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Article

Use of Subject Metadata in Library Discovery Systems: A Global Survey

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Abstract

This paper reports on a survey of research library catalogs and the ways these information retrieval systems support subject searching, the use of knowledge organization systems (KOSs), and the subject-searching options made available to users. The research was conducted by the International Society for Knowledge Organization (ISKO) Scientific and Technical Advisory Council (STAC) Working Group on Subject Access Metadata. Libraries commonly use KOSs such as general subject heading and classification systems, subject-specific thesauri, and other controlled vocabularies. However, there is concern that many library discovery systems do not provide easy or seamless access to this enriched metadata. The study examined available subject-searching and browsing features and explored barriers to their use. A survey of 114 academic and research libraries in 34 countries revealed widespread adoption of discovery systems, although many institutions continue to rely on Online Public Access Catalogs (OPACs) as the primary interface for subject searching. Libraries reported using a range of library management and discovery systems from suppliers including Ex Libris, SirsiDynix, EBSCO, Koha, and OCLC. Frequently used general KOSs include Library of Congress Subject Headings, Dewey Decimal Classification, Universal Decimal Classification, and the Chinese Library Classification, while Medical Subject Headings was the most commonly cited domain-specific system. Reported barriers include limited user familiarity with KOSs, system complexity, lack of natural-language access, language issues, and interface design problems. The ultimate goal of the research is to develop guidelines for improving access to enriched subject metadata in library discovery systems.

Keywords: knowledge organization system; discovery system; academic library; information retrieval; OPAC; metadata; subject access

1. Introduction

1.1 Background

Over the past four decades, there has been growing concern about poor support for subject access across a broad range of information retrieval systems. There is, for instance, a plethora of research evidence showing how the existing subject metadata based on knowledge organization systems (KOSs) such as classification systems, subject headings systems or information retrieval thesauri is either insufficiently visible, poorly integrated, or difficult to access within catalogs and discovery systems used by academic and research libraries (Golub et al., 2024). This significantly limits users' ability to find relevant information about topics of study or research within a broad context of existing knowledge systems that usually reflect educational and scientific consensus. This is especially important in educational and research information seeking scenarios. KOSs play an important instructional role, not only, by offering precise and standardized terminology but also through presenting those in a systematic way through hierarchical and associative relationships between concepts. When connected to information resources, these semantic relationships enable search expansion, encourage exploration, and serendipitous information discovery.

Although libraries invest significant effort in creating and maintaining high-quality subject metadata, current discovery interfaces frequently fail to expose this metadata in ways that meaningfully support user searching and browsing. As a result, users may be unable to take advantage of structured subject access, rely instead on basic keyword searching, or encounter barriers related to system complexity, unfamiliar terminology, or interface design limitations. These challenges risk reducing the effectiveness of subject-based retrieval, obscuring the value of knowledge organization systems, and limiting users' ability to explore collections in a systematic and intuitive manner.

The International Society for Knowledge Organization (ISKO) Scientific and Technical Advisory Council (STAC) Working Group on Subject Access Metadata addressed this challenge. In its first phase, it provided a review (Golub et al., 2024), which suggests that library discovery systems are often modelled on the single search box widely used in online search interfaces such as Google or Bing. It highlights the potential benefits of KOSs to enhance retrieval in library discovery systems. The survey reported in this paper is part of the second phase of the ISKO STAC Working Group and is intended to identify current use of KOSs and barriers to their use in research and academic libraries.

1.2 Objectives and Research Questions

There are several possible obstacles to the effective use of KOSs that limit subject discovery including: the availability and richness of subject metadata and necessary expertise in exploiting them, limitations of the underlying technology (library or information discovery systems), and the lack of awareness of the required interface functionalities that need to be provided. The objective of this research is to establish the extent to which these obstacles affect the findability. Its final goal is to provide guidelines for the implementation of subject metadata, KOS in particular, in information retrieval systems.

With the ultimate goal of this research being the development of a set of guidelines for research and academic libraries about providing easy and seamless access to enriched subject metadata via library discovery systems, this survey aimed to discover how research libraries provide subject searching support to users. The third phase of this project will be to develop a set of guidelines for library

managers procuring discovery systems to ensure that library users have access to subject metadata.

This survey was conducted to help with the following research questions:

RQ1: What kind of search/browse interface is provided by academic and research libraries?

RQ2: Are users able to access subject metadata from KOSs?

RQ3: What support is provided to users for subject access?

RQ4: What are the barriers to the adoption and use of subject metadata in library discovery systems?

1.3 Literature Review

Golub et al. (2024) provide a comprehensive review of research literature on the role and use of subject metadata in library search interfaces: from traditional online public access catalogs (OPAC) to web-scale discovery systems. The discovery systems, nowadays widely adopted in academic and research libraries, are designed to offer unified access to diverse collections through a single search interface. Prior studies have shown that this design paradigm prioritizes ease of use and keyword-based retrieval, often at the expense of explicit support for structured subject access. Prior studies dating back to the work of Borgman (1996), highlighted the challenges presented by the introduction of online catalogs. More recently, Cuna (2025) has identified lack of conceptual guidance for users as a factor affecting the performance of discovery systems in libraries.

The above mentioned background research attested to the longstanding value of KOSs in supporting subject information retrieval, specifically, by improving relevance, enabling subject browsing and exploratory searching. Furthermore, Golub et al. (2024) found that the initial studies in information seeking and subject access already confirmed the benefits of controlled vocabularies, especially when it comes to addressing language ambiguities (synonymy, homonymy, and polysemy), thus increasing the precision in searching. Having a vocabulary to select from also helps users in identifying their information problem and formulating the query. Last but not least, they reported numerous studies of classification-based browsing that highlight the importance of hierarchical and associative relationships in facilitating learning, exploratory searching pathways, and information discovery.

Despite this theoretical and empirical foundation, there is a noticeable and consistent gap between the availability of subject metadata and its effective use in discovery systems. Teague-Rector and Ghaphery (2008) pointed out that the use of one large search box may mislead the user in assuming that the library search functions like an online search engine and, in some cases, becomes an obstacle (Swanson and Green, 2011). Lown et al. (2013) cautioned that the use of a "single search box communicates confidence to users that our search tools can meet their information needs from a single point of entry" (p. 240) and therefore systems must be designed for a user experience that balances expectations with the system capabilities. Research on user interaction with discovery systems shows that subject-based features are often hidden in advanced search options and inconsistently implemented. Several studies cited in the review report low user awareness of KOSs, as well as limited understanding of how these structures can be used to refine searches. Interface design based on full-text search algorithms entirely diminishes the value of existing subject metadata.

The review also highlights librarians' concerns that discovery systems obscure intellectual labor invested in metadata creation. This has been increasingly difficult to justify given the advances in technology and current trends towards metadata enrichment, expansion and semantic integration with the help of linked data and artificial intelligence (AI)-supported information discovery. On one hand, we have innovative and highly advanced integrated information portals deploying and enriching legacy metadata aggregated from libraries, archives and museums; on the other, we have catalogs and discovery systems showing a small proportion of the same metadata infrastructure. Empirical evaluations of discovery platforms reveal wide variation in how subject metadata is indexed, displayed, and linked, leading to low findability and high dissatisfaction among user experiences. Golub et al. (2024) conclude that while KOS-based subject metadata remains central to the organization of library collections, its potential is significantly underutilized in contemporary discovery systems. They call for renewed attention to interface design, system transparency, and user training, as well as further empirical research into how enriched subject metadata can be more effectively integrated into user-centered discovery environments.

Since the publication of the 2024 background research report, most related research has focused on advances in AI, particularly Large Language Model (LLM) based systems. As a result, this section is intentionally brief and primarily directs readers to the earlier work. Nevertheless, several recent studies continue to reinforce the value of KOSs, demonstrating their ongoing relevance in supporting precise querying, mitigating hallucinations, and improving interpretability despite rapid developments in AI (Salatino et al., 2025). Similarly, a case study of an Lesbian, Gay, Bisexual, Transgender, Queer, plus (LGBTQ+) fiction database demonstrated that commercial information retrieval systems, social tagging approaches, and AI-based indexing are greatly outperformed by a combination of (1) a high-quality KOS, (2) an indexing policy emphasizing exhaustivity and specificity as well as consistency, and (3) a search interface that supports broader and narrower searches, disambiguation, and the translation of user terms into the vocabulary used by the system (Golub, 2025). Kamal and Golub (2025) explain that the library and museum

catalog interface plays an important role in how people understand and use subject metadata. Even when subject terms follow good standards, users may struggle to find or interpret them if the interface does not show them clearly or support browsing and exploration.

Golub and Szostak (2025) highlight that challenges in subject access and discovery systems are particularly pronounced in the humanities and social sciences. This is recently confirmed by research on the application of AI, specifically LLM as research tools in the humanities and social sciences, pointing to the limitations of LLMs in this field due to interpretation and context dependency (Simons et al., 2025). In their article on information retrieval (IR) of humanities resources, Golub and Szostak examine why existing search systems often fail to support the interpretive, exploratory, and context-sensitive information practices characteristic of humanities scholarship. They argue that these failures are closely linked to the way subject metadata and KOSs are implemented – or neglected – within contemporary information retrieval environments. The authors emphasize that humanities resources are typically rich in conceptual nuance, ambiguity, and cultural context, making them especially reliant on subject metadata from KOSs. However, as with library discovery systems more broadly, these structures are frequently hidden from users, poorly integrated into interfaces, or overridden by automated search algorithms. This work further criticizes established evaluation methodologies in IR: standard IR evaluation frameworks involving precision and recall measured against predefined relevance judgments are poorly suited to assessing the value of subject metadata, browsing features, and exploratory search. Thus, improving subject access in discovery systems requires not only better interface design and user training, but also the development of evaluation approaches that recognize the distinctive role of KOSs in supporting information search and discovery.

Also relevant are developments in the knowledge graph technologies when KOSs are applied. Hyvönen (2020; 2024) and Koho et al. (2021) demonstrate how KOSs can function as knowledge graphs to improve search and discovery in cultural heritage and library systems. Central to this work is the Finnish national ontology and vocabulary infrastructure Finto (https://finto.fi/en/), which publishes KOSs as linked open data (LOD). By representing concepts, relationships, and identifiers in a shared knowledge graph, this infrastructure enables semantic search, faceted browsing, and cross-collection linking beyond simple keyword matching. The Sampo model (Hyvönen, 2020 and applications like WarSampo (Koho et al., 2021) illustrate how these knowledge graphs support exploratory interfaces that help users navigate complex collections and understand meaningful connections across datasets.

On a final note, the use of KOSs in online information retrieval systems, whether based on traditional technologies or knowledge graphs, only realizes its full potential when interfaces are designed to make these structures visible and usable through features such as facets, concept hierarchies, disambiguation, etc. Doing so directly addresses long-standing limitations in end-user search and discovery interfaces. This highlights the need for much closer collaboration between the knowledge organization, cultural heritage, knowledge graph, information retrieval, and human–computer interaction communities. Bringing these perspectives together in both research and practice is essential to ensure that semantic structures embedded in subject metadata and knowledge graphs are effectively translated into interface features that support meaningful searching, browsing, and sense-making for end users.

2. Methods

A questionnaire survey was distributed to academic and research libraries via the International Federation of Library Associations and Institutions (IFLA), ISKO and professional library associations affiliated with IFLA. The emailing lists of these organizations provide an international reach to subscribers interested in library and information matters in general and in knowledge organization specifically. The questionnaire was distributed as a link to a survey in Microsoft Forms and was in English. It was administered by Edinburgh Napier University and followed its ethical approval process. Translations of the questionnaire were made available in Portuguese, Spanish, and Chinese. The survey was conducted between October 2024 and February 2025, with a total of 114 valid responses received. Incomplete and duplicate responses were removed from the analysis set.

The survey was based on a pilot survey (Haynes et al., 2023), which identified key issues and barriers to the use of subject metadata in library discovery systems. Both the pilot survey and this survey primarily targeted research and academic libraries where higher expectation and more demand is placed on information discovery. A draft English-language questionnaire was tested by the project group and members of ISKO, representing different language traditions and countries including: the United Kingdom, the United States, Brazil, China, Portugal, and Spain. This allowed disambiguation of questions and enumeration of choices in the final version of the questionnaire. Respondents were also asked whether they would be willing to be approached for follow-up questions and clarification of their answers. Further exchange will provide valuable insights into some of the qualitative analysis during the next stage of this project.

Textual analysis was used for qualitative analysis of the open-ended questions. Quantitative analysis of closed questions enabled some patterns to be observed. Descriptive statistics were used to provide an indication of the relative prominence of different issues and concerns, and also to identify which KOSs were widely used. A detailed statistical analysis and correlation statistics were not considered

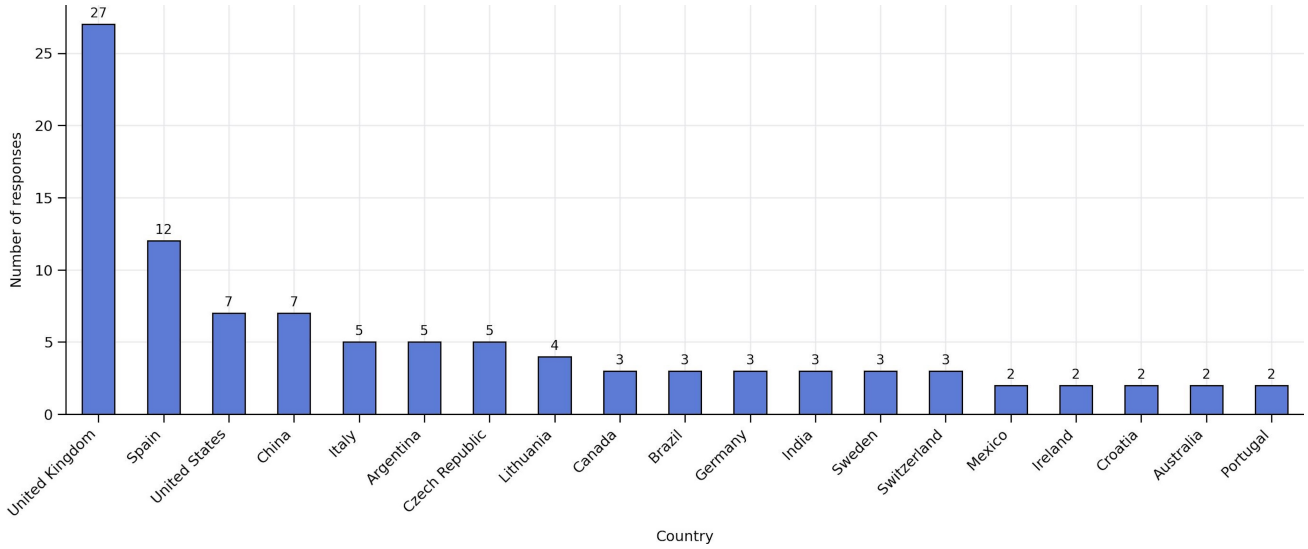

Fig. 1. Responses by country.

appropriate for this sample of respondents, as they are not necessarily representative of the total population of research and academic libraries globally.

3. Results

3.1 Geographical Distribution

The survey was distributed globally and received responses from 114 academic and research libraries in 34 countries. Although this was an international survey, the majority of the responses were from the United Kingdom, Spain, China, and the United States. There was a good spread of European libraries represented in the survey, followed by the Americas and Asia. There were two responses from Australia and no responses received from Africa. Fig. 1 provides a breakdown by country where there was more than one response (a total of 100 responses; single responses were received from a further 14 countries).

3.2 Responding Libraries

The aim of the study was to consult academic and research librarians worldwide. We used communication channels and contacts through IFLA and ISKO, both international organizations representing all types of libraries and comprising professionals specializing in knowledge organization. However, in spite of the questionnaire being distributed in four languages, the majority of responses received were from the English-speaking world. The fact that no answers were received from some of the largest parts of the world, such as Africa, indicates that an analysis of the global and regional differences would require a more representative sample.

As shown in Table 1, the respondents are predominantly from academic libraries, with 69 representing university libraries and a further 19 from libraries specializing in a particular domain or field of study within universities. A smaller number of responses were received from centers or research institutes (7) and national libraries (7). Other library types are represented only marginally, including archives (3), museum libraries (3), government libraries (2), and other special libraries outside academia (2). Consortia and corporate libraries are each represented by a single respondent.

3.3 Software

3.3.1 Library Management Systems

Library management systems incorporating discovery systems included suppliers such as Ex Libris, SirsiDynix, Aleph, EBSCO, Koha, and OCLC (see Table 2 for software mentioned by two or more respondents). The most commonly reported system is Primo (29), followed by Alma (13) and then by other systems (12), indicating a strong presence of Ex Libris products alongside a diverse set of alternatives. EBSCO Discovery System (10), Aleph (9), and Koha (8) form a second tier of widely used platforms. The remaining systems, such as OCLC WorldCat Discovery, OCLC WorldShare Management Services (WMS), Summon, Symphony, VuFind, and Dot Beyond are each used by only a small number of respondents, reflecting a fragmented landscape beyond the dominant discovery solutions. Thirteen respondents did not indicate any library management software, and some only indicated a vendor and not the specific software used. Several libraries use more than one system.

Several respondents distinguished between software used to manage library collections, and workflows and software used as search interfaces for end users. For example, Koha is used in some libraries by library staff for day-to-day management tasks, while Aspen is an open-source discovery system developed by ByWater Solutions that provides the public search interface. Similarly, some respondents re-

Table 1. Breakdown of responses by library type.

Library type	Frequency	Description and notes
Academic	69	university library
Academic special	19	libraries specializing in a particular subject within academia (e.g., social sciences)
Center	7	identified either as an institute, center or academy with one or more research organizations
National	7	national library (total is 7, not counting here the 1 counted under "academic"; 1 is national-special counted here)
Archives	3	(1 government/state archive) mainly an archival collection (not part of an academic library with archives)
Museum library	3	
Government	2	government library (e.g., EU Council)
Other special	2	includes a specialized library outside an academic setting, e.g., library in a religious institution (church or monastery), law/legal
Consortia	1	catalog includes collections from member libraries
Corporate	1	a collection in a corporation/industry
TOTAL	114	

EU, European Union.

Table 2. Software used by libraries.

Software	Frequency
Primo	29
Alma	13
Other	12
EBSCO Discovery System	10
Aleph	9
Koha	8
OCLC WorldCat Discovery	4
OCLC WMS	3
Dot Beyond	2
Summon	2
Symphony by SirsiDynix	2
VuFind	2

WMS, WorldShare Management Services.

ported using an OPAC/WebPAC as the front-end for Sierra (by Innovative Interfaces, now part of Clarivate), alongside a separate discovery system such as EBSCO Discovery Service (EDS).

Others clarified relationships between systems and interfaces, for instance: Primo is the underlying discovery system, while OneSearch is the branded search interface built on Primo that allows users to search across multiple resources. In the case of SirsiDynix, the company is the vendor, and Symphony is its integrated library system. One respondent also referred to the UNESCO WXIS library catalog, describing Weblis as the web-based catalog application built on UNESCO CDS/ISIS, with WXIS (or WWWISIS) being the software developed by BIREME to enable web access to CDS/ISIS databases.

3.4 Use of KOSs for Subject Access

General KOSs (i.e., those covering all areas of knowledge, whether classifications or alphabetical indexing languages) are most typically used in educational or academic settings. Special KOSs (i.e., those covering specialized subjects, e.g., law, medicine, art, etc.) are typically used in special and research libraries. Some specialized research or university libraries have a supporting reference collection covering general knowledge alongside the main part of the collection for their specialized field. Such libraries will be using both types of KOSs: general and special.

This study is expected to reflect these usage patterns and to highlight some concerns with searching solutions that support or limit respective interface functionalities of all types of KOS, in addition to their simultaneous and seamless use. In an analysis of KOS, one has to keep in mind that some libraries may be reporting the use of multiple systems, and only some of the KOS being supported on the searching interface.

According to the responses received, the most frequently used general classification systems are Dewey Decimal Classification (DDC), Universal Decimal Classification (UDC), and Library of Congress Classification (LCC), followed by three national schemes: Chinese Library Classification System, German Library Classification System (Regensburger Verbundklassifikation - RVK) and Russian State Rubricator for Scientific and Technical Information. The high frequency of DDC, UDC and LCC comes as no surprise; these systems are used internationally and translated into a number of languages and are known as the most widely used classifications and de facto standards. Amongst special classification systems, the National Library of Medicine Classification is mentioned multiple times, which is also to be expected given that this is one

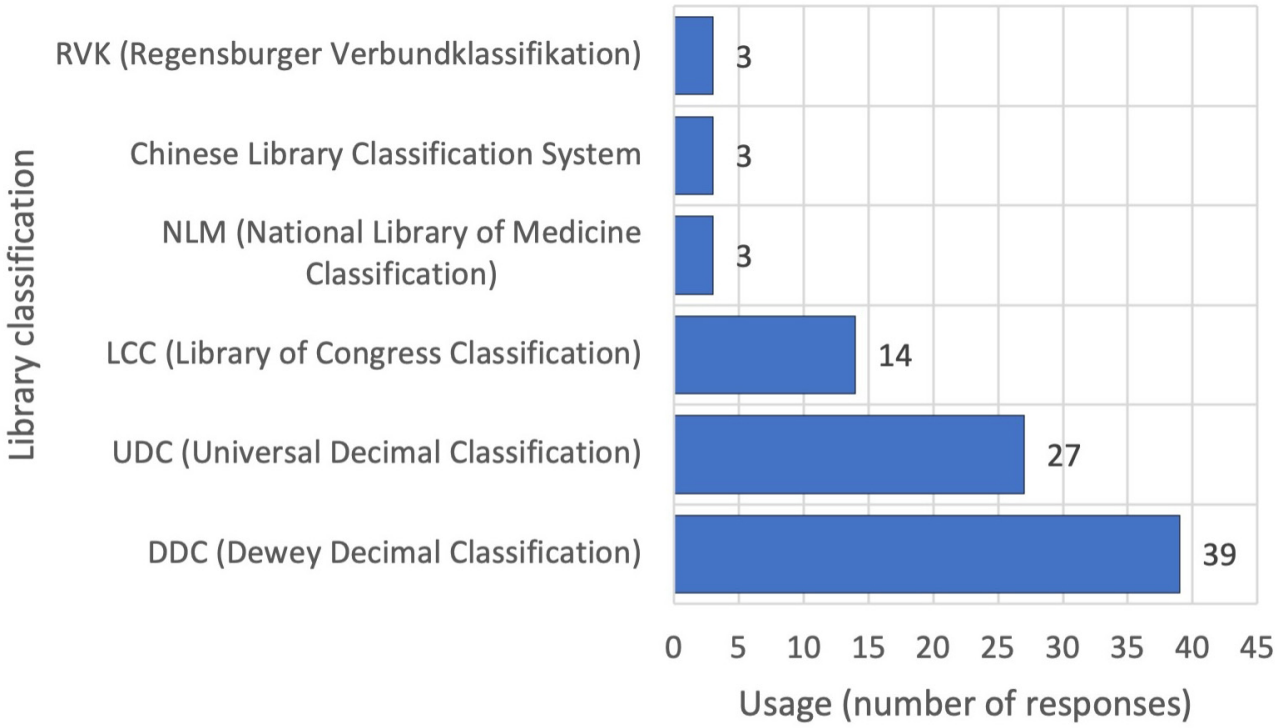

Fig. 2. Library classification systems usage (3 or more instances).

of the most widely used special classifications. Fig. 2 provides statistical details.

A selection of other specialist classifications was mentioned by individual libraries, some are used on the national level only (e.g., Basisklassifikation in Germany) or are special extensions of larger systems, such as McColvin Classification for Music designed to be used alongside DDC.

Table 3 displays the usage frequency of various international subject indexing languages used by two or more respondents. The most widely used international subject indexing language among respondents is Library of Congress Subject Headings (LCSH) (48), plus its syntactical version Faceted Application of Subject Terminology (FAST) (9). It is followed by Medical Subject Headings (MeSH), including national translations (20), while Homosaurus (6) and the Art & Architecture Thesaurus (AAT) (3) are used by a smaller but notable group of institutions, all indicating some uptake of more specialized vocabularies. A few respondents reported using related but more narrowly scoped vocabularies, such as Library of Congress Genre/Form Terms (LCGFT) for genre and form rather than topical subjects (6), and Library of Congress Medium of Performance Thesaurus for Music (LCMPT) (2).

Table 4 shows the use of nationally used and language-specific subject indexing languages reported by more than one library in the survey. Logically, national subject indexing languages are used in a wide range of country-specific systems, and although equally important for the objectives of this survey, they are not likely to stand out statistically. The Integrated Authority File of the German National Library (Gemeinsame Normdatei - GND) is the most frequently reported (5), followed by the Czech National Subject Authority File (CZENAS) and Italian New Subject Index (Nuovo soggettario) (4 each). Several other national systems, such as Spanish Subject Headings (Encabezamientos de materia), Swedish Subject Headings (Svenska ämnesord - SAO), French subject heading system RAMEAU (Répertoire d'autorité-matière encyclopédique et alphabétique unifié), Canadian Subject Headings (CSH) and the Chinese Classified Thesaurus (CCT), are each reported by three respondents.

3.5 Libraries Without Subject-Based Controlled Vocabulary Aids

A survey question, about whether KOS are provided in most of the bibliographic records available in a discovery system, and if not which part of the collections is not covered - was left unanswered by 53 (out of 114) of respondents. In total 11 indicated that all their collections provide subject metadata. As seen in Table 5, a total of 50 (43.9%) responses indicated that they do not provide subject metadata to portions of their collections. Of these, 34 are academic libraries, 4 academic-special, 4 research centers, 4 national libraries, and 1 each of consortia, corporate, government, and museum libraries. Of these, 36 do not provide classification data, and 39 do not provide subject terms to a portion of the collection.

Table 3. International subject indexing languages.

Subject indexing languages: international	Frequency
LCSH (Library of Congress Subject Headings)	48
MeSH (Medical Subject Headings), including national translations	20
FAST (Faceted Application of Subject Terminology)	9
Homosaurus	6
LCGFT (Library of Congress Genre/Form Terms) by LoC for genre and form, no subject	6
AAT (Art & Architecture Thesaurus)	3
LCMPT (Library of Congress Medium of Performance Thesaurus for Music)	2

Table 4. National subject indexing languages.

Subject indexing languages: national	Frequency
GND (Integrated Authority File of the German National Library)	5
National Authorities of the National Library of Czech Republic (CZENAS)	4
Nuovo soggettario (National Central Library of Florence, Italy)	4
Chinese Classified Thesaurus	3
Swedish Subject Headings (SAO)	3
Canadian Subject Headings	3
RAMEAU (Répertoire d′autorité-matière encyclopédique et alphabétique unifié, French subject headings)	3

Table 5. Collections without subject metadata.

Type	No. of responders	No subject metadata (n)	Percentage of all respondents (N = 114)	No Classification	No subject terms
Academic	69	34	29.8%	24	25
Academic-special	19	4	3.5%	4	3
Archives	3	0	0%	0	0
Centers	7	4	3.5%	1	3
Consortia	1	1	0.9%	1	1
Corporate	1	1	0.9%	1	1
Government	2	1	0.9%	1	1
Museum library	3	1	0.9%	1	1
National	7	4	3.5%	3	4
Other-special	2	0	0%	0	0
Total	114	50		36	39

3.6 Training and Support for Users

Respondents were asked about the level of training and support that was available to users. Of those that responded to this question, 20% (n = 23) did not provide any training or support for users for subject searching.

Libraries in academic institutions offered introductory training for new students at undergraduate and/or postgraduate levels. In a few instances, the training was integrated into the students' academic program - these can be either distinct information literacy courses or integrated with other subjects during the course of study or as training on the use of information resources (e.g., in research methodology).

Some libraries did not proactively provide support, but did respond to specific requests by users. This took the form of on-demand (5 responses), one-to-one training (3) or *in situ* support from a subject specialist. Online training, training videos, and user guides were also mentioned as ways of supporting users.

Individual libraries mentioned support for advanced searching using specific resources, such as the British Nursing Index, Library of Congress Subject Headings, Cumulative Index to Nursing & Allied Health (CINAHL), and Science Direct. Another library mentioned a link to a thesaurus directly from the search interface.

3.7 Barriers to the Use of Subject Metadata

Answers to the open question on barriers to the use of subject metadata were grouped into conceptual categories, which in turn can be linked to three main problems, listed in order of prevalence: (1) the implications of using KOSs as opposed to alternative approaches, such as free-text search-

ing or automatic indexing; (2) the quality of interfaces and ease of use or availability of instructions; and, (3) the quality of the library-provided bibliographic services and subject metadata.

3.7.1 Barriers Related to KOSs

Mentions of barriers for KOS use fell into the following categories, listed by frequency:

- Lack of familiarity with KOS: Users may not be familiar with KOSs, and the terms or notations are too different from everyday language (46 responses). They are "not intuitive" and may use expressions that are unfamiliar to users, e.g., "hovercraft going under Ground-effect machines". Some users may not be aware of the KOS being available or do not understand their function. As one respondent observed: "there is a growing expectation for natural language search capabilities due to AI advancements". While classification codes are more aimed for librarians than end users, it takes time to get used to them, and even librarians not trained in cataloging may have difficulties in using KOS.
- Effort of using a KOS: Least effort, preference for keywords or natural language (20 mentions) is a related point: "for most users, it's not worth learning our bespoke systems which may not be useful anywhere else". Although KOSs include natural language, most interfaces do not display it together with the equivalent class numbers or preferred terms.
- KOS limitations, e.g., in terminology or updates (18) may be an intrinsic problem: they can be outdated, unsuitable for indexing some kinds of document, "Eurocentric" and "harmful", representing "ideological barriers". These issues have been frequently reported in the literature (e.g., Olson, 2002) with an intention to stimulate faster revision of KOSs; the frequency of updates will also affect their relevance.
- KOS language (7): KOS can be in a language, often English, different from the one preferred by users, especially in multilingual countries. This may affect the very structure of terms: "Norwegian language allows for an extensive use of a combination of terms, but the subject headings system is partly built in a different way". US terminology and spelling may look unusual in other countries.
- KOS diversity and mashup (4): Union catalogs sometimes include subject metadata from a large number of libraries in a variety of different KOSs. This diversity may not be well supported by interfaces, or by use instructions and training, thus preventing users from discriminating between systems.

3.7.2 Interfaces and Ease of Use

A second group of barriers reported by respondents concerns interfaces and instructions on how to search:

- Subject fields and metadata are poorly visible (20 responses), being only available in advanced search or only within particular databases, but not in the unified discovery tool. This is especially so in the case of special collections, which may be nested in detail or expanded views, or searchable only from already found results. "While the keyword index does include the subject headings, these are drowned in all the other data such as summaries, abstracts, etc." Generic search by keywords, titles, authors, or even reading lists are usually more visible than subject search.
- Classmark captions (descriptions) are often missing, while class notation is obviously difficult (11), in spite of having "an irreplaceable value in anchoring new subject terms in the structure of science": users should "start a search with a term, then take the corresponding DDC number and restart a search". This highlights the need for interfaces that allow end-user entry to classifications, enabling users to start with natural-language terms, identify the corresponding DDC number, and then continue or refine their search using the classification rather than requiring prior knowledge of notation.
- Instructions, context-sensitive help or training are missing (10), both written and as part of staff help and information literacy opportunities; this includes "information on benefits".
- Interfaces are unfriendly (9): while some functionalities may be missing or not clear, "many options for search and facet might overwhelm patrons". Also, they may create barriers for users with disabilities.
- Browsable lists are missing (4): this would clearly be an essential functionality to leverage alphabetical or systematic order provided by the KOSs; as classifications and thesauri have tree structures, "the possibility to navigate the tree" should be offered.
- Facets or descriptors in compound subjects (complex expression) cannot be selected and combined individually or vice versa: they are not linked when then form a semantic unit (4): "they are hyperlinked as a whole, so where there are subdivisions you can't access the broader term by clicking the hyperlink, only that whole string", particularly in case the faceted combination is "too narrow to perform other searches"; in contrast, in another case: "system is post-coordinated and therefore the user needs to combine words that they normally use in compound".
- Functionality supporting separate search fields is missing (4).
- Term truncation functionality is missing (3), which is a significant limitation for making effective use of hierarchical notation or descriptor subdivisions.
- Boolean functionalities are limited (1).

3.7.3 Barriers Within the Library Service

Finally, barriers can reside in the library services, independently of the used systems and interfaces:

- Quality of indexing is poor (11 responses): there may be "historic cataloging inaccuracies"; indexers may "not be fully educated" or updated; assigned classes and

terms are sometimes too general, which might have to do with changing indexing policies or lack of indexing control; they may be incorrect; "not every relevant subject heading is added to every resource, so people miss useful resources". These may be related to a lack of indexing policies or a lack of their alignment in union catalogs; or a lack of a senior catalog librarian team who would check and align assigned index terms. Also, material may not be indexed uniformly, or not be indexed at all, often due to a lack of time or resources.

- Librarians are not familiar with KOSs (3), e.g., "don't fully understand the difference between subject headings and keywords", pointing to the lack of and the decline of appropriate education and training in knowledge organization (Hudon, 2021).
- Lack of dialogue with interface developers (1): "we don't have sovereignty over algorithms, ranking and so on".
- Lack of reference service (1).

3.8 General Comments From Librarians

3.8.1 Lack of Subject Search Functionality

The questionnaire invited librarians to contribute their general comments. While some of these reflected on the issues already mentioned as barriers, others were more original. Of those that responded (n = 15), the majority commented on challenges limiting effective use of KOSs. Six respondents commented on the underuse or limited functionality of subject search in current systems. Of these, one noted that their subject headings could be put to greater use, another that subject searches based on controlled vocabularies should be more visible, while one mentioned that their library includes UDC fields in records but without using them in searches. A third respondent lamented the general decline of subject searching despite its greater precision. The fourth expressed interest in doing more with subject indexing, particularly around persistent identifier (PID) and name authority file (NAF) management for the disambiguation functions, as well as Linked Open Data (LOD) options. Two others commented on the loss of visibility and support for subject heading indexes in modern discovery tools. One noted that previous systems provided useful subject heading indexes, which are now dismissed as outdated and accessed only indirectly.

3.8.2 Lack of Visibility of KOSs

Seven respondents identified technical limitations in library systems and discovery services. One noted that many discovery engines mix KOSs from different databases, leading to inconsistent and incomplete results. Another pointed out that current library management systems do not support optimal subject heading use or classification browsing. Similarly, a third called for improved visibility of classification systems and thesauri in discovery layers, so as not to lose decades of investments into subject metadata, and also asserting their importance for precision and comprehensive search. Another stated that many discovery tools do not make use of KOS advantages in the process of searching, such as disambiguation, term explosion, or related-term navigation. One respondent recommended implementing background mapping functions, while another emphasized the importance of making entities and relationships from subject indexing systems visible and understandable to users. One focused on local customization and system variation, highlighting that their institution has a sophisticated search interface enabled through catalogerled configuration, something not possible everywhere. One commented that there are no good library systems on the market that allow optimal searches by subject or by class.

3.8.3 Need for Improved User Training

Two other major themes emerged from this open-ended question: literacy training and raising of awareness. The majority of respondents (n = 5) emphasized the need for improved user training. Three individuals specifically called for more training sessions and one-on-one consultations to help users understand subject searching and navigate library tools effectively. Another person advocated for integrating information literacy into the academic curriculum to strengthen students' research capabilities. Additionally, one contributor noted a decline in support for subject searching among research students and suggested that libraries should reinvest in this area.

3.8.4 Enhanced User Education

Four respondents pointed to the need to raise awareness of KOSs in subject searching. Two individuals highlighted that students and academics often remain unaware of controlled vocabularies, even though their use significantly improves search results. One contributor pointed out that while subject searching is often considered less relevant for undergraduates, there is a noticeable gap in support for research students. This area had previously received more attention but has declined in recent years. One person also emphasized the importance of academic libraries actively promoting their discovery tools, particularly in contrast to general search engines, to showcase the advantages of structured metadata and curated content. These insights reflect a demand for both enhanced user education and proactive communication about the benefits of subject access and cataloging practices.

3.8.5 Support for Continued Use of KOSs

Another six respondents expressed strong support for the continued use of KOSs. Three respondents specifically emphasized that controlled subject access points are essential for accurate and effective information retrieval, particularly for enabling precise and specialized searches. One of these noted that they also enhance the interoperability of library discovery tools with other databases and web technologies. Two respondents highlighted the broader value of

subject indexing, with one describing it as a "hidden treasure" that should be better recognized and utilized. One respondent welcomed ISKO's initiative to develop recommendations in this area, viewing it as a positive step forward. Finally, one person stressed that even with the rise of AI tools, the role of KOSs remains important and should not be overlooked.

3.8.6 Resources for Subject Indexing

Three respondents raised concerns about the economic and resource constraints affecting subject indexing. Two respondents directly pointed to the lack of human resources and the high cost of subject cataloging, and that there are probably not enough human resources to index all the documents. One of them specifically identified two major pressures threatening subject cataloging: ongoing government budget cuts and unrealistic expectations about artificial intelligence replacing human expertise in this area. The third respondent emphasized that changes affecting subject indexing practices in their context were driven primarily by a lack of funding.

3.8.7 Navigation Within KOSs

Two respondents emphasized the importance of visible and navigable subject hierarchies. One noted that their library makes a deliberate effort to highlight the subject hierarchy within their OPAC to support user discovery. The other respondent stressed the necessity of offering clear navigation aids for any classification system used, recommending the display of classification headings, ideally through a tree representation of the system, which they found to be particularly effective.

3.8.8 Out-of-Date and Biased KOSs

Five respondents raised concerns about bias, outdated terminology, and exclusionary practices in controlled vocabularies. Three respondents reported that their institutions are actively engaged in efforts to address harmful or offensive subject terminology. One described a subject remapping project aimed at replacing such terms in the discovery layer; another stated they were preparing to tackle offensive headings; and a third noted that their library had already revised its in-house classification scheme after identifying outdated and offensive language. Two additional respondents addressed broader structural and systemic issues. One noted that inconsistencies and bias in cataloging quality can negatively affect discovery. Another called for more discussion and action around decolonizing classification systems, particularly in the context of digital transformation and AI, which often rely on Eurocentric, biased vocabularies. This respondent also highlighted the Latin-script dominance of discovery technologies, which creates barriers to retrieving and representing data in non-Latin scripts. For example, El Sherbini (2026) points out the deficiencies of English-language subject headings and thesauri when it comes to the retrieval of material in Arabic.

3.8.9 Lack of Engagement With Subject Headings

Four respondents expressed doubt, frustration, or concern about the perceived declining relevance and appreciation of subject headings and classification in current library environments. Two respondents reflected on the limited use of subject headings by users, especially undergraduates, who tend to search for known items and bypass structured metadata. One of them questioned whether users even engage with systems such as Primo at all. The other observed that even public-facing librarians often underestimate or overlook the value of subject headings when helping users, which reduces their promotion and use. One respondent voiced existential concerns about the utility of their work, wondering whether subject cataloging still has a meaningful impact. Another acknowledged the historical importance of subject classification in organizing physical collections, but questioned how this value carries over in a digital, full-text search environment, indicating a lack of training in the value of controlled vocabularies.

3.8.10 Specialist KOSs

At the same time, five respondents affirmed the continued importance of KOSs in supporting effective discovery, particularly in specialized or constrained contexts. Two respondents emphasized that subject metadata must be properly included in metadata and catalogs, with one stressing that it is a professional responsibility to follow standards and ensure subject metadata are treated as a primary search component. Two others discussed the value of locally developed or specialized KOSs. One respondent explained that general descriptors are often too broad for their specialized users and collections; as a result, they create tailored taxonomies to improve search relevance. Another similarly argued that university libraries should use specialized thesauri or controlled vocabularies to offer more precise access to academic resources. One respondent shared a practical example of subject access' value during the pandemic, when access to physical collections was limited. They successfully promoted the "browse shelf" function in their discovery system, which leveraged subject metadata to group related resources and aid virtual discovery.

These answers and comments show a widespread awareness of the value and need of subject access tools among librarians, despite a general trend towards their abandonment or replacement with fully automated information processing tools. While the interest of most professional literature seems to be impressed by innovative technological approaches, a large number of professionals still believe that traditional tools are needed for their daily work.

4. Discussion

This survey set out to gather evidence to address the following research questions:

RQ1: What kind of search/browse interface is provided by academic and research libraries?

RQ2: Are users able to access subject metadata from KOSs?

RQ3: What support is provided to users for subject access?

RQ4: What are the barriers to the adoption and use of subject metadata in library discovery systems?

4.1 Use of Discovery Systems

The survey showed that the use of discovery systems is widespread in academic and research libraries. These tend to be interfaces provided by the Library Management Systems themselves and could be seen as a development from the first generation of OPACs. In the majority of cases, the user is presented with a simple search box (rather like an internet search via Google). This may allow searching of several different resources in one go, rather than repeating the search strategy for each online resource. This is convenient for users, especially if they are not digging too deeply into a topic. However, it comes with challenges for users due to the ambiguity of natural language.

4.2 Access to Subject Metadata

End users do not seem to have enough benefits from subject metadata. Subject metadata are not made use of at search interfaces (disambiguation, related terms, narrow terms, browsing, etc.). Users do not often have access to KOS displays. Introduction and basic training in the use of the library catalog often do not cover subject searching using KOSs. The result is that users do not have the means to use KOSs to aid their searching. The risk here is that, due to shortcomings of the subject searching interface, the value of KOSs and their potential are not recognized and appreciated.

4.3 Loss of Intellectual Content

There is a very real danger that the intellectual content of KOSs will be completely bypassed by users and will eventually cease to be created and maintained. However, it is becoming clear that KOSs have a vital role to play in AI mediated searching (Salatino et al., 2025). Further developments in automatic indexing could also make searching easier and more accurate. There has certainly been a change in the search paradigm from measures of precision and recall to a more statistical approach, which provides a best match and ranked search results according to relevance (Hambarde and Proença, 2023; Khalid et al., 2025). This leads to the question: Is there still a role for human indexing and cataloging of resources? And a wider question of whether there is still a role for KOSs and indexed resources, regardless of whether the indexing is human or machine-based. A third question arising from this is: What role can LLMs play to support human indexing?

4.4 Support for Users

From the responses received, it transpires that effective use of subject metadata and other advanced search features depends on support provided to users. The librarians are concerned that users are unaware of the existence of subject metadata or are not sure how to use them. Support in the form of training, advice, and assistance with specific search tasks was provided by the majority of libraries. This ranged from induction courses for new library users through to specialized training for specific KOSs such as DDC or MeSH. More detailed research is needed to investigate the content of the courses and induction sessions to determine whether they include features such as advanced searches and the use of KOSs that are appropriate to the users' interests. Some libraries provided user guides and online tutorials to guide students. The content of these guides would be another interesting area of investigation. A significant number of libraries did not provide any support, several citing a lack of resources. There does not seem to be evidence of much demand from users, coupled with a more worrying lack of awareness of KOSs among librarians. This suggests that a stronger case needs to be made to librarians and library users about the benefits of using KOSs, to secure uptake of these services.

4.5 Barriers to the Use of KOSs

This brings us to the next concern about what barriers there are to the use of KOSs and how they might be overcome. A significant number of respondents did not report on the provision of user support when it comes to accessing KOSs. This may be because the interfaces never provided a KOS searching option in the first place. Another possible explanation is the lack of adequate training for users, although this problem may be mitigated with a well-designed and intuitive interface. This survey was not best suited to investigate reasons for this, and this is something planned to be covered in follow-up interviews. One possible explanation is the lack of resources available for user training. Although most academic libraries have induction sessions for new students, subject searching is covered in very general terms - usually based on the construction of search statements and selection of free-text terms to formulate the search statements.

Very few mentions were made of links to searching aids such as subject heading lists, thesaurus systematic displays, or classification schemes. This may be perceived as a shortfall of the discovery system. In some cases, the possibility of these links exists but has not been implemented. If library managers do not know how to ask for this functionality and if salespeople from the system vendors are unaware of the requirement, this is then not made available to the user. This suggests that engagement with vendors is vitally important to make them aware of the importance of subject searching by their customers.

4.6 Improving the Quality of Search Results

The reality of searching today is that users have been habituated to a single search box rather than a multi-field search interface. They have been insulated from the 'mechanics' of advanced searching via tools such as thesauri and other controlled vocabularies, as well as subject headings and other classification schemes. Statistical approaches and ranked search results have become the standard approach to searching. Knowledge graphs and other linked data systems have also enhanced the quality of searches. LLMs have become a standard part of the search environment for Internet searches. Clearly, these approaches have their place, and the question now is whether there is any benefit in integrating these automated approaches with human indexing. Several speakers at the recent IFLA session (Nadj-Guttandin, 2025) and Networked Knowledge Organization Systems/Services/Structures (NKOS) workshops argued for a positive answer (Busch and Zeng, 2025), and the ISKO UK 2025 Conference (Zeng, 2025). Automatic indexing has been in place for a while, and enhanced search features that use controlled vocabularies 'behind the scenes' are also well established. This means that a search term entered by a user may generate suggested alternatives based on synonyms or preferred terms to the one used by the searcher. A keyword can also reveal the relevant section or sections of a classification scheme. With the recent advances in LLMs, might there be a role for the use of KOSs to train the LLM for better searching, for example?

Although the use of AI and LLMs was beyond the scope of this survey, it is clear from the user response that this is an area of growing interest and it warrants further investigation. This theme could be picked up in follow-up interviews.

5. Conclusions

This study set out to survey the use of KOSs, in particular subject term vocabularies and classifications for subject searching, when using a library information retrieval system or a discovery tool. Although this was a global survey, a large number of responses came from the UK, European countries, China and the United States. This was partly because of the access to strong professional networks in those countries. The limited language coverage of the survey undoubtedly acted as a barrier to institutions in countries outside English, Spanish, Portuguese or Chinese-speaking regions.

The survey provided an up-to-date snapshot of the software solutions used in libraries at the time of the continuous and fast-changing library technology scene. The findings show libraries use a variety of tools or software to provide access to resources, with several cases using a different tool for managing the collection's resources and for the user interface for searching the collection. For example, some use an integrated library system (ILS) for managing the collection and for resource descriptions or metadata, but a separate but linked tool for resource searching or discovery (often referred to as a discovery tool or layer).

It is also evident that most research libraries include subject metadata in the description of their resources, some for the entire collection and others for the majority of their collection. Subject metadata are incorporated as assigned terms from controlled vocabularies, such as LCSH, and class numbers from classification schemes, such as the DDC. Although subject metadata are included in the metadata records, they are not always presented to the user or presented as an option to incorporate the data from the KOSs in browsing or searching for collection resources. It is even more interesting that when metadata exists and systems allow the use of the subject metadata for browsing or searching, these options are hidden behind an advanced search interface that is not obvious to the user.

Several barriers were identified, which relate to the use of, and access to KOSs by users, system and interface support for subject searching, complexity of KOSs, and user familiarity, skills, and experience in using subject metadata when browsing or searching for information.

The findings are aligned with the findings of other studies that show the benefits of KOS metadata and their importance in automatic indexing and integration of AI in resource discovery tools (Salatino et al., 2025).

Further research is necessary for a better understanding of the implications, benefits, and disadvantages of the use of subject metadata at various methods and levels, e.g., fully incorporating KOS information, partial use of KOS information, and hybrid use of KOS and advanced technologies, such as AI in resource discovery.

This project is part of a wider initiative to develop a set of guidelines for libraries during the procurement of discovery systems. The focus is on making subject metadata available during searches and to enable users to navigate through KOSs. International collaboration and involvement of the different stakeholder groups (library users, library managers, vendors) will help to address the challenges presented by the use of subject metadata during searches. This has been a concern from the earliest days of OPACs (Gödert and Horny, 1990).

The next stage of this research will focus on moving from analysis to action by engaging key stakeholders around a shared set of goals. This will involve consultation with discovery system and library platform providers to understand how subject-based features can be better implemented. This would be followed by engagement with end users and their representatives to identify which forms of support, interface features, and interaction patterns are most valuable in practice. Bringing these perspectives together will help ensure that rich subject metadata and KOS structures can be translated into usable and accessible discovery interfaces. Afterwards, the scope could be expanded beyond the primary research library focus of the current

study to include other cultural heritage institutions, such as public libraries, museums, archives, and institutional repositories, where subject indexing and controlled vocabularies also play an important role.

Together, these activities would support closer collaboration between researchers, practitioners, system providers, and users, and would be used to inform the ongoing development of the ISKO STAC guidelines for subject search and browse functionalities of interfaces (https://www.isko.org/stac/metadata.html). By grounding the guidelines in empirical evidence and cross-sector dialogue, this work would help align theoretical principles of subject access with practical requirements for information retrieval and interface design, ultimately supporting more effective searching, browsing, and sense-making across diverse collections.

Availability of Data and Materials

Anonymised survey data is available on application to Edinburgh Napier University Research Repository (https://www.napier.ac.uk/research-and-innovation/repository).

Author Contributions

DH, CG, KG, ASal and ASla designed this study. DH set up the survey, DH, CG, KG, ASal and ASla contributed to the data analysis. DH drafted the manuscript. All authors contributed to critical revision of the manuscript for important intellectual content. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

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The authors declare no conflicts of interest. CG, DH and ASla are serving as Editorial Board Members of this journal. We declare that CG, DH and ASla had no involvement in the peer review of this article and have no access to information regarding its peer review. Full responsibility for the editorial process for this article was delegated to NT.

Declaration of AI and AI-Assisted Technologies in the Writing Process

During the preparation of this work, the authors used Microsoft Copilot in order to check spelling and grammar. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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