

Theoretical Domains Framework: A Bibliometric and Visualization Analysis from 2005-2023

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Background: The Theoretical Domains Framework (TDF) is among the most extensively utilised foundational frameworks in implementation science. It was developed from 33 psychological theories, with the latest version identifying 14 domains encompassing 84 theoretical constructs. These domains and constructs capture the complexity of factors that affect behaviours, making the framework a valuable tool for designing and implementing interventions within health and social care settings.

Objective: To summarise the development, hot topics, and future trends in TDF-related research and provide implementation practitioners with more information on the application of TDF.

Methods: We used TDF as the topic and searched the ISI Web of Science Core Collection, identifying 1382 relevant publications. We used analytical tools such as Excel, Tableau, VOSviewer, and Citespace to conduct a bibliometric analysis of the relevant publication.

Results: We identified the United Kingdom as the primary contributor, with University College London as the key institution. Susan Michie ranked highest in total citations. The analysis highlighted cancer and stroke as primary clinic medicine-related topics using TDF. Emerging themes encompass abuse, violence, maternal health, antenatal care, patient involvement, and trauma-informed care et al. "Nurse" and "qualitative research" emerged as recent and enduring hotspots, possibly indicating future research trends.

Conclusion: This article represents the first attempt to summarise the TDF using bibliometric analysis. We suggest this method can be used to analyse other theoretical frameworks in scientific implementation of its objectivity and quantifiability. Overall, the application scope of TDF is shifting from public health towards more specialised clinical directions, although its application in the field of public health is continuously expanding. In the future, the number of users of TDF is also expected to expand from implementation scientists to professional technical personnel.

Keywords: theoretical domains framework, bibliometric analysis, visualization, implementation science

Introduction

Theoretical Domains Framework (TDF) is one of the most widely used foundational theoretical frameworks in the field of implementation science.¹ The development and validation of the TDF went through two phases. The first phase involved the establishment of a comprehensive theoretical framework consisting of 12 domains and 128 explanatory constructs by a team of behavioural scientists and implementation researchers.² In the second phase, Cane et al refined the TDF in 2012 after validation, identifying 14 domains covering 84 theoretical constructs. The 14 domains include Knowledge, Skills, Social/Professional Role and Identity, Beliefs about Capabilities, Optimism, Beliefs about Consequences, Reinforcement, Intentions, Goals, Memory, Attention and Decision Processes, Environmental Context and Resources, Social Influences, and Emotion and Behavioral Regulation.³ Also in 2012, French et al published an article on the four steps for developing intervention measures using the TDF, guiding researchers in comprehensive intervention strategy design.⁴ In 2017, Atkins published a guide with the aim of assisting the implementation community

in achieving their implementation goals using TDF.⁵ Over the past decade, TDF has been extensively utilised in the global healthcare arena. Its application has bolstered the confidence of healthcare professionals in carrying out projects.⁶

The topic of TDF-related research encompasses evidence-based guidelines implementation,⁷ health check initiatives execution,⁸ vaccinations,⁹ health promotion app utilisation,¹⁰ school-based daily physical activity,¹¹ and others. The study population is inclusive of administrators, healthcare practitioners, patients, and the general populace. Research settings span across various contexts, including hospitals, communities, households, and schools et al. Qualitative research predominates, with the primary research method utilising interviews and focus groups.⁵ Several systematic reviews have synthesised existing research findings, addressing specific research questions such as how to apply the TDF to design interventions for behaviour change in healthcare practitioners and the general population.^{12–14} Other studies have summarised the application of TDF in identifying barriers and facilitators in areas like guideline implementation,¹⁵ medication adherence,¹⁶ sustainable practices in operating theatres,¹⁵ and pressure injury prevention.¹⁶ It is essential to access these publications to evaluate their impact on research and development.

Bibliometric analysis is a valuable research methodology that provides quantitative insights into the publication landscape of a particular field.¹⁷ Compared to systematic reviews, it does not require an in-depth interpretation of each literature piece, allowing for a larger volume of literature inclusion. It focuses on quantitative analysis of citations and co-citations, offering a macroscopic view of research field hotspots and trends. At this level, it can serve as a valuable complement to systematic reviews. Notably, there is currently a dearth of bibliometric studies about the TDF. We aim to offer valuable insights for future research by conducting a bibliometric analysis of literature centred around the TDF.

Materials and Methods

Retrieval Strategies

The data for the study was obtained from the Web of Science Core Collection (WOSCC, Clarivate Analytics, Philadelphia, PA, USA), recognised as one of the most commonly utilised databases for bibliometric studies. The search was conducted on December 27, 2023, using “Theoretical Domains Framework” as the topic. We also included an article by Cane et al in our search strategy, as this article formed the original version of the TDF, but the full text does not mention the term “Theoretical Domains Framework”. To ensure comprehensive retrieval, we added the article’s title to our search strategy. Therefore, our search term was: (TS=(“Theoretical Domains Framework”)) OR TI=(“Making psychological theory useful for implementing evidence-based practice: a consensus approach”).

The data utilised in this study are publicly accessible and do not contain protected health information. Therefore, no approval was sought from the Ethics Committee of Fudan University Affiliated Children’s Hospital. This study adheres to the BIBLIO checklist for reporting the bibliometric reviews of the biomedical literature.

Analytical Tool

Excel

Excel (version 16.49) developed by Microsoft company was used to display the annual number of publications.

Tableau

Tableau (version 2023.2.1),¹⁸ developed by Christian Chabot, Chris Stolte and Pat Hanrahan, was utilised for presenting global publishing density and high-frequency keywords.

VOSviewer

VOSviewer (version 1.6.19) is a software for creating, visualising and exploring bibliometric maps of science literature developed by the team of Professor Ludo Waltman and Nees-Jan van Eck (Leiden University).¹⁹ We used it to visualise (1) the citations of articles, (2) the top institutions by the number of publications, and (3) the collaboration network of authors and countries.

Citespace

CiteSpace, developed by Professor Chen Chaomei’s team (version 6.1.R6), serves as an additional software for bibliometric analysis and visualization.²⁰ The graphs generated by Citespace are more diverse, including (1) the

keywords with the strongest citation bursts. The figure will display six columns of data, namely keywords, year (the years in which the keywords appear), strength (burst strength), begin (the start time of keyword burst), end (the end time of keyword burst), and a timeline of the burst; (2). The Timezone of keywords.

Metrics

Here are all the metrics used in the tables: (1) Total citation(TC) is a noteworthy metric that denotes the frequency with which an article has been referenced by other publications since its publication. Total link strength(TLS) refers to the cumulative strength of connections between nodes in a network or graph.

The graphs generated using VOSviewer to analyse data present three key elements: nodes, lines, and colours. nodes represent the analysed elements, such as institutions and countries. The size of the nodes represents the quantity or frequency. For instance, when analysing the literature citation, a larger node representing a particular document indicates a higher frequency of citations. Lines represent the relationships between two nodes, with thicker edges indicating greater collaboration or more frequent co-occurrences between the two elements. Nodes of the same colour signify that they belong to the same cluster.

Results

Annual Number of Articles on TDF

A total of 1382 articles were included in the study. Figure 1 illustrates a consistent upward trend in the annual publication count of articles focused on TDF from 2005 to 2023. Based on the currently available data, the lowest counts were observed in 2005 and 2009, each with one publication. From 2012 onwards, the annual publication count on TDF exceeded 10 articles, reaching its peak at 301 in 2023.

National Publication Count

Figure 2 displays the publication counts for each country from 2005 to 2023. A total of 73 countries were included in the analysis, with higher publication counts concentrated in Europe, North America, and Australia. The top ten countries by publication count are as follows: England (N=656), Australia (N=353), Canada (N=337), USA (N=182), Ireland (N=83), Netherlands (N=53), Germany (N=36), New Zealand (N=24), People's Republic of China (N=24), and Denmark (N=20).

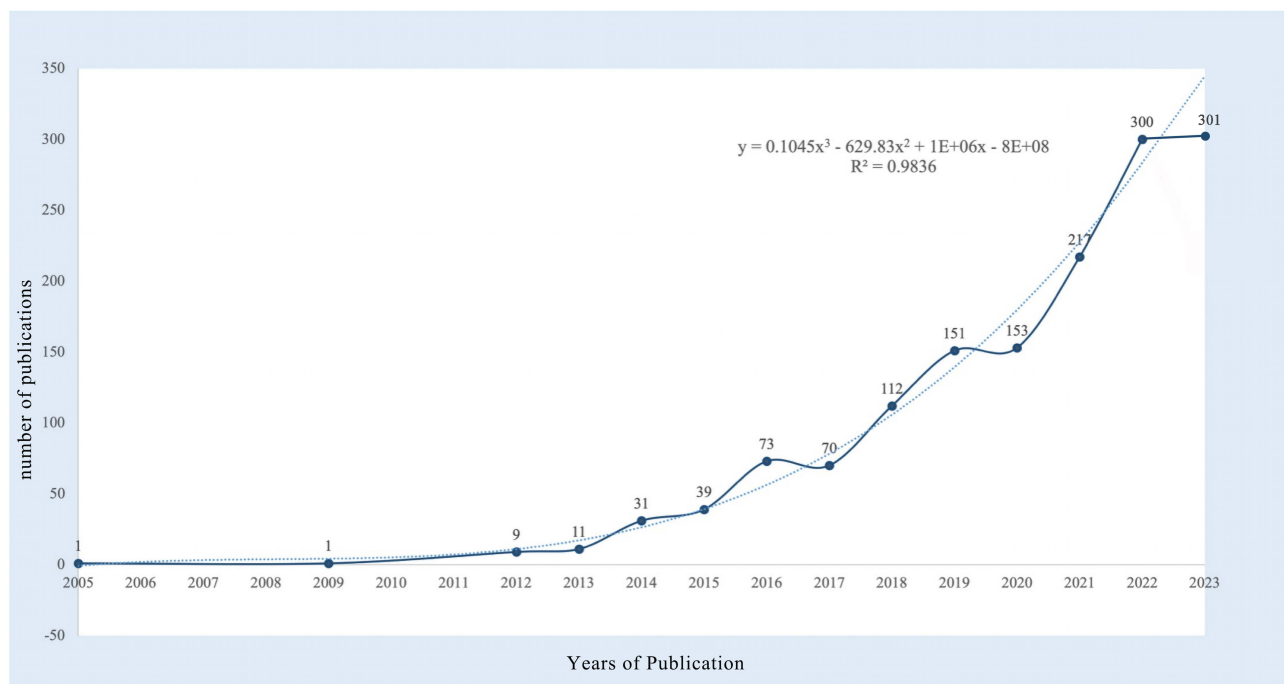


Figure 1 Annual number of published articles of TDF from 2005 to 2023 on Web of Science.

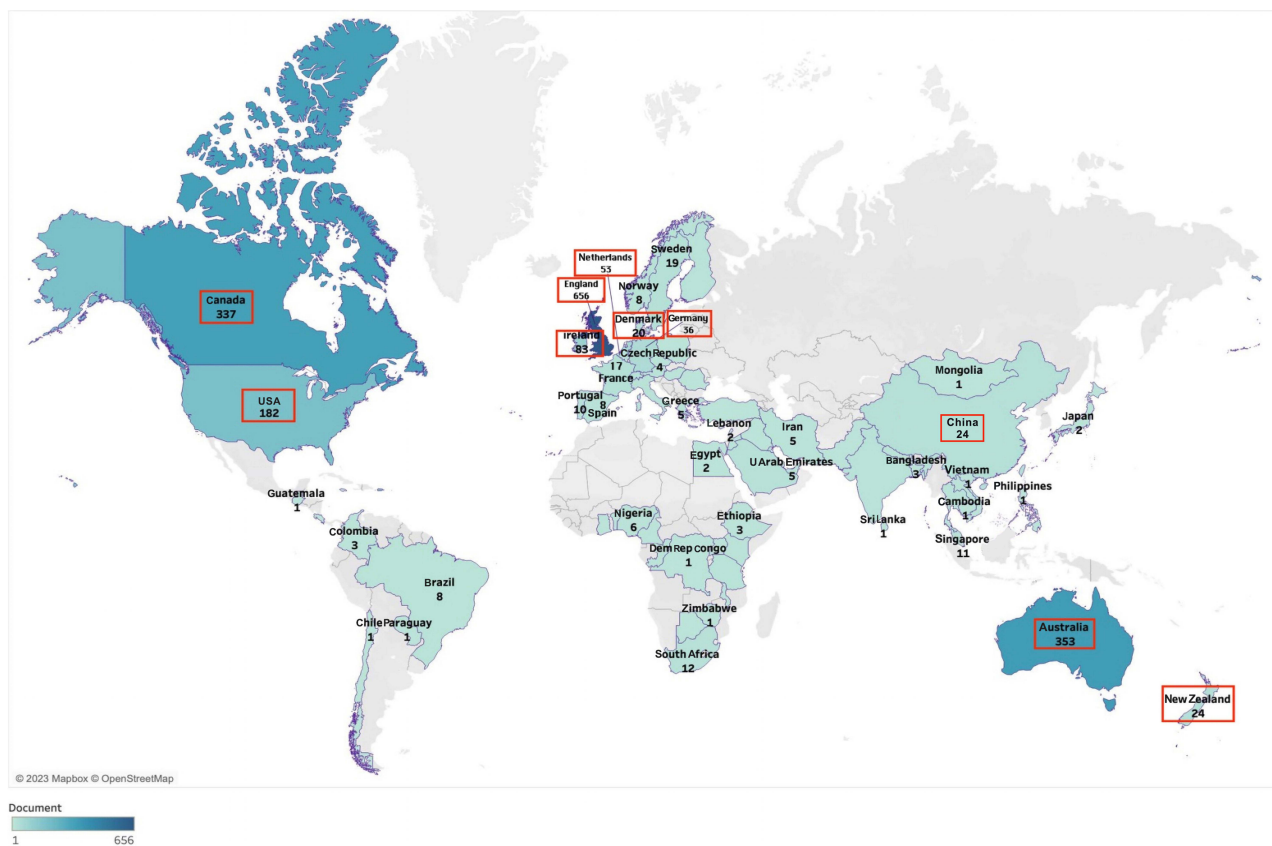


Figure 2 National publication count. The countries within the red boxes were the top ten countries in terms of publication numbers.

TC of Included Articles

We set the VOSviewer filter to a minimum TC of 50, 59 articles were included in the analysis, as shown in [Figure 3](#). [Table 1](#) presents the highest 10 citations based on the document's citation analysis. In most fields, an article is considered a classic citation if it exceeds 100. The top 10 cited articles in TDF range from a minimum of 182 to a maximum of 2167 citations. Notably, the two articles share the same first author, Susan Michie, a key founder of the TDF. Six articles were published in the same journal, *Implementation Science*, a leading publication dedicated to presenting evidence on methods to integrate research findings into regular healthcare practices and health policies. The earliest article, published in 2005 and ranked second in citation count, introduced the original version of TDF. The most-cited article, published by James Cane in 2012, involved validating and refining the original version. The latest article, published in 2017, provides practical guidelines for using the TDF to assess implementation issues and design interventions.

Contribution of the Institutions

A total of 1770 institutions were analysed. By applying the VOSviewer filter to include only institutions with a minimum document count of 10, 87 institutions met the criteria (refer to [Figure 4](#)). These institutions were categorised into 5 clusters. The largest cluster, highlighted in red, encompasses 31 institutions, with University College London (UCL) playing a central role. The second-largest green cluster includes 26 institutions, with key contributors such as the University of Melbourne, the University of Sydney, and Monash University. The third-largest blue cluster comprises 20 institutions, prominently featuring the University of Toronto, the University of Ottawa, and the Ottawa Hospital Research Institute. The smaller yellow and purple clusters each contain 5 institutions. [Table 2](#) presents the top 10 institutions based on publication count, with half hailing from Canada, three from the UK, and two from Australia.

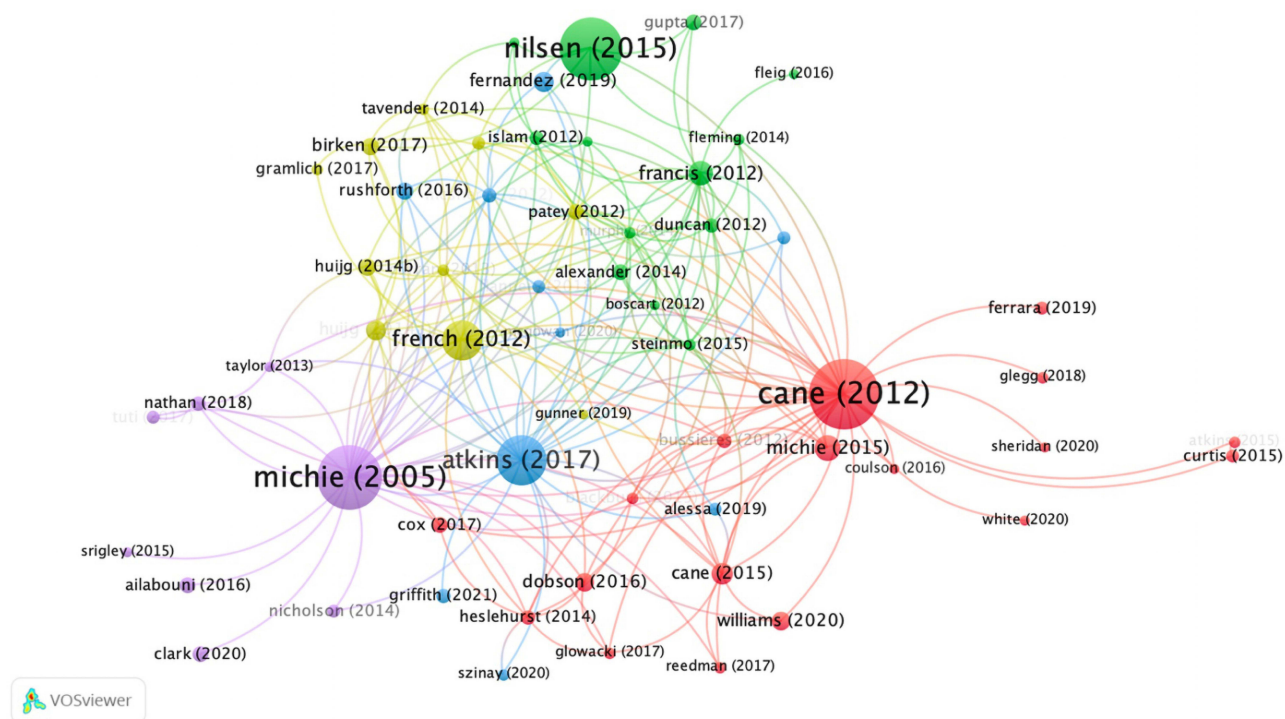


Figure 3 Articles total cited more than 50 times.

Contribution of the Countries

Co-authorship offers insights into how collaboration and knowledge exchange occur within and across scientific fields. We included the top 100 authors by publication count in the collaborative network analysis (Figure 5) and found that these 100 authors were divided into 11 clusters represented by different colours. Authors from the same country and institution tend to collaborate more closely. The largest cluster, in red, includes 26 authors, most from Canada. The second-largest cluster, in green, consists of 21 authors, most from the UK, radiating outward with key figures such as Susan Michie, Jill J Francis, and Fabiana Lorencatto. Overall, authors within the green and red clusters tend to collaborate more closely, while their collaboration with other clusters is less tight. The yellow cluster, represented by Luke Wolfenden, collaborates closely with the red cluster, and the purple cluster, represented by Natalie Taylor from Australia, also collaborates closely but has fewer connections with other authors.

Table I Top 10 Cited Articles in TDF Research Between 2005 and 2023

Rank	Title	First author	Journal	Publication year	Total citation	Country
1	Validation of the theoretical domains framework for use in behaviour change and implementation research	James Cane	Implementation science	2012	2167	UK
2	Making psychological theory useful for implementing evidence based practice: A consensus approach	Susan Michie	Quality & safety in health care	2005	1842	UK
3	Making sense of implementation theories, models and frameworks	Per Nilsen	Implementation science	2015	1769	Sweden
4	A guide to using the theoretical domains framework of behaviour change to investigate implementation problems	Lou Atkins	Implementation science	2017	1125	UK

(Continued)

Table I (Continued).

Rank	Title	First author	Journal	Publication year	Total citation	Country
5	Developing theory-informed behaviour change interventions to implement evidence into practice: A systematic approach using the theoretical domains framework	Simon D French	Implementation science	2012	733	Australia
6	Behaviour change techniques: The development and evaluation of a taxonomic method for reporting and describing behaviour change interventions (a suite of five studies involving consensus methods, randomised controlled trials and analysis of qualitative data)	Susan Michie	Health technology assessment	2015	301	UK
7	Theories of behaviour change synthesised into a set of theoretical groupings: Introducing a thematic series on the theoretical domains framework	Jill J Francis	Implementation science	2012	264	UK
8	From lists of behaviour change techniques (bcts) to structured hierarchies: Comparison of two methods of developing a hierarchy of bcts	James Cane	British journal of health psychology	2015	207	UK
9	Implementation mapping: Using intervention mapping to develop implementation strategies	Maria E Fernandez	Frontiers in public health	2019	197	USA
10	Discriminant content validity of a theoretical domains framework questionnaire for use in implementation research	Johanna M Huijg	Implementation science	2014	182	Netherlands

Co-Authorship of Countries

We included the top 35 countries by publication count in the co-authorship analysis, revealing three clusters (see [Figure 6](#)). The largest cluster is represented in red, and although the connections between clusters appear relatively thin, indicating a lower degree of collaboration, the countries within this cluster are widely distributed, spanning North America, South America, Asia, Africa, and Europe. The 15 countries in this cluster include the USA, Brazil, India, Kenya, Malaysia, Nigeria, People's Republic of China, Qatar, Saudi Arabia, Singapore, South Africa, Spain, Switzerland, United Arab Emirates, and Wales (which belongs to the UK). The USA, Canada, and England (part of the UK) establish close and intensive collaborative relationships. The second-largest cluster is green, consisting of 12 European countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Netherlands, Norway, Portugal, and Sweden. The third-largest cluster in blue includes five countries, boasting the highest publication count and demonstrating close collaboration with other clusters. This cluster comprises Australia, Canada, the UK (England, North Ireland, and Scotland), Iran, Ireland, and New Zealand.

High-Frequency Keywords

High-frequency keywords serve as crucial indicators of core concepts and hotspots. Analyzing these terms provides valuable insights into the field's dynamics, focal points, and major trends, guiding researchers in understanding its structure and knowledge network. [Figure 7](#) illustrates the top 35 keywords with the highest occurrence frequency in TDF. Apart from TDF, the top five keywords are qualitative research, barriers and facilitations, behaviour change, implementation, and primary care.

TDF has been widely utilized in the field of clinical medicine. We screened disease keywords with a minimum occurrence of 5, and ultimately, 21 keywords were included in the analysis (see [Figure 8](#)). From the figure, it is evident that TDF is most frequently employed in the field of cancer, followed by stroke, diabetes mellitus, COVID-19, dementia, obesity, asthma, low back pain, depression, aphasia, COPD, chronic illness, chronic kidney disease, osteoarthritis, pressure ulcer, chronic pain, diabetic retinopathy, HIV, severe mental illness, hypertension, and traumatic brain injury.

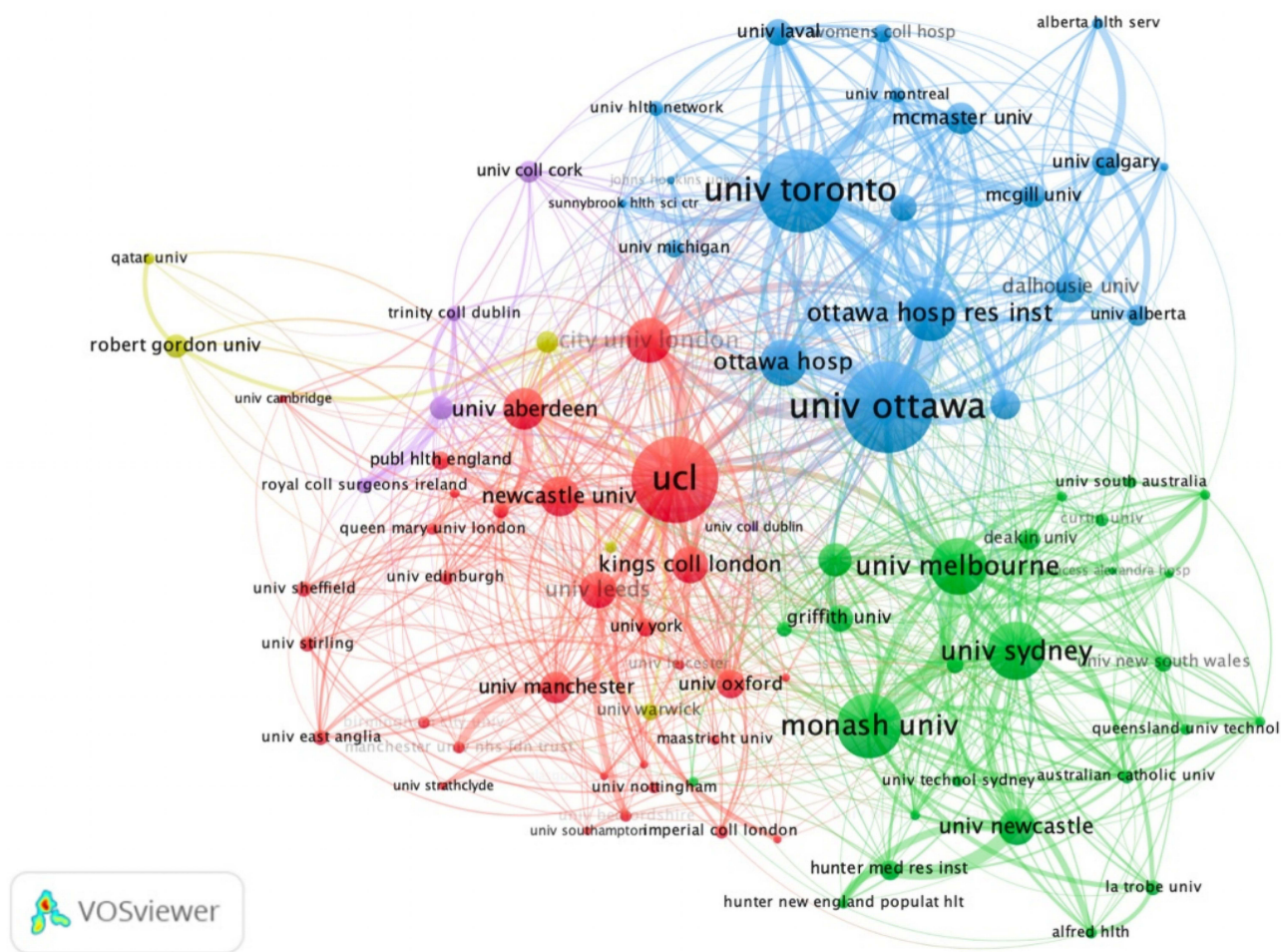


Figure 4 Top 87 institutions by number of publications.

Top 50 Keywords with the Strongest Citation Bursts

Keyword bursts map reflects a sudden increase in the citation frequency of a particular keyword during a specific period, providing a comprehensive insight into the evolving trends of hot topics in the TDF research field. The stronger the burst intensity and the longer its duration, the greater the attention and research output received by the topic. We utilized CiteSpace’s burst detection algorithm to analyze keywords in 1382 TDF-related articles from 2005 to 2023. (see Figure 9)

Table 2 Top 10 Institution by Number of Publication

Rank	Institution	Country	Number of publication	Total citation	Total link strength
1	University of Ottawa	Canada	111	3802	4718
2	University College London	UK	103	7740	6237
3	University of Toronto	Canada	101	2027	2567
4	Monash University	Australia	79	5247	4701
5	University of Sydney	Canada	71	689	1241
6	University of Melbourne	Australia	68	1434	1870
7	Ottawa Hospital Research Institute	Canada	64	2048	2665
8	Ottawa Hospital	Canada	57	775	1866
9	City University London	UK	54	1282	1709
10	Newcastle University	UK	49	5455	4583

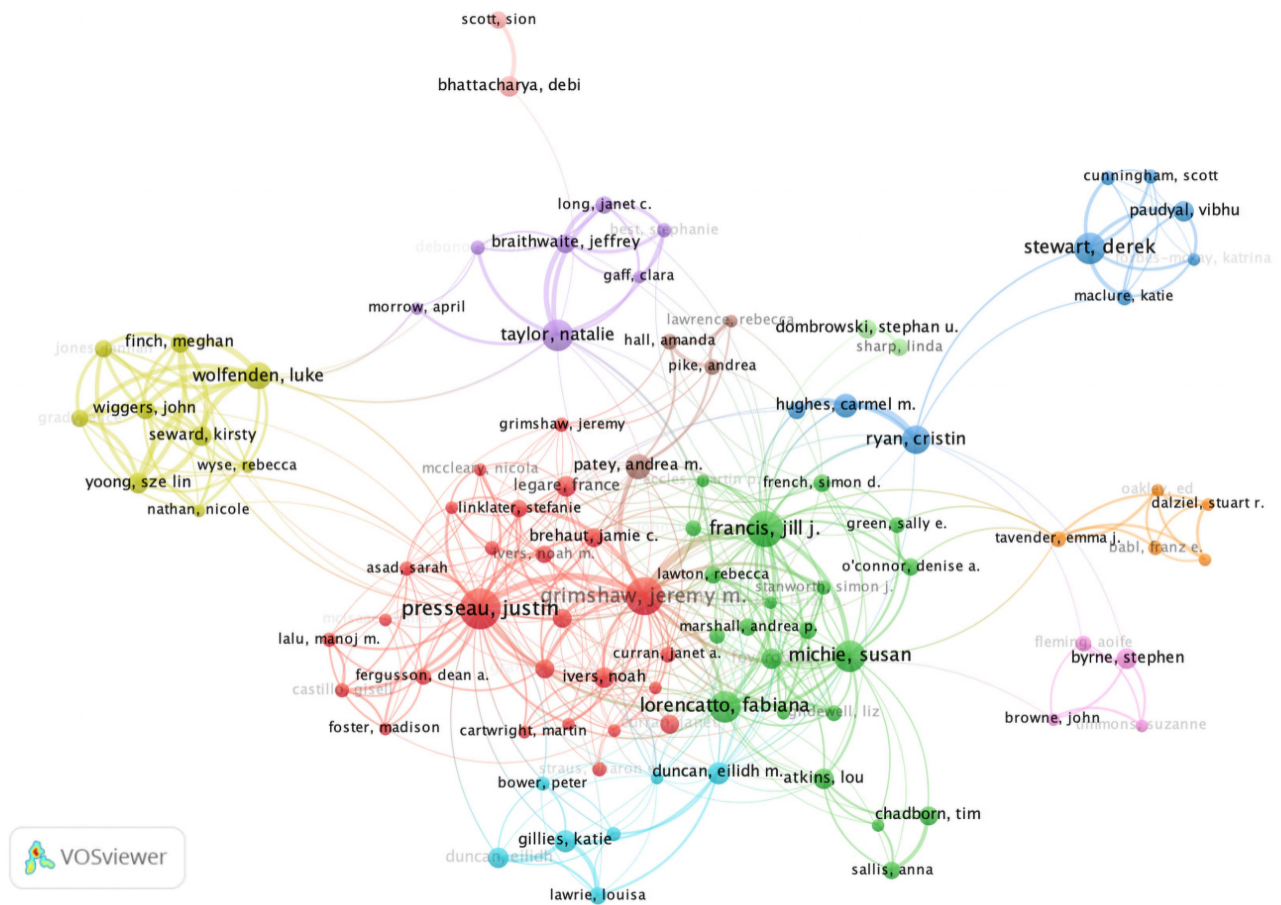


Figure 5 Collaboration network of top 100 authors.

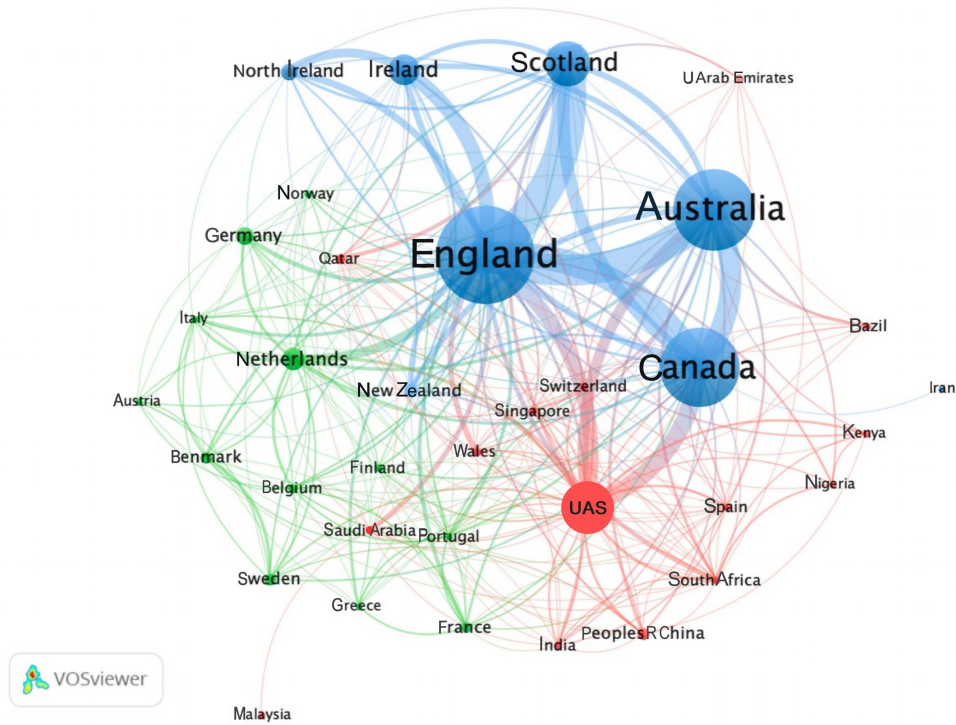


Figure 6 Collaboration network of countries.

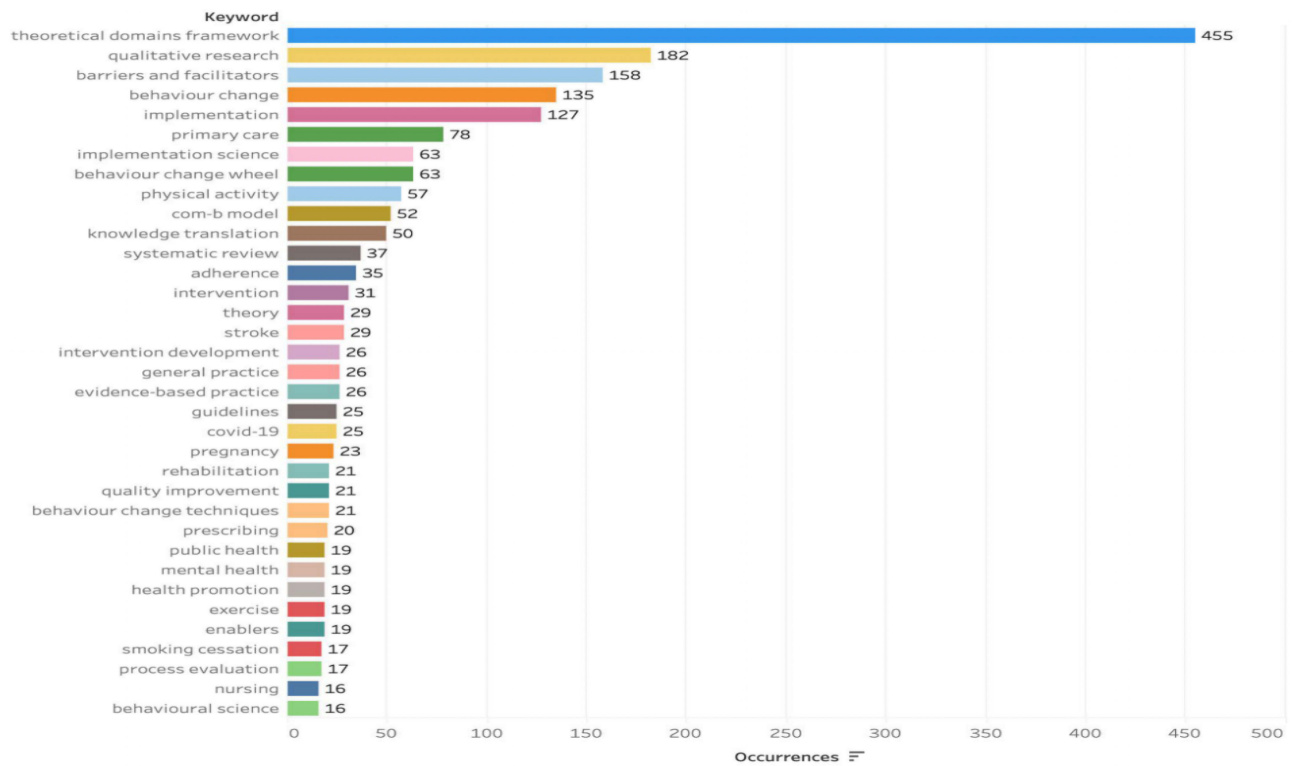


Figure 7 The top 35 high-frequency keywords in TDF.



Figure 8 21 diseases-related keywords.

In the charts generated by CiteSpace, the timeline is depicted in blue, with the intervals of keyword bursts highlighted in red at specific positions along the blue timeline. Specific details regarding burst keywords, burst intensity, and the start and end years can also be found in Figure 9. The top three keywords with the highest burst intensity are highlighted: behaviour change intervention (8.33), implementation science (5.87), and psychological theory (5.32). The top three

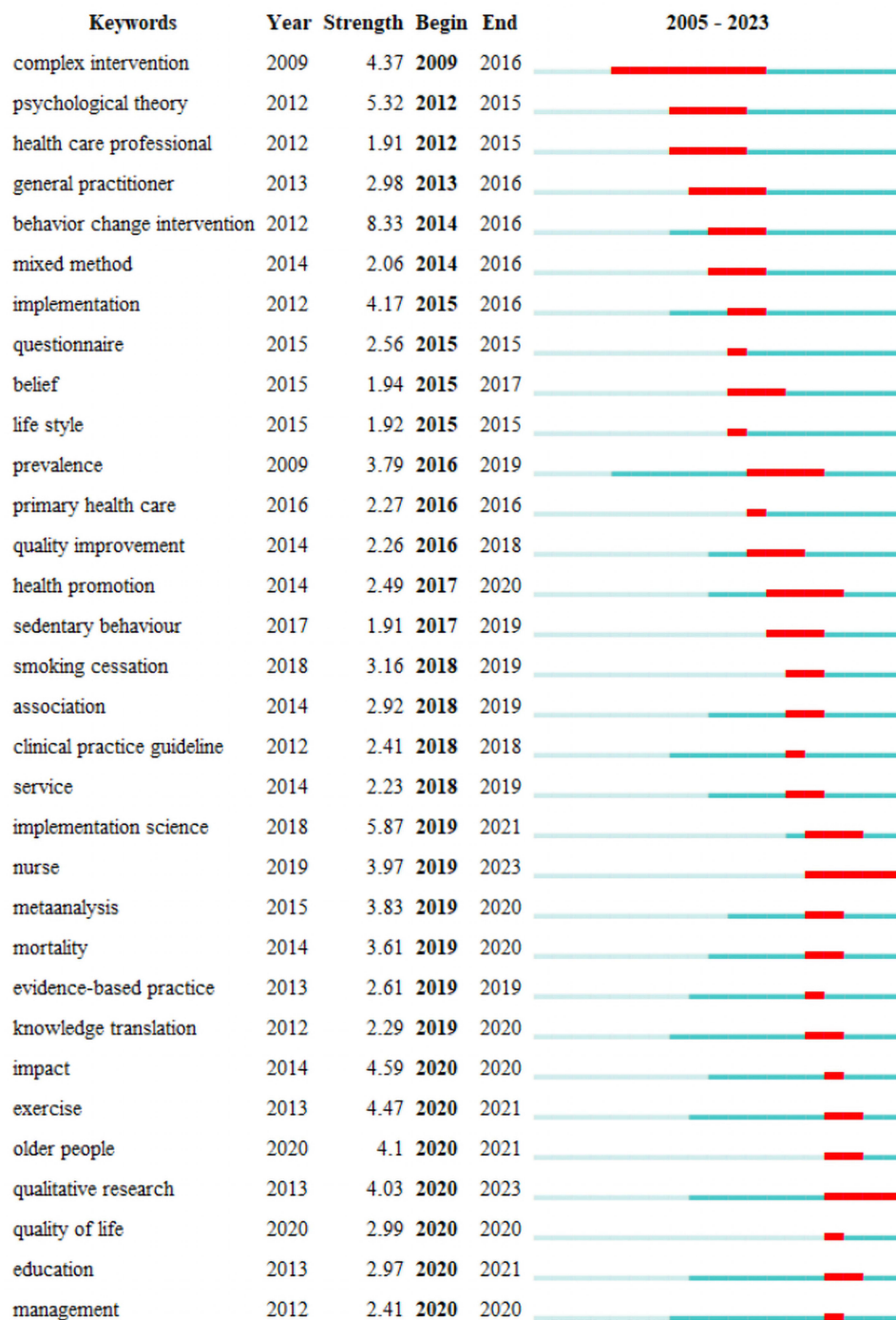


Figure 9 Top 50 keywords with the strongest citation burst.

keywords with the longest burst time are: complex intervention (8 years), nurse (5 years), psychological theory (4 years), health care professional (4 years), general practitioner (4 years), prevalence (4 years), health promotion (4 years), implementation science (4 years), qualitative research (4 years). The keywords burst until 2023 include nurse (from 2019 to 2023) and qualitative (from 2020 to 2023).

Timezone of Keywords

The Timezone of keywords, depicted in Figure 10, is of significant importance as it traces the evolution of research hotspots, identifies emerging trends, and evaluates the dynamics of a research field over time. It has the capability to

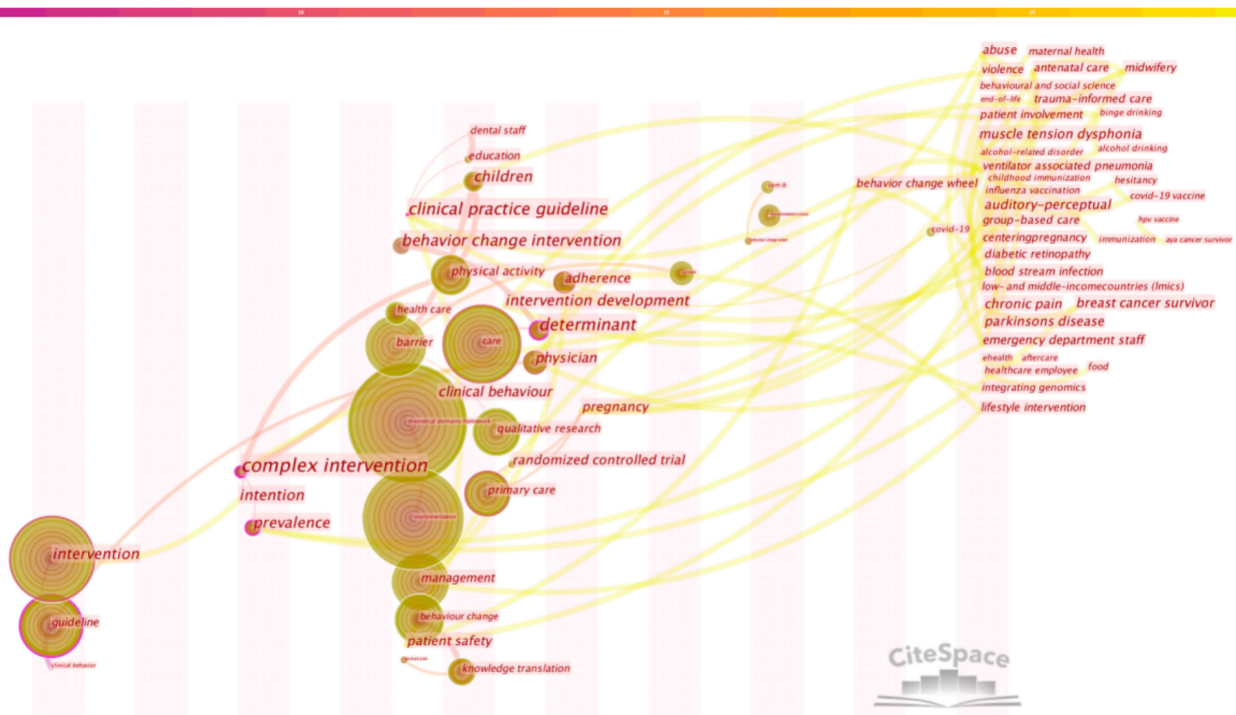


Figure 10 The Timezone of keywords.

unveil words that might not have reached a significant burst strength but represent emerging research areas. These less frequently occurring terms, often overlooked by researchers, can offer valuable directions for further exploration. In the figure, the size of the circles represents the frequency of occurrences, with the horizontal axis denoting time and the vertical axis indicating the keywords corresponding to specific time points. The curves reveal the developmental and declining patterns of keywords.

The figure illustrates a substantial influx of high-frequency keywords around the 12-year mark, persisting until 2020 and beyond. Around 2023, a surge in low-frequency keywords, such as “abuse”, “violence”, “maternal health”, and “antenatal care”, becomes apparent. These may signify potential research focal points in the coming years.

Discussion

As healthcare knowledge evolves and evidence-based medicine advances, researchers no longer rely solely on experience and assumptions in implementation research. Using theory and framework to understand the mechanisms behind behaviour, implement intervention measures, and promote behaviour change has gained increasing recognition among researchers. However, given the richness of behavioural psychology theories, there is a risk of overlooking important factors that may determine behaviour when conducting behaviour change research and intervention designs based on only one or a few theories. Researchers often face challenges when selecting and applying the most appropriate theory.

The TDF was first established by Michie et al in 2005.² Its core strength lies in attempting a comprehensive coverage of behaviour change theories, integrating various complex psychological theories that were previously disparate. It integrates 33 relevant psychological theories into 128 constructs organized into 12 domains. This simplification of theory application in behaviour change research addresses researchers’ dilemmas.

From 2005 to 2012, there was relatively limited research using “TDF” as a keyword. It was not until 2012, when James Cane’s team validated and refined the TDF, resulting in a version with 84 constructs sorted into 14 domains.³ Over the past decade, articles with TDF as the main topic have shown a rising trend, and according to the fitted formula based on data from 2005 to 2022, it is projected to surpass 1000 articles per year on the Web of Science by 2030. TDF places emphasis on individual factors while also taking into account social and environmental aspects. Its application affords

healthcare professionals a broad perspective for discerning barriers and facilitators, augmenting their confidence in project implementation.

The UK leads by a significant margin in terms of publications, followed by Australia and Canada. These three countries also exhibit the highest intensity of collaboration among themselves, with domestic research institutions actively participating in international research projects and sharing experiences and resources with other countries and organisations. For example, Newcastle University forms a cluster with Australian universities such as the University of Melbourne, University of Sydney, Monash University, and Griffith University (see [Figure 5](#)), indicating a close collaboration that contributes to advancing the implementation of science and research globally. China is the only Asian country in the top ten for publication volume, and the application of TDF in China has garnered increasing attention. From 2016 to 2013, there were 20 articles in China's primary literature database, the Wanfang Database.

From our analysis of citation bursts for key terms, two keywords have exhibited significant bursts in recent years, persisting until 2023, namely "nurse" and "qualitative research." Qualitative research first appeared in 2013 and has emerged as the primary research methodology in TDF applications. This prominence continued through 2020 and persist into 2023, establishing itself as a focal point and trend in TDF research for the foreseeable future. The emergence of "nurse" is a novel finding in this study. Nurses, playing a crucial role in primary health care, have garnered increasing attention regarding their behaviours and experiences. Examples include enhancing nurses' capabilities in correctly utilizing electronic medication management systems,²¹ identifying factors influencing nurse and pharmacist prescriber management of respiratory tract infections,²² and exploring the components of nurse-patient therapeutic engagement in acute mental health wards.²³ The primary motivation behind our research is to explore the application of TDF in conducting implementation research at our centre, addressing clinical issues, and extending the findings to China.

Cancer is a primary focus in TDF research, and our study reveals that TDF research in the field of cancer is concentrated on cancers of the male and female reproductive and urinary systems, such as prostate cancer, cervical cancer, and bladder cancer. For example, identifying factors inconsistent with guidelines for staging clinical prostate cancer and designing guideline-concordant intervention measures,^{24,25} explores modifiable influences on medication-taking behaviour in women with breast cancer,²⁶ Evaluating women's perspectives on human papillomavirus (HPV) self-sampling is another aspect of the research.²⁷

Beyond cancer, there is a wealth of TDF research in stroke rehabilitation. Various chronic diseases are also the key topics, including diabetes mellitus,^{28–31} chronic obstructive pulmonary disease (COPD),^{32,33} chronic kidney disease (CKD),^{34–36} chronic pain,^{37,38} and pressure ulcers, among others. Given the global impact of the COVID-19 pandemic on healthcare systems, a considerable portion of research attempts to address issues related to COVID-19 vaccination using TDF.^{39,40} Furthermore, low back pain is another crucial disease topic, and it was one of the earliest areas where an improved version of TDF was applied in clinical practice.

Through the Timezone of keywords, we observed a significant emergence of conceptual keywords related to implementation science in 2012, including "clinical practice guideline", "behaviour change intervention", "complex intervention", and "clinical behaviour", among others. Notably, there were no specific disease-related terms during this period. In 2020, there was a surge in disease and healthcare-related terms, encompassing public health topics such as "immunisation" and "food", as well as specific diseases like "muscle tension dysphonia", "ventilator-associated pneumonia", "Parkinson's disease", "bloodstream infection", and others. Additionally, emerging topics in recent years include "end-of-life", "violence", "abuse", and "binge drinking". While most of these terms have not reached the 'burst' level, they reflect the expanding application of TDF across various medical specialities, a trend expected to continue.

Limitation

The limitations of this study include a potential publication bias, as it solely relies on literature indexed in the WOSCC. The focus on English-language publications may also introduce language bias, neglecting valuable contributions in other languages. While providing a macro-level overview, the bibliometric analysis may lack depth in qualitative understanding of specific TDF applications. Furthermore, the study's cross-sectional nature captures a snapshot in time, potentially overlooking evolving trends. Despite these limitations, the study offers valuable insights into TDF-related research's current state and trends.

Conclusion

This study is the first attempt to apply bibliometric analysis to the TDF, offering insights into its development, hot topics, and future trends. By identifying key research articles, major contributors, and emerging themes, we provide a comprehensive overview of the TDF's impact and application scope. The findings highlight the TDF's evolving role from public health to more specialised clinical directions, while its use in public health continues to expand.

Researchers can leverage bibliometric analysis to explore the evolving landscape of implementation science more effectively. By identifying influential works, key contributors, and collaboration networks, researchers can better strategize their studies to address current and future challenges in the field. The emergence of new topics such as abuse, violence, maternal health, and trauma-informed care suggests that future research may increasingly focus on these areas, expanding the TDF's applicability.

Future research should consider interdisciplinary applications, particularly in areas where understanding behaviour change is crucial. Exploring the integration of TDF with emerging technologies, such as digital health interventions and artificial intelligence, can enhance the design and implementation of behaviour change strategies. Moreover, Strengthening international collaborations, developing and refining methodological approaches for different cultural and healthcare settings, and conducting longitudinal studies to evaluate the long-term impact of TDF-based interventions will provide deeper insights into their sustainability and effectiveness.

Data Sharing Statement

All the data used in this study are available from the corresponding author Ying Gu.

Institutional Review Board Statement

The data utilized in this study are publicly accessible and do not contain protected health information. Therefore, no approval was sought from the Ethics Committee.

Informed Consent Statement

Not applicable.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare no conflicts of interest in this work.

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