privacy concerns, lack of enforcement, and insufficient procedural knowledge remain persistent barriers (Ollé et al., 2023).

The limited availability of institutional policies and curation services further constrains the development of a robust sharing culture (Monteagudo-Haro & Prieto-Gutiérrez, 2024).

Weak implementation and monitoring limit the effectiveness of Open Science policies

Another overarching theme, emerging from Open Science, Projects, and Repositories, is the discrepancy between regulatory ambition and practical implementation.

Although the Science Act of 2011 established the foundation for Open Science in Spain, its impact has been diminished by the absence of effective monitoring mechanisms. Despite legal mandates for depositing publicly funded research outputs in open access, compliance remains low: only 58.4 % of publications met the requirement two years after the law's approval (González-Teruel et al., 2022).

Subsequent reforms, including the 2022 amendment and the University System Act (LOSU), introduced clearer terminology such as FAIR data and citizen science, but still lacked operational specificity. Both laws thus remain largely declarative frameworks rather than enforceable instruments.

Institutionally, the implementation gap persists. Although many universities endorsed Open Science through CRUE's 2019 Commitment, over half still lack defined objectives or performance indicators (Abad García et al., 2022). By contrast, monitoring practices are significantly more advanced in other European contexts, where up to 80 % of universities track repository deposits and 70 % monitor open-access compliance (Morais et al., 2021).

A major structural barrier lies in the misalignment between Open Science principles and traditional research assessment models. Quantitative, metric-driven evaluations continue to dominate, discouraging collaboration and data sharing (González-Teruel et al., 2022; Ollé et al., 2023). Ràfols and Molas-Gallart (2022) warn that Spain's reliance on bibliometric indicators undermines the European Agreement on Research Assessment Reform. From a technical standpoint, Manghi (2024) highlights that without robust metadata, interoperability, and standardized validation, monitoring frameworks lack both legitimacy and functionality.

International comparisons reinforce this concern. The UK's Research Assessment Exercise (RAE), for instance, generated unintended effects, fostering competitiveness at the expense of academic autonomy (Dnes & Seaton, 2001). Spain risks a similar outcome unless evaluation and accountability systems are reformed. In sum, despite a strong legislative discourse, Open Science in Spain remains primarily rhetorical limited by weak enforcement, fragmented infrastructures, and outdated evaluation criteria.

Limited training and support reduce the perceived usefulness of data management plans

The final cross-cutting issue, predominantly reflected in the FAIR Principles and Library Services categories, concerns the limited technical training and understanding of DMPs among both researchers and support staff.

Uncertainty about the practical utility of DMPs is widespread. Arias-Coello et al. (2018) report that only 31.9 % of researchers found DMPs useful for managing data, while 63.8 % were unsure. This indicates not only insufficient training but also a weak integration of DMPs into daily research workflows. Despite their regulatory promotion, DMPs are often viewed as bureaucratic rather than strategic instruments.

Martin-Melón et al. (2023) identify the shortage of specialized personnel as a major factor limiting RDM service quality in universities. This mirrors broader gaps in professional development: training activities tend to prioritize conceptual aspects such as FAIR principles or repository use, over practical skills like data validation, anonymization, or visualization (Martín-González & Iglesias-Rodríguez, 2022). Consequently, DMPs are frequently perceived as isolated compliance documents rather than as tools guiding the entire data lifecycle.

International evidence echoes these findings. Tang and Hu (2019) and Bresnahan and Johnson (2013) both note that librarians engaged in RDM services often lack applied experience, while Oo et al. (2022) emphasize user-centered pedagogy and continuous assessment as key to effective training. Rod (2023) further argues that librarians' own research experience enhances their ability to provide relevant, context-sensitive RDM support.

In Spain, RDM services largely concentrate on consultation and preservation, neglecting stages such as data analysis and visualization (Martín-González & Iglesias-Rodríguez, 2022). As Santos-Hermosa and Boté-Vericad (2024) contend, advancing Open Science support requires "training the trainers" empowering librarians to address interconnected areas like citizen science, research integrity, and incentive systems. González-Teruel et al. (2022) highlight the need for generational renewal: the transition toward a genuinely open research culture depends on cultivating Open Science–native professionals.

Finally, as Pinfield et al. (2014) argue, university libraries are uniquely positioned to assume a strategic role in research by expanding their involvement across all stages of the data lifecycle. Achieving this, however, requires sustained investment in advanced technical training and practice-based experience that moves beyond mere policy compliance.

Conclusions

This scoping review identified 26 publications addressing research data in the Spanish context comprising 23 journal articles, two conference papers, and one documentary review. Although modest in number, this body of work demonstrates growing scholarly interest, particularly during the past five years. The thematic dispersion and diversity of sources indicate a field in active formation: the bibliographic corpus is taking shape but remains fragmented and unevenly developed.

The reviewed studies span eight thematic categories that together provide a comprehensive overview of the Spanish research data ecosystem. However, they also reveal an imbalance in research attention: areas such as FAIR Principles and Editorial Management remain underexplored, while greater emphasis has been placed on the establishment of library services and the institutionalization of Open Science as both a cultural and policy framework.

From a methodological perspective, online surveys predominate in six of the eight categories. While accessible and effective for mapping practices, this approach limits analytical depth and interpretive potential. The Open Science and Research Data category exhibits the greatest methodological diversity, including case studies and mixed methods, suggesting higher thematic maturity. By contrast, studies on FAIR Principles rely mainly on normative analyses and mixed designs, reflecting an earlier stage of methodological development. Overall, there is a notable absence of in-depth qualitative and longitudinal research capable of capturing real-world data management practices and structural challenges.

These methodological patterns confirm that research data in Spain remains in an exploratory phase, largely descriptive and diagnostic in nature. Future investigations should broaden their scope toward interpretive and evaluative methodologies including longitudinal studies, interviews, ethnographic case analyses, and mixed-method frameworks that can generate robust evidence on how policies, infrastructures, and institutional cultures influence data management behavior. Methodological diversification will be key to advancing from surface-level description toward a deeper, evidence-based understanding of how research data is evolving within Spain's research ecosystem.

In summary, this review demonstrates that research on research data in Spain is beginning to consolidate around a core set of thematic areas, though with uneven development in both output and methodological rigor. Current studies tend to approach data management from technical or normative perspectives, without yet fully examining its implementation in everyday research practice. Strengthening this emerging field will require both methodological innovation and the cultural integration of research data into Spain's broader research environment.

Beyond the underrepresented themes identified such as FAIR implementation and editorial data policies this review also exposes broader gaps that merit attention. Few studies address the institutional, behavioral, and cultural dimensions shaping research data adoption, including incentive structures, disciplinary variations, and researchers' perceptions of data value. Likewise, there is limited evidence regarding the effectiveness of national and institutional Open Science policies, or how data management practices differ across research domains and organizational contexts. Addressing these gaps is essential for moving from a normative, policy-driven discourse toward an evidence-based understanding that connects regulation, infrastructure, and researcher behavior. Future research integrating sociological, organizational, and evaluative perspectives will be vital to consolidating research data as a mature, context-sensitive, and sustainable field of inquiry within Spain and beyond.

CRediT authorship contribution statement

Roxana Cerda-Cosme: Writing – review & editing, Writing – original draft, Visualization, Validation, Resources, Methodology, Funding acquisition, Formal analysis, Conceptualization. **Eva Mendez:** Writing – review & editing, Validation, Supervision.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.acalib.2025.103151.

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