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Title:
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Date:
2024-01-01

Citation:
Halman, A. & Oshlack, A. (2024). Catchii: Empowering literature review screening in healthcare. Research Synthesis Methods, 15 (1), pp.157-165. https://doi.org/10.1002/jrsm.1675.

Persistent Link:
https://hdl.handle.net/11343/337556

Received: 22 March 2023 | Revised: 17 August 2023 | Accepted: 18 September 2023

DOI: 10.1002/jrsm.1675

SOFTWARE FOCUS

Research Synthesis Methods WILEY

Catchii: Empowering literature review screening in healthcare

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Funding information
National Health and Medical Research Council, Grant/Award Number: GNT1196256

Abstract

A systematic review is a type of literature review that aims to collect and analyse all available evidence from the literature on a particular topic. The process of screening and identifying eligible articles from the vast amounts of literature is a time-consuming task. Specialised software has been developed to aid in the screening process and save significant time and labour. However, the most suitable software tools that are available often come with a cost or only offer either a limited or a trial version for free. In this paper, we report the release of a new software application, Catchii, which contains all the important features of a systematic review screening application while being completely free. It supports a user at different stages of screening, from detecting duplicates to creating the final flowchart for a publication. Catchii is designed to provide a good user experience and streamline the screening process through its clean and user-friendly interface on both computers and mobile devices. All in all, Catchii is a valuable addition to the current selection of systematic review screening applications. It enables researchers without financial resources to access features found in the best paid tools, while also diminishing costs for those who have previously relied on paid applications. Catchii is available at https://catchii.org.

KEYWORDS
data extraction, duplicate detection, screening, systematic review, web application

Highlights

What is Already Known

- There are several software applications available for performing systematic review screening.
- However, those programs are either paid or offered for free but with limited features and utilities.

What is New

- This paper presents Catchii, a free, user-friendly web application that offers all the key features of systematic review screening tools found in the best paid applications.

- In addition, Catchii offers several unique features that are not provided in other available screening tools.

Potential Impact for Research Synthesis Methods Readers

- Regardless of their financial resources, all researchers can now access a systematic review screening application that contains all the necessary features to perform their manuscript screening, which facilitates more equitable research capabilities.
- In addition, Catchii includes all previously described desirable features and includes new features which can speed up the process of systematics review manuscript screening.

1 | INTRODUCTION

A systematic literature review or systematic review (SR) is a research method used to systematically evaluate the scientific literature on a specific topic. The process involves identifying relevant studies from a large pool of literature, assessing their relevance and quality, and synthesising their findings to provide an overview of the current state of knowledge on the topic. SRs are commonly used in the healthcare field and are becoming increasingly popular, with a four-fold increase in the number of SRs published over the past decade indexed by PubMed with over 30,000 articles in 2022 alone.[1]

One of the challenges of conducting an SR is the time-consuming process of screening articles. To address this, various software tools and applications have been developed to aid reviewers during the screening process. A feature analysis of 16 different SR software applications and methods was conducted by Van der Mierden and colleagues, who determined and scored the mandatory, desirable and optional features of an SR tool in the biomedical research context.[2] The five highest-scoring tools were DistillerSR,[3] EPPI-Reviewer,[4] SWIFT Active Screener,[5] Covidence[6] and Rayyan.[7] The authors concluded that the first four applications all support mandatory features and are preferred for screening.[2] However, those applications require a paid subscription. The highest scoring free application was Rayyan, but it does not have all the mandatory features, specifically missing the full-text screening phase.[2] Similarly, another comparison of SR tools in healthcare recommended Covidence and Rayyan as the highest-scoring tools in their feature analysis.[8]

With regards to pricing, as of February 2023, the cheapest DistillerSR package costs $19.95 in U.S. dollars (USD) a month for three students (limited to one project) and access to multiple projects and additional features requires a more expensive package.[3] EPPI-Reviewer provides two packages: £10/month ($12.40 USD, based on the current exchange rate) for one user (unlimited single-user reviews) and £35/month ($43.40 USD) for one user (unlimited multiple-user reviews).[4] Covidence on the other hand has yearly packages, the cheapest one costs $240 USD for one user and is limited to one review.[6] While Rayyan is commonly considered as a free tool, the free version is limited. For example, it has a maximum of three active reviews, a maximum of 100 decisions on mobile app, cannot revoke a reviewer and no PRISMA flow-chart generation is included. To access more features from Rayyan requires a professional package that costs $8.25 USD/month for one user.[7] All in all, a substantial cost can be incurred by researchers as a systematic review takes around 15 months on average to complete and publish,[9] and the use of two reviewers for screening is the current standard.[10]

In this article, we present a new software application called Catchii, which is designed to perform efficient and fast screening of articles for a systematic review. The development of Catchii focused on creating a user-friendly experience and included all necessary features identified for an SR tool. Importantly, Catchii is offered as a free unlimited application, enabling researchers without financial resources to access the same features as paid applications, facilitating more equitable access for conducting an SR. In the subsequent sections, we provide an overview of the workflow and explain the process of feature selection and their subsequent integration into the software, followed by a comparison with other similar tools.

2 | DESIGN AND IMPLEMENTATION

2.1 | Using Catchii for literature screening

A general workflow for conducting literature screening using Catchii is outlined in Figure 1. It starts with the creation of a new review project and subsequent

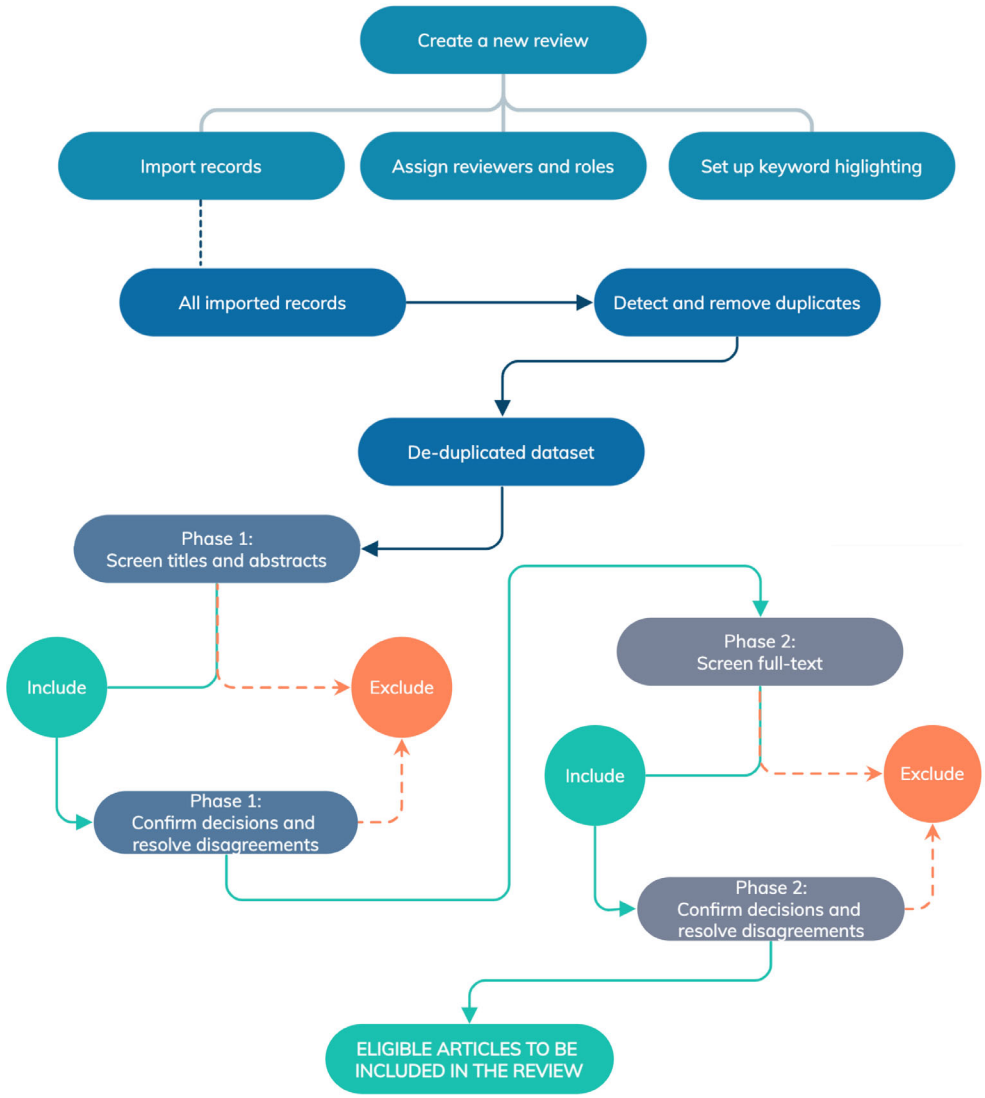

FIGURE 1 General workflow for undertaking a systematic review using Catchii. [Colour figure can be viewed at wileyonlinelibrary.com]

configuration of the project. This configuration phase includes the assignment of reviewers along with their respective roles within the review and determining the keywords for highlighting. Records can be imported into the system, followed by detecting and removing duplicate entries (optional).

The deduplicated dataset is then subjected to manual screening by the designated reviewers. In the first screening phase, the reviewers perform an initial evaluation of titles and abstracts, resulting in either the inclusion or exclusion of records. In the event of disagreements among reviewers, a second step is initiated to resolve these disparities. In scenarios where no discrepancies arise or only a single reviewer is assigned to the review, all decisions can be confirmed and records are forwarded to the next phase.

The second phase involves an assessment of full-text reports and making a decision whether to include or exclude it. As before, the confirmation of decisions and resolving disagreements is allowed in the second step. When excluding a record during the second phase, a reason should be provided, which will also be reported when creating the PRISMA flow chart. Reports that successfully go through this process are eligible for inclusion in the systematic review. An example of the interface is shown in Figure 2 and Table 1 provides overview of Catchii's features present at different stages.

2.2 | Application design and selection of software features

We designed Catchii to include all the features of importance in SR software identified in the previously published literature screening tool comparison analysis.[2] This article rates the importance of each software feature into three categories: mandatory, desirable and optional. The features are related to the functionality of the tool

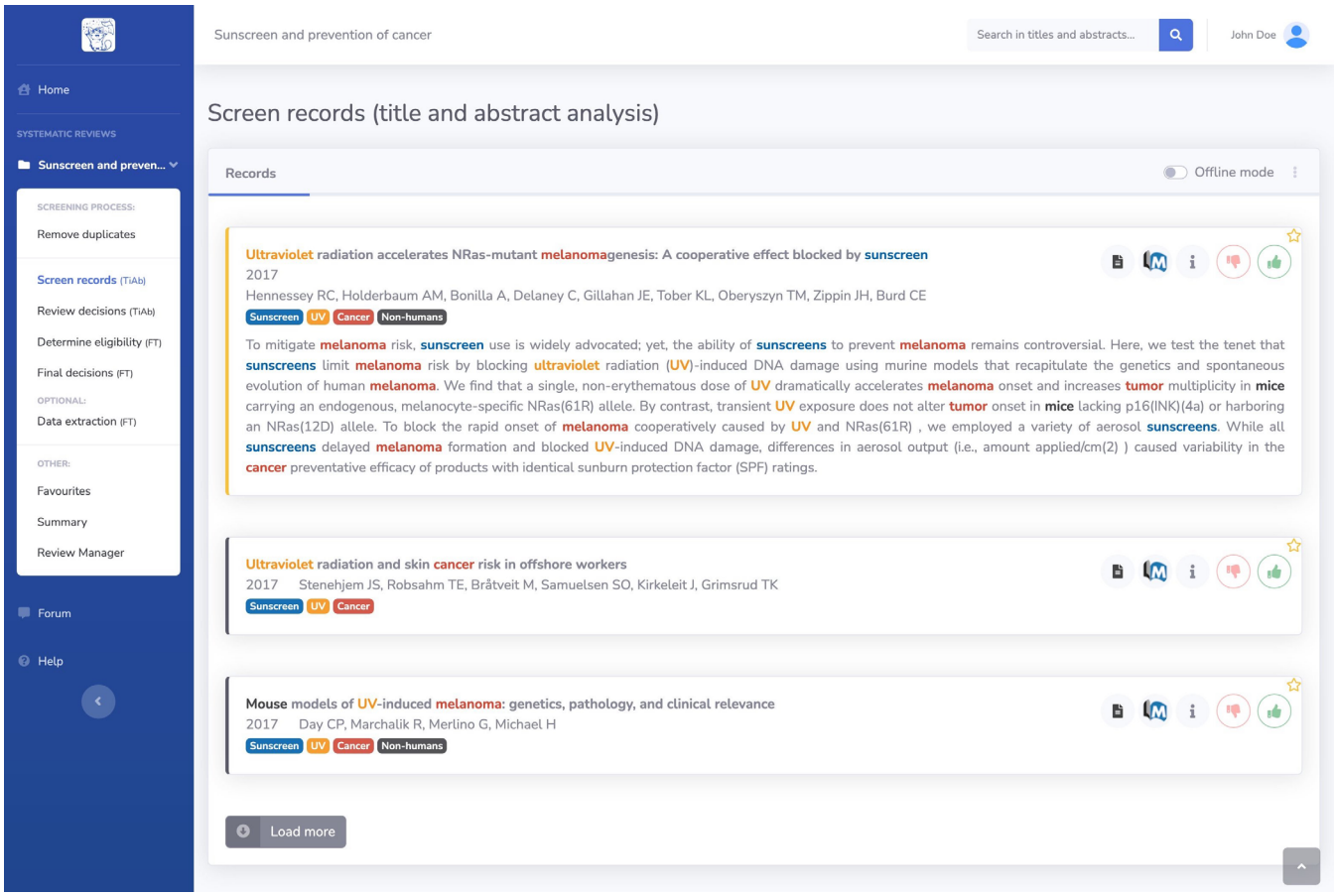

FIGURE 2 An example of the Catchii interface in the phase 1 screening. In the main panel the topmost record's title and abstract is displayed, accompanied by action buttons that offer options for linking out to the full-text article on the journal website, link to PubMed, link to view details of the record, and finally accepting or rejecting the record (top right of the record). The current example highlights four keyword groups using different colours. [Colour figure can be viewed at wileyonlinelibrary.com]

and include nine mandatory features (M1–M9), nine desirable features (D1–D9) and three optional features (O1–O3): support for importing references (M1), multiple users (M2), the ability to (re-)allocate references (M3), having distinct title and abstract (TiAb) and full-text phases (M4), including or excluding references (M5), resolving discrepancies (M6), exporting results (M7), having a stable release of the software (M8) and the level of customer support (M9). The desirable and optional features are not critical for a SR, but they can assist the process. Features such as support for non-Latin characters (D1), multiple different user roles (D2), randomising the order of references (D3), keyword highlighting (D4), attaching PDF (Portable Document Format) files (D5), attaching comments (D6), displaying project progress (D7), project auditing (D8), and being free to use (D9) were considered desirable, while reference labelling (O1), some form of machine learning/automation (O2) and flow-diagram creation (O3) were considered optional. An acceptable threshold was assigned for each feature (e.g., a "distinct TiAb and full-text" feature has the following options: "no distinct phases", "TiAb & full-text phase" and "user defined phases" and acceptable threshold is "TiAb & full-text phase"). In the following section the Catchii implementation of each feature at acceptable threshold is discussed.

2.3 | Implementation of features

Catchii is a systematic literature review tool that fully supports reference importing (M1). Users can easily import references in different formats, including files created by PubMed, Web of Science, OVID (e.g., PsycINFO, MEDLINE), Scopus, a general RIS (Research Information Systems) file created by online databases or reference manager tools (for instance, Mendeley, Endnote, Zotero, Paperpile), as well as a CSV (Comma Separated Values) file. For each uploaded set, a dataset label can be specified for the contained references (O1). Additionally,

TABLE 1 Overview of screening stages and features of Catchii supporting it.

Stage	Feature	Description
Pre-screening	Importation of references in various formats	References can be imported easily from several databases, including PubMed, Web of Science, OVID, Scopus, ScienceDirect, and Cochrane. Additionally, they can be imported from a CSV file or a reference manager software, such as Paperpile, Mendeley, Zotero, and EndNote. References in non-Latin characters are also supported.
Pre-screening	Duplicate detection and removal	References from different sources are compared with each other to find duplicate records. All detected duplicates can be removed from the dataset with one click.
Screening	Project progress	Progress of each reviewer (number of records screened/remaining) can be viewed by all other reviewers.
Screening	Multiple user support with different roles	Screening can be done by one or multiple reviewers with different roles: screening only, resolving discrepancies only, or both.
Screening	Reallocating references	In the event of a reviewer drop-out, all references can be reallocated to another user.
Screening	Distinct phases and resolving discrepancies	Two-phase screening is supported, where the first phase involves analysing title and abstract and the second phase involves assessing full-text for eligibility.
Screening	Keywords highlighting	Multiple groups of keywords can be created by using distinct colours to highlight words in titles and abstracts.
Screening	Records ordering	Records can be ordered in different ways (alphabetical, by year or randomised).
Screening	Favourites list	During screening, each record can be added into the favourites list and saving it for later use (despite whether it is screened in or out).
Screening (phase 1)	Offline screening	By default, screening requires an Internet connection. However, offline screening can be conducted without one and all decisions can be synchronised later, making them public.
Screening (phase 2)	Commenting	A reviewer can attach their comments/notes to each record, either a private one visible only for the reviewer only or a one visible for all other reviewers as well.
Screening (phase 2)	PDF upload	Any reviewer on a review can attach PDFs on each report that will be assessed for eligibility. Uploaded PDFs can be accessed by all reviewers.
Post-screening	Data extraction	The free-text data extractor allows to extract data from any eligible report in a free-text form. Uploaded PDFs can be viewed side-by-side with the data-extraction text field. Extracted data can be exported and downloaded as a separate document.
Post-screening	Results exporting	All eligible records can be exported as a RIS file (for reference manager programs) with the option to include PDFs, enabling to read them in reference manager programs.
Post-screening	PRISMA flowchart generator	A PRISMA flowchart can be automatically created based on the finalised review results (records screened in/out on different stages together with set exclusion reasons).
Post-screening	Project auditing	Each action/decision by a reviewer is recorded and can be tracked later in a plain-text audit log.
All	Designed for multiple devices	Both computers and mobile devices (smartphones and tablets) can be used for screening without any limitations.
All	Community engagement and user support	The system incorporates a public forum for community engagement or support, along with a help section and an option to contact the authors via email.

Catchii supports articles written using various characters (D1), including Latin, Cyrillic, Chinese, Japanese, Arabic and others.

Each user can perform screening for an unlimited number of reviews, and for each review, multiple users are supported (M2). Each reviewer is blind to others' decisions until everyone has made their decision for a particular article. Multiple roles for reviewers (D2) are also supported, including a manager of the review (with full access to the review), a reviewer (with rights to make

inclusion/exclusion decisions but cannot resolve discrepancies), a reviewer with the rights to also resolve discrepancies, and a reviewer who only has rights to review and resolve discrepancies (if there are any).

In the event that a reviewer drops out, references from that user can be re-allocated (M3) to a new user. Catchii has an easy system for adding, removing, and replacing reviewers from a review. A replacement reviewer can be added to the review at any time including before other reviewers have finished the title-abstract screening.

Catchii also has a built-in duplicate detection feature which compares the title or abstract of all articles published in a particular year. Articles that have an abstract or title that is at least 80% similar are returned to the user for review. By default, all duplicate records except one are selected and can be collectively removed with one click. In the case of a missing abstract, only titles are compared. We consider this feature as an automation feature (O2), as users do not have to manually find duplicate records but can automate the task. However, from the Van der Mierden article it is unclear which automation features are included in this category.[2]

Catchii also supports distinct TiAb and full-text phases (M4). In both phases, reviewers must decide whether to include or exclude a particular article (M5). In the full-text phase, a reason for exclusion can be recorded by the reviewer. Each phase is divided into two parts: in the first part, inclusion/exclusion decisions are made, and in the second part, the decisions are confirmed and discrepancies are resolved (M6). Technically, a decision for a disagreement between reviewers can be made by the manager of the review, a reviewer with rights to solve disagreements, or an additional reviewer who only has rights to solve disagreements and does not take part in the screening process. In the screening process, each reviewer can choose the order of records: either sort them by year, title, dataset label, or list them in a randomised order (D3).

To enhance the efficiency of title and abstract assessment, Catchii has incorporated an extended keyword highlighting feature (D4). In contrast to vast majority of systematic review tools, Catchii supports multiple groups of keywords and allows for the assignment of distinct colours to differentiate them. Conventional systematic review tools typically utilise two sets of keywords – inclusion and exclusion, which are highlighted in green and red, respectively. This approach can limit the acquisition of information and may cause difficulties for individuals with red-green colour blindness. By utilising keyword groups, reviewers are able to assign different colours for inclusion or exclusion keywords. For example, when the inclusion keywords are "Sun," "UV," "cancer," and "humans," Catchii can assign distinct colours for each of the inclusive word as well as for exclusive keywords (e.g., "mice," "rats," "rabbits," etc. as opposite to "humans"), allowing for quick visual acquisition of the content. We believe that this improves the assessment of abstracts and ultimately accelerates the screening process. The colours used are chosen from a range of the colour spectrum and are suitable for individuals with different forms of colour blindness. Additionally, reviewers may also have the ability to collect papers for other purposes during the screening process, which may not be included in the review but are still valuable to the reviewer. By specifying a keyword group to identify relevant papers, a reviewer can easily locate and add them to the list of favourite articles (an additional feature of Catchii). These articles can then be excluded from the screening process but can be later revisited from the list of favourite articles.

In the full-text phase, Catchii supports the attachment of PDFs (D5) both manually and through automatic download from publicly available resources on the Internet, such as PubMed Central. Uploaded PDFs will be accessible to all reviewers. If necessary, each reviewer can add comments (D6) to the records that can be made visible to other reviewers or kept private for the writer. A detailed project progress (D7) is displayed for each project/review, separated by phases and sub-phases. The progress of each reviewer can be also viewed by other co-reviewers on the review.

Upon completion of the screening, records can be fully exported (M7) into a reference manager software or as a CSV file. PDF files can be added to the exported references and opened in a reference manager software, making it easy to perform data extraction on the user's computer. A PRISMA flowchart can be generated (O3) as an editable document, allowing reviewers to make any necessary corrections. Catchii has a built-in logging system where each decision and update in a review is recorded. For auditing purposes, the manager of the review can download an audit log (D8) to review the actions of each reviewer.

Finally, Catchii is a free-to-use tool (D9) with a stable release (M8) that is actively supported. There is a short documentation, a forum, and a direct support option for users (M9). Additionally, Catchii has other features not previously outlined in the requirement from Van der Mierden. Specifically, Catchii supports mobile devices (smartphones and tablets), free-text data extraction, favourites list and a unique offline screening mode that enables fast screening of records even without an active internet connection (such as on airplanes), or in areas with an unstable connection.

2.4 | Planned developments

The authors of this software plan to carry out further developments based on user feedback and needs. They aim to implement natural language processing models to select and prioritise records of interest. Additionally, integrated connectivity with the PubMed database is planned to enable automatic querying and screening of new articles that might have been missed before or identifying newly published articles that are not present in the current dataset.

2.5 | Technical details

The Catchii software is hosted on a secure server running the Linux operating system. This server is shielded by a firewall and routinely undergoes system updates and security patches, ensuring the protection of users' data against unauthorised access. Users' data on the server is backed up and encrypted on a daily basis, except for PDFs, which are backed up weekly. Decisions made in offline screening mode are stored solely in the user's browser until they are synchronised with the server. Catchii is compatible with both computers and mobile devices (tablets and smartphones), provided they have a modern browser with JavaScript enabled.

3 | RESULTS

3.1 | Duplicate detection

We evaluated the performance of duplicate detection of Covidence and Rayyan, tools which are one of the most popular and have been recommended.[2,8] Both tools were compared to Catchii, in two ways. Firstly, we assessed their sensitivity by counting the number of duplicates detected. We conducted a search for records containing the term "7,8-DHF" in PubMed, Scopus, and Web of Science databases, and selected all records published between 2010 and 2020 (inclusive). A total of 390 records were downloaded (130 in PubMed, 125 in Scopus, and 135 in Web of Science).[11] We manually reviewed the records and identified 246 duplicates in the combined dataset. Then, we imported the records into Rayyan, Covidence, and Catchii, and counted the number of duplicates detected by each tool.

Catchii missed four records out of 246 (98.4% sensitivity)—one with a different publication year and three records with a large block of text added to the abstract that resulted in a low similarity percentage, below the 80% threshold. Catchii showed higher sensitivity than Covidence, which missed eight records (94.3%), but had lower sensitivity than Rayyan, which found all duplicates (100%). However, while Rayyan did not miss any duplicates, their system requires manual resolution of duplicates, which is a time-consuming task. For example, resolving 100 records with one duplicate each would require 300 clicks (select the record, click on a link to resolve the duplicate and click to remove the chosen duplicate). In Covidence, duplicates are removed automatically after import, with the review of removed duplicates taking place afterwards. In Catchii, all duplicates can be removed with one click after reviewing them.

Secondly, we evaluated the duplicate detection capabilities of each tool. For this purpose, we downloaded six records and modified them manually to test various scenarios.[11] We tested case sensitivity by converting one record's abstract and title to uppercase, altered the abstract (added a short copyright notice in the end), created duplicates with more than two instances of the same record, removed abstract of one record (titles were identical), removed abstract of one record and altered title (added "[review]" in the end), and the use of non-Latin characters (title and abstract both in Mandarin Chinese).

Of the three tools, only Catchii was able to accurately identify all types of duplicates (6/6). Both Rayyan and Covidence missed the duplicate that had a missing abstract and a small alteration in the title (5/6). The results of both experiments are presented in Table 2.

3.2 | Feature comparison

The systematic review screening tools comparison article by Van der Mierden evaluated available software based on the number of features they offer in three categories.[2] We calculated the score for Catchii by taking into account the number of features with an acceptable

TABLE 2 Results of duplicate detection by Rayyan, Covidence and Catchii.

	Rayyan	Covidence	Catchii
Sensitivity	246/246 (100%)	238/246 (94.3%)	242/246 (98.4%)
Different types of duplicates detected	5/6	5/6	6/6
Resolving duplicates	Very slow (manual resolving)	Fast (removed automatically)	Fast (one-click removal)

TABLE 3 Feature comparison of SR tools.

Application	Mandatory	Desirable	Optional	Total	Free
Catchii	9	9	2	20	Yes
DistillerSR[3]	9	8	3	20	No
EPPI-Reviewer[4]	9	7	3	19	No
SWIFT Active Screener[5]	9	7	2	18	No
Covidence[6]	9	5	2	16	No
Rayyan[7]	8	6	2	16	Partially

Note: The number of features as per Van der Mierden et al. article[2] including the addition of Catchii, and an indication of whether the software is free. In the article, the first completely free tool (CADIMA) scored 14 points in total and the next partially free tool (SysRev) scored 15 points, positioning right after Rayyan (not shown). For Catchii, the score in the "optional" features is either 2 or 3 (and total score of 20 or 21) depending on whether duplicate detection and removal is considered as automation, which remained unclear from the Van der Mierden article.

threshold described previously and combining it with the results of the Van der Mierden article. Catchii received a score of 20 points (21, if duplicate detection and removal is considered automation), which is the same or higher than the highest-scoring tool, DistillerSR. Compared to Catchii, DistillerSR has one fewer desirable feature but one more (or the same) optional feature. As shown in Table 3, among the top-scoring SR tools, Catchii is the only one that is completely free for the user. Upon exploring other assessed free tools, we found none had significant developments or surpassed Rayyan in features, therefore they were not included in the feature comparison table.

Additionally, we calculated a score for the Systematic Review Accelerator (SRA) tool,[12] which was published after Van der Mierden's article and thus was not included in the comparison. The SRA toolbox is not an all-in-one screening application, but more a set of tools (Deduplicator, Screenaton and Disputatron) that can be used individually to perform deduplication, TiAb screening and resolving disagreements between reviewers (respectively), which can be evaluated based on their features. The following features with an acceptable threshold were found for the SRA: M1, M2, M3 (unsure), M6, M7, M8, M9, D1, D4, D9, and O2 (Deduplicator), resulting in a total score of 10 or 11, and thus it was not included in the comparison table with the top five tools.

4 | DISCUSSION

Catchii is a systematic review screening application, designed with a user-focused approach and optimised for use on computers, tablets, and mobile devices. It contains all the essential features of SR screening software, as well as numerous desirable and optional ones, making it a whole solution for reviewers. We have demonstrated that Catchii offers equal or more features to the leading SR screening tools available, while also being free to use.

Catchii has some recognised limitations. Firstly, it is oriented to health sciences and therefore currently supports the main formats of records in biomedical literature and thus may not have the capacity to directly import records from some databases used in other fields. Although this issue can be overcome by using CSV files, we aim to expand our support for additional formats based on user demand. Secondly, our duplicate detection algorithm compares articles published in the same year only. This significantly speeds up the process but could result in missing some duplicates whose publication year differs between databases. However, as is rather a rare occurrence (e.g., only one duplicate with a different year was present in our test dataset) it is likely faster to review a few additional undetected duplicate records for the whole dataset than wait for a much slower deduplication process to finish.

Catchii's support and development is ongoing and we have plans to introduce more features to assist users in their systematic review process. The application can be accessed from https://catchii.org.

AUTHOR CONTRIBUTIONS

Andreas Halman: Conceptualization; methodology; validation; software; project administration; writing – original draft; investigation. **Alicia Oshlack:** Supervision; writing – review and editing; resources.

ACKNOWLEDGMENT

Open access publishing facilitated by The University of Melbourne, as part of the Wiley - The University of Melbourne agreement via the Council of Australian University Librarians.

FUNDING INFORMATION

AO is funded by an NHMRC Investigator Grant GNT1196256.

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflict of interests.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in Zenodo at https://doi.org/10.5281/zenodo.7613707.

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How to cite this article: Halman A, Oshlack A. Catchii: Empowering literature review screening in healthcare. *Res Syn Meth*. 2023;1-9. doi:10.1002/jrsm.1675