R E V I E W

Landmark publications in onychology: A bibliometric analysis

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Abstract: *Background and aim:* Onychology refers to the study of the various disorders of nails. The present study aimed to determine research productivity and trends in onychology research by analyzing the top 100 articles with the highest citations. *Methods:* The Web of Science core collection database (WOSCC) was searched by utilizing an advanced search query builder feature that predominantly utilized the TI (title) and (AK) author keywords fields. The top 100 cited documents were retrieved and analyzed for authorship and collaboration patterns, relevant sources of publication, most prolific authors, productive countries, and organizations. *Results:* 'Articles' emerged as the most proliferative documents with 81 publications and 9686 citations. The USA emerged as the most productive country with 39 publications. Columbia University and the University of California emerged as the most productive institutions. The 'Journal of the American Academy of Dermatology' emerged as the most productive source, with 19 publications. 'Baran R' emerged as the most prolific author with 8 publications. The USA emerged as the most collaborative country in the field of onychology, collaborating mainly with the UK, France, Germany, Italy, Canada, and Spain. *Conclusions:* Bibliometric analysis of research productivity and publication trends in onychology revealed that the USA emerged as the most significant contributor and collaborative country. Contributions from Asian countries were not impressive, possibly due to limited resources of significant healthcare delivery systems and research facilities (www.actabiomedica.it).

Key words: onychology, dermatology, nail pathology, nail anatomy, nail microbiology, bibliometrics

Introduction

Onychology refers to the study of nail structure and disorders. It is one of the areas that holds significant importance within dermatology (1). Despite the nail's aesthetic considerations, it serves other essential functions, including digit protection, tactile discrimination, and scratching, and can be used as a self-defense tool (2,3). Furthermore, nails could also act as indicators of potential systemic diseases such

as liver cirrhosis, congestive heart failure, and bacterial endocarditis (4,5). Multiple etiologies are attributed to nail disorders, most commonly infectious, as it accounts for half of the nail disorders (6), followed by inflammatory and metabolic conditions such as psoriasis and chronic renal disease, respectively; less common etiologies include malignancies and pigment disturbances such as subungual and periungual tumors and invasive melanoma (7). Moreover, nail changes can be drug-induced, most commonly encountered in

chemotherapy patients (8,9). Despite the current advancement in dermatology, managing and diagnosing nail disorders remain a global challenge for many dermatologists (1,2). This is often due to a need for a more in-depth understanding of the underlying pathogenesis of these disorders and a deficiency in research in this area (2,10). Therefore, we propose a bibliometric analysis as a crucial tool to address this deficiency. By identifying gaps in onychology research, this analysis can unveil hidden research opportunities in the field (11), thereby potentially advancing the understanding of nail disorders and their management. Bibliometric analysis is a quantitative assessment method that utilizes applied statistics, mathematics, and graphics to track and evaluate research trends and citations, publication's impact, participating authors, and journals in the field of interest (10,12–14). Also, it provides valuable insight for researchers regarding institutions and countries actively involved in publications (15–17). Bibliometric analysis has been utilized previously to investigate some disorders in onychology, including onychomycosis and nail psoriasis (18,19). Bibliometric studies investigating the subject of onychology are lacking in the literature. Therefore, to fill this gap, we visualized the top 100 publications indexed in the Web of Science (WOS) database based on citations, and statistical methods were applied to identify the research productivity trends in this area and construct a knowledge map. This study provides comprehensive and reliable data in the field of onychology for clinicians and researchers and guides future research in onychology.

Methodology

The Web of Science Core Collection (WOSCC) database was selected as the data source to conduct the present study. The present study employed a bibliometric analytic approach, utilizing the WOSCC database to acquire and extract data specifically related to onychology research. The Web of Science (WOS) database is a highly regarded analytical database widely recognized as a reputable and authoritative resource for conducting international investigations in the academic community (20). We performed a bibliometric

analysis on the 100 most frequently cited documents in the field of onychology. Bibliometrics is the systematic examination of publications to quantitatively assess and characterize the scholarly output within a specific topic. We utilized the WOSCC database to access the most often cited documents due to its inclusion of a greater number of distinct journals in comparison to other databases (21).

Search approach

In the WOSCC, we utilized an advanced search query builder feature that particularly targeted the TI (title) and (AK) author keywords fields only to ensure the exclusion of irrelevant records with the following search query: TI= (onychology OR nail* OR periungual OR subungual) OR AK= (onychology OR nail* OR periungual OR subungual)). The initial search resulted in 25,755 records being retrieved and downloaded in plaintext format on January 8th, 2024. It was converted to Microsoft Excel format with the help of Biblioshiny (22), and handed over to the other team members of the research group for review. Two team members of this research group conducted a comprehensive review of downloaded records one-by-one based on title and abstract to identify the relevant records related to the research topic. The top relevant documents were considered up to serial number 476 of the downloaded records, and according to the total number of citations. We employed the "Sort on" feature "Cited by (highest)" to arrange the search results in WOSCC in descending order, and finally, the top 100 cited documents were downloaded on March 13th, 2024. There were no limitations on language or time. We conducted a final review of WOSCC to revise the citation count for each item. A recent document was considered highly cited in the case of documents with the same number of citations (23). The data was obtained and organized using "Microsoft Excel 2021 for Windows, developed by Microsoft Corporation in Redmond, WA" (21).

Criteria for inclusion and exclusion

Only documents focusing on onychology without applying any time or language restrictions were considered for inclusion. The exclusion criteria encompassed

publications that were not relevant to the field of onychology, as well as those from other non-medical and health science domains. Additionally, the documents that were published in other form such as Meeting Abstract, Early Access, Book Review, Correction, News Item, Poetry, Discussion, Fiction, Creative Prose, Film Review, Biographical-Item, Art Exhibit Review, Reprint, Correction, Addition, Retracted Publication, Book Chapters, Item About an Individual, Retraction, Record Review, Software Review, Theater Review, Abstract of Published Item, Bibliography, Data Paper, or Excerpt were also excluded.

Data collection and analysis

The data was arranged in Microsoft Excel format based on the number of citations in descending order. This study incorporated research that focused on onychology, assessed the publications for eligibility, and ultimately reached a consensus on compiling the top 100 most cited publications. Then, the top 100 cited publications were downloaded on March 13th, 2024, with the help of WOSCC Advanced Search Query Builder Field Tags (UT= Accession Number) and imported into Bibliometrix software in R-studio for further analysis (22). The data in this study was converted into Microsoft Excel format. Biblioshiny desktop and Bibliomaster tools were utilized to generate and analyze the tables. The results were visualized using the online tools Wordart (https://wordart.com) and Microsoft Power BI (https://app.powerbi.com/home?experience=power-bi).

Results

Summary of the data

The bibliometric analysis employed a comprehensive collection of 100 highly cited documents, including research articles, reviews, conference papers, letters, and notes. A total of 100 highly cited documents have been collected from 57 sources. The top 100 articles with the highest citations were published between 1954 and 2020. The statistical analysis conducted by Biblioshiny reveals that the number of authors is 431, with 13 single-authored documents and 2,911 references (22,24). The data utilized for bibliometric analysis are comprehensively summarized in Figure 1.

Growth and publication trends

Figure 2 illustrates the growth and publication trends in research related to onychology. The data report the arrival of the first two publications in 1954. The analysis shows a slow publication growth with a gap of years in many cases. The overall publication trend was slow, with only a single-digit publication in all productive years. The year 2007 appeared as the most productive, with nine publications. 1998, 2000, and 2010 each contributed six documents, whereas 2004 and 2008 each contributed five documents. The year 2007 also secured the highest number of citations (n=1300), followed by 2000 (n=997), and 2010 (n=704).

Timespan 1954:2020	**Sources** 57	**Documents** 100	**Annual Growth Rate** -1.04 %
Authors 431	**Authors of single-authored docs** 13	**International Co-Authorship** 20 %	**Co-Authors per Doc** 5.02
Author's Keywords (DE) 180	**References** 2911	**Document Average Age** 24.3	**Average citations per doc** 122.2

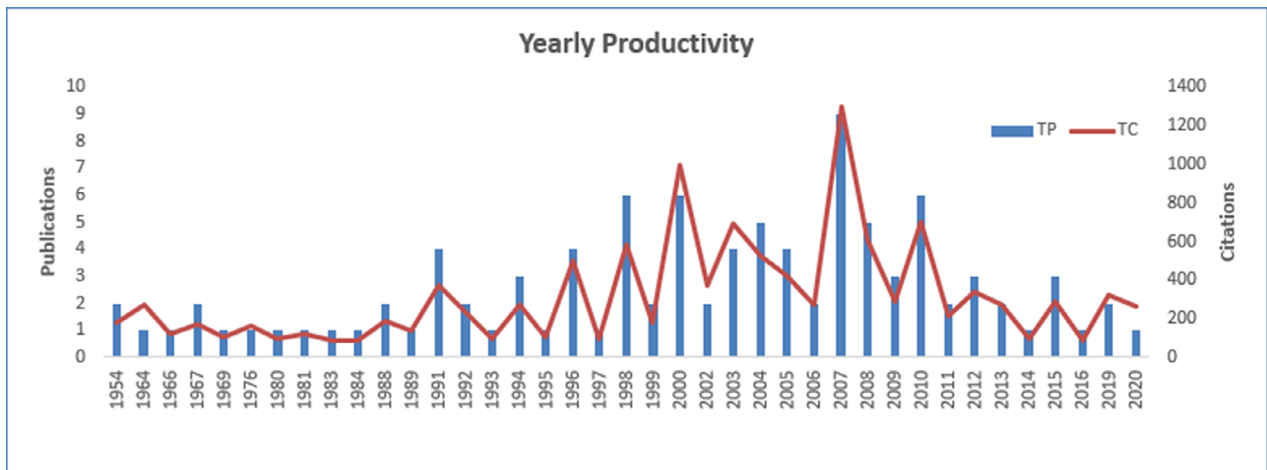**Figure 1.** Summary of the data on onychology research.

Figure 2. Yearly productivity and trend in highly cited top 100 onychology research publications.

Table 1. Most productive countries

Country	TP	TC	C/P	Percent
USA	39	5,230	134.1	30.23
UK	18	2,422	134.56	13.95
Italy	12	1,187	98.92	9.3
Germany	11	1,173	106.64	8.53
France	11	1,314	119.45	8.53
Canada	5	1,109	221.8	3.88
Brazil	3	306	102	2.33
Belgium	3	320	106.67	2.33
Spain	3	325	108.33	2.33
Japan	3	369	123	2.33

Abbreviations: TP=total publications, TC= total citations, C/P= citations per publication.

Document types

The document type 'Article' included 81 publications with 9,686 citations (119.58 citations per publication). 'Review' documents (n=12) received 1,574 citations (131.17 citations per publication). 'Proceedings Paper' (n=4), 'Letter' (n=2), and 'Note' (n=1) formed the rest of the top 100 publications with a total of 601, 187, and 167 citations, respectively.

Most productive countries

Table 1 presents the most productive countries publishing research related to onychology. The USA

Figure 3. Most productive institutions in onychology research. Abbreviations: TP=total publications, TC= total citations, C/P= citations per publication.

emerged as the top country with 39 publications, comprising 30.23% of the total publications, followed by the UK with 18 publications, 13.95% of the total, and Italy with 12 publications, 9.3% of the total. The USA also secured the highest number of citations (n=5,230), followed by the UK (n=2,422) and France (n=1,314). However, Canada obtained the highest score of citations per publication (C/P), followed by the UK and the USA.

Most productive institutions

The most productive institutions are depicted in Figure 3. The analysis ranked Columbia University and the University of California System in the top positions due to equally contributing publications

Figure 4. Word cloud of author keywords in onychology research.

related to onychology (n=7), followed by the University of Bologna (n=6). The Oregon Health & Science University and the University of Leeds maintained the third position with equal publications (n=5). Columbia University also obtained the highest number of citations (n=1,419), followed by Oregon Health & Science University (n=1,129) and the University of California System (n=1,038). However, the University of Toronto maintained the highest score of citations per publication (C/P), followed by Oregon Health & Science University and the University of Washington.

Authorship patterns

The authorship patterns in onychology research ranged from single to 23-author patterns. The two-author pattern contributed 18 publications with 143.6 citations per publication, followed by the three-author pattern (n=15), single-author pattern (n=13), five-author pattern (n=10), and four-author pattern (n=9), with 102.3, 110.6, 132.6, and 107.6 citations per publication, respectively.

Word cloud of author keywords in onychology research

Figure 4 depicts the word cloud of author keywords in onychology research. The word size reflects the frequency of the use of author keywords. The keywords 'onychomycosis' and 'nail' emerged as the most frequently used keywords by the researchers in this field. The other prominent keywords include 'nails', 'psoriasis', 'psoriasis arthritis', 'treatment', 'nail disease', 'tavaborole', 'quality of life', 'nail matrix', and 'toenail'.

Most productive sources

Table 2 presents the most favorite sources for researchers to publish their research related to onychology. The 'Journal of the American Academy of Dermatology' has published the highest number of research articles related to onychology (n=19), followed by the 'British Journal of Dermatology' (n=12). However, the journals 'Journal of the European Academy of Dermatology and Venereology' and 'Archives of Dermatology' shared the third position with an equal number of documents (n=5). The 'Journal of the American Academy of Dermatology' also secured the highest number of citations (n=2995), followed by the 'British Journal of Dermatology' (n=1429) and 'Journal of the European Academy of Dermatology and Venereology' (n=584). The journal 'Rheumatology' obtained the highest number of citations per publication (C/P), followed by the 'Journal of the American Academy of Dermatology' and 'Dermatology'.

Table 2. Most productive sources

Source	TP	TC	C/P
Journal of the American Academy of Dermatology	19	2995	157.63
British Journal of Dermatology	12	1429	119.08
Journal of the European Academy of Dermatology and Venereology	5	584	116.8
Archives of Dermatology	5	543	108.6
Dermatology	4	539	134.75
Journal of Clinical Microbiology	2	197	98.5
Rheumatology	2	319	159.5
Journal of Pharmacy and Pharmacology	2	180	90
Journal of Rheumatology	1	129	129
Journal of Pharmaceutical Sciences	1	99	99

Abbreviations: TP=total publications, TC= total citations, C/P= citations per publication.

Table 3. Most prolific authors

Rank	Author	TP	TC	C/P
1	Baran, R	8	945	118.12
2	Piraccini, B.M	7	639	91.29
2	Tosti, A	7	647	92.43
4	Rich, P	6	1235	205.83
4	Scher, R. K	6	1104	184
6	Reich, K	4	451	112.75
7	Emery, P	3	397	132.33
7	Lipner, S. R	3	583	194.33
7	Aly, R	3	605	201.67
7	McGonagle, D	3	411	137

Abbreviations: TP=total publications, TC= total citations, C/P= citations per publication.

Most prolific authors

Table 3 presents the ranking of the top 10 authors contributing research related to onychology. The analysis ranked 'Baran, R' in the first position with eight publications. Two authors, 'Piraccini, B.M' and 'Tosti, A' equally contributed seven publications each, and were jointly ranked second. Likewise, 'Rich, P' and 'Scher, R.K.' jointly ranked third, contributing six publications each. Author 'Rich, P' secured the highest number of citations (n=1,235), followed by 'Scher, R. K' (n=1,104), and 'Baran, R' (n=945). The author 'Rich, P' also obtained the highest number of citations per publication, followed by 'Aly, R.' and 'Lipner, S. R'.

The top highly cited documents

Table 4 lists the top 10 highly cited documents. The analysis placed 'A large-scale North American study of fungal isolates from nails: the frequency of onychomycosis, fungal distribution, and antifungal susceptibility patterns' at the top position with 377 citations, followed by 'Nail psoriasis severity index: A

useful tool for evaluation of nail psoriasis' with 372 citations, and 'The yellow nail syndrome' with 271 citations. However, the document 'Retrospective Analysis of Adverse Events with Topical Onychomycosis Medications Reported to the United States Food and Drug Administration' obtained the highest number of citations per year, followed by 'Onychomycosis Clinical Overview and Diagnosis' and 'Nail Psoriasis Severity Index: A Useful Tool for Evaluation of Nail Psoriasis'.

Most collaborative countries

Figure 5 portrays research collaboration among the countries related to onychology research. The USA appeared as the most collaborative country, collaborating mainly with the UK, France, Germany, Italy, and Canada. The UK is the second most collaborative country, mostly published in collaboration with Germany, Italy, Spain, and Finland. France is the third most collaborative country, and it is mostly collaboratively published with Germany, Canada, Spain, and Brazil.

Broad subject areas of research in onychology

'Dermatology' is the most prominent broad subject area of research in onychology, followed by 'Pharmacology / Pharmacy', 'General / Internal Medicine', 'Surgery', 'Rheumatology', and 'Chemistry'.

Table 4. The top highly cited documents

Authors, year of publication, and source	Title	TC	C/Y
Ghannoum M.A, 2000, J Am Acad Dermatol (25)	A large-scale North American study of fungal isolates from nails: the frequency of onychomycosis, fungal distribution, and antifungal susceptibility patterns	377	15.71
Rich P, 2003, J Am Acad Dermatol (26)	Nail psoriasis severity index: a useful tool for evaluation of nail psoriasis	372	17.71
Samman P.D, 1964, Brit J Dermatol (27)	The yellow nail syndrome	271	4.52
Jiaravuthisan M.M, 2007, J Am Acad Dermatol (28)	Psoriasis of the nail: anatomy, pathology, clinical presentation, and a review of the literature on therapy	268	15.76
Wang Y, 2020, Arch Dermatol Res (29)	Retrospective analysis of adverse events with topical onychomycosis medications reported to the United States Food and Drug Administration	261	65.25
Dejong Emgj, 1996, Dermatology (30)	Psoriasis of the nails associated with disability in a large number of patients: results of a recent interview with 1,728 patients	215	7.68
Murdan S, 2002, Int J Pharm (31)	Drug delivery to the nail following topical application	190	8.64
Lipner S.R, 2019, J Am Acad Dermatology (6)	Onychomycosis clinical overview and diagnosis	180	36
Ronger S, 2002, Arch Dermatology (32)	Dermoscopic examination of nail pigmentation	180	8.18
Tan A.I, 2007, Rheumatology (33)	The relationship between the extensor tendon enthesis and the nail in distal interphalangeal joint disease in psoriatic arthritis - a high-resolution MRI and histological study	180	10.59

Abbreviations: TP=total publications, TC= total citations, C/P= citations per publication.

Discussion

This bibliometric analysis incorporated highly cited top 100 documents published on onychology. The analysis revealed that the USA was the leading nation overall in contributing literature regarding onychology, with 39 publications, followed by the UK and Italy, with 18 and 12 publications, respectively. Unsurprisingly, it was also observed that most of the leading institutions were USA-based. From these findings, we can conclude that the USA is still the leading country in literature and productivity, which is consistent with the findings of Al Bucker et al., in a prior bibliometric analysis (18). It can be predicted that the USA may continue its upward trend within literature contribution owing to the vast resources and healthy academic environment already present within the country. Nevertheless, UK, Italy, and Canadian-based institutions played a pivotal part in contributing

to the literature. From the trend shown within the analysis, it can be understood that major leading academic institutions, particularly those across North America and Western Europe, are likely to have a significant impact on publication output, possibly due to greater resources available compared to other academic institutions in Asia and South America, due to the productive academic research environment present within leading global institutions. Although the USA was seen to have been the leader in contributions to the literature, it was interesting to note that Canada held the spot for the greatest number of citations per publication. These findings are significant and highlight the growing interest of Canadian institutions in onychology and their commendable effort in publishing high-value interest papers that have yielded the most citations. The UK held the spot for the second-highest citations per publication, followed closely by the USA.
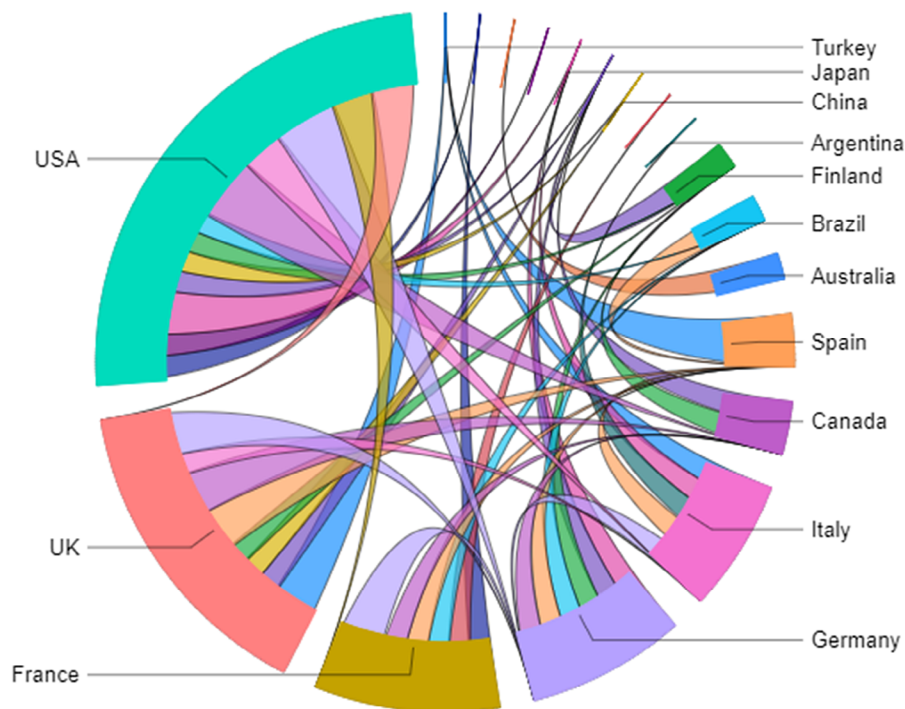
Figure 5. Most collaborative countries in onychology research.

A positive note that can be perceived is that it is already known that there is a heightened awareness of nail disorders within the healthcare community, since prior publications have proved crucial in helping dermatologists refine their clinical practice (1), which may support the reason for the high number of citations from articles dated years before. The article with the highest number of citations was published by Ghannoum et al. (25), which described an overall view of fungal isolates across the North American region. Since the USA holds the topmost rank for the highest publications, it can be perceived from this finding that the paradigm is shifting from classical reports toward effective primary prevention strategies within regional areas. The second study with the highest number of citations, published by Rich et al. (26), also sheds light on the fact that modern research focuses on primary prevention and effective secondary prevention strategies to manage multi-systemic diseases, to provide effective time-saving treatment to patients. An essential factor to consider in conducting a bibliometric analysis is bibliometric coupling, where authors working in the same field of research tend to cite similar literature.

Hence, citations will continue to play a pivotal role in revealing current trends to researchers (34). Our word cloud was also crucial in revealing potential hotspots for further research and helping to identify the paradigm shift. 'Onychomycosis', 'psoriasis', and 'psoriatic arthritis' were the leading keywords within our word cloud. These findings are consistent with those presented in Table 4, which showed three leading articles on psoriasis with a high number of citations. This hypothesis can be further supported by the fact that our analysis revealed that the highest number of citations per publication, according to the journal, was the 'Journal of Rheumatology'. Therefore, it can be concluded that psoriasis is potentially a popular hotspot for future researchers, which can be attributed to the fact that this group of nail disorders is challenging for most physicians. Another potential hotspot observed in our word cloud was 'treatment'. This revelation could be because the nail bed has been observed to grow very slowly, which can hamper drug delivery and reduce its effect (35). Due to the delay in drug delivery, it may take months to observe promising results for the patient. This finding warrants further research, such as

that published by Murdan et al. (31), which discussed the issue of drug delivery systems. It is also worthwhile to note that this was a top-cited topic.

Conclusion

To the best of our knowledge, this is the first bibliometric analysis in the field of onychology, which incorporates 100 high-quality articles across journals. The USA was the foremost country in contributions to the literature, with Columbia University holding the first rank and five USA-based academic institutions playing a significant role in literature contribution. The existing literature has revealed critical hotspots and highlighted top issues in nail disorders towards effective drug treatment and primary/secondary prevention of disorders. Further research is warranted, especially in Asia and Eastern European countries with limited resources to enhance healthcare delivery systems and improve patient care concerning nail disorders. Bibliometric analysis of publications in a field based on citations can be useful for understanding the impact of the published work. However, this impact often relates to the usefulness of a published document to other authors citing the published document and does not necessarily account for the impact of a published document on the related applicability in practice. For instance, the document titled "The yellow nail syndrome" (27), published in the year 1964 and receiving the third highest number of citations in the field of onychology (Table 4), may not be informative to present-day practitioners. This document reported a new syndrome then and continues to be cited, possibly for historical purposes.

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Authors Contribution: NFB: Conceptualization, Resources, Methodology, Writing – Original Draft; HK, HAA: Conceptualization, Methodology, Writing – Original Draft; NS: Resources,

Formal Analysis, Visualization, Writing – Original Draft; AW, MAK: Methodology, Visualization, Writing – Review and Revision (MAK also Data Curator and Guarantor); AA, KM, SSM: Conceptualization, Interpretation of Results, Writing – Review and Revision; RGM: Conceptualization, Writing – Review and Revision, Supervision. All authors have read and approved the final version of the manuscript, ensuring that questions related to the accuracy and integrity of any part of the work were appropriately analyzed and discussed.

Declaration on the use of AI: None

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