Global Research On Cognitive Frailty: A Bibliometric and Visual Analysis of Papers Published During 2013 – 2021

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Abstract

Background: Cognitive frailty relates to various adverse health outcomes of older adults and is proposed as a new target of healthy ageing. This study aimed to analyze the status, hotspots, and emerging trends / frontiers of global research on cognitive frailty.

Methods: Articles and reviews related to cognitive frailty of older people published from 2013 to 2021 were retrieved from the Web of Science Core Collection (WoSCC) database on 26 November 2021. CiteSpace 5.8.R3 was used to conduct the collaboration analysis, document co-citation analysis, and keyword co-occurrence analysis.

Results: A total of 2,077 publications were included. There has been a rapid growth of publications on cognitive research since 2016. The United States, Italy, England, and Australia were the leading research centers of cognitive frailty; however, China has recently focused on this topic. The National Center for Geriatrics and Gerontology and Shimada H. were found to be the most prolific institution and author, respectively. Co-citation analysis identified 16 clusters, of which the largest was cognitive frailty. The most frequently occurred keyword was older adult, followed by cognitive impairment, frailty, risk, dementia, prevalence, mortality, health, and Alzheimer's disease. Burst keyword detection revealed a rising interest in cognitive frailty models.

Conclusions: By analyzing the publications over the past years, this study provides a comprehensive analysis of cognitive frailty research. A variety of visualized networks offer an in-depth understanding of the countries / regions, institutions, authors, hotspots, and research frontiers.

Background

Frailty is a common geriatric syndrome in which there is an increase in an individual's vulnerability to stressors as a result of reduced capacity of different physiological systems, characterized by diminished strength, endurance, and reduced physiologic function [1]. Many studies revealed that physical frailty and cognition interact within a cycle of decline associated with ageing [2]. Among older people, physical frailty and cognitive impairment often co-occur and predict the onset of each other [2–4]. In 2013, the consensus Group of the International Academy on Nutrition and Aging and the International Association of Gerontology and Geriatrics (IANA / IAGG) officially defined cognitive frailty as a syndrome in older adults with evidence of both physical frailty and cognitive impairment without a clinical diagnosis of Alzheimer's disease or another dementia [5].

With a growing worldwide interest in healthy aging, better understanding of cognitive frailty may help deepen the discourse around the maintenance of functional ability in old age [6]. Since 2013, cognitive frailty as a new concept has raised a broad range of attentions from ageing health practitioners and researchers worldwide. In a recent systematic review, the pooled prevalence of cognitive frailty among community-dwelling older adults was reported to be 9% and has increased in recent years [7]. Evidence showed that a variety of socio-demographic factors and health conditions can increase the risk of

cognitive frailty, such as advanced age, low schooling, comorbidity, malnutrition, low social participation, sedentary lifestyle, and insomnia [8, 9]. Moreover, many studies revealed that cognitive frailty can significantly increase the risk of dementia, mortality [8, 10, 11], falls [12, 13], and disability [14].

Given the increasing prevalence and adverse health outcomes, it is necessary to pour considerable interests into this research field. Understanding the dynamics of a research front is essential for researchers to be able to identify hotspots and emerging trends in the body of scientific knowledge [15]. Although several reviews have been conducted for cognitive frailty of older adults [7, 8, 10, 11, 16, 17], no studies have previously attempted to analyze the development of cognitive frailty research since its definition was officially proposed. Bibliometric analysis enables researchers to unpack the evolutionary nuances of a specific field while shedding light on the emerging areas in that field by making sense of large volumes of unstructured data in rigorous ways [18]. Based on bibliometric analysis, this study aimed to systematically investigate the status, hotspots, and emerging trends / frontiers of global research on cognitive frailty.

Methods

Data source and search strategy

The Web of Science Core Collection (WoSCC) database which contains the world's leading scholarly journals was selected as the data source for this study. Literature related to cognitive frailty were searched from 2013 to 26 November 2021. The search terms and strategy were: ("cognitive frailty") OR (("cognitive decline" OR "cognitive impairment") AND (frail*)). To examine the effectiveness of the search results, one researcher assessed the relevance of the top 100 most recently published articles to this study. Results showed that 86% were closely related to cognitive frailty, indicating that the search terms and strategy are appropriate.

Inclusion and exclusion criteria

Inclusion criteria were: (a) peer-reviewed original articles on cognitive frailty; (b) reviews related to cognitive frailty; (c) articles retrieved from the WoSCC database; (d) articles published from 2013 to 2021; and (e) articles published in English. Articles collected by hand, repeated publications, conference abstracts, and book chapters were excluded from the bibliometric analysis. Two researchers independently screened the literature according to the inclusion and exclusion criteria. Disagreement was resolved by consulting to a third researcher.

Data analysis and visualization

The GraphPad prism 9 and CiteSpace 5.8.R3 were used to analyze the included articles. The GraphPad Prism software was performed for making bar and line charts. CiteSpace was used to conduct the bibliometric analysis, including collaboration analysis, document co-citation analysis, and keyword co-occurrence analysis. Different nodes in visualization knowledge maps represent elements such as country, institution, author, or a cited reference; links between nodes represent relationships of

collaboration, co-occurrence, or co-citations; the color of nodes and lines represents different years. The parameters of CiteSpace were set as follows: (1) time slicing from 2013 Jan to 2021 Dec, years per slice = 1; (2) term source = title / abstract / author keywords / keywords plus; (3) node types = country / author / institution / reference / keyword; (4) select top 10% of most cited or occurred items from each slice (except country collaboration analysis); (5) pruning = none; (6) visualization: cluster-static, show merged network. Modularity Q > 0.3 means that the network is reasonably divided into loosely coupled clusters and the mean Silhouette score > 0.7 indicates that the homogeneity of the clusters on average is significant [19].

Results

Publication years and journals

A total of 2,077 publications were retrieved from the WoSCC database. Among these publications, 1,677 were original articles (80.7%) and 400 were reviews (19.3%). The year-wise distribution of publications on cognitive frailty from 2013 to 2021 is shown in Figure 1. The red points represent the number of original articles published per year and the blue bar graphs demonstrate the number of total publications, both indicating a slow growth and then a noticeable rise except the last year. Of note, more than 200 papers were annually published since 2017. The green triangles illustrate the annual published reviews, exhibiting a steady upward trend during the period of 2013 – 2020. These results indicate that cognitive frailty is receiving increased attention in the research field and more relevant studies are being performed.

Elsevier had published the largest number of papers on cognitive frailty from 2013 to 2021 (n = 510). Regarding journals, four had published at least 50 publications on cognitive frailty, of which BMC Geriatrics was the most prolific (n = 75). Table 1 lists the top 10 journals that published the largest number of papers regarding cognitive frailty during 2013 – 2021. The top 10 journals contributed to 23.11% of the total publications. Among these journals, Journals of Gerontology Series A: Biological Sciences and Medical Sciences ranking No. 7 has the highest impact factor (6.053).

Table 1
Top 10 most prolific journals

Journal	No. of publications (%)	IF[a]	JCR ® Category
1. BMC Geriatrics	75 (3.61)	3.921	Geriatrics & Gerontology (Q2) Gerontology (Q1)
2. Journal of The American Medical Directors Association	62 (2.99)	4.669	Geriatrics & Gerontology (Q2)
3. Journal of Nutrition Health Aging	61 (2.94)	4.075	Geriatrics & Gerontology (Q2) Nutrition & Dietetics (Q2)
4. Geriatrics & Gerontology International	52 (2.50)	2.730	Geriatrics & Gerontology (Q3) Gerontology (Q2)
5. Archives of Gerontology and Geriatrics	46 (2.22)	3.250	Geriatrics & Gerontology (Q3)
6. Journal of The American Geriatrics Society	44 (2.12)	5.562	Geriatrics & Gerontology (Q1) Gerontology (Q1)
7. Journals of Gerontology Series A: Biological Sciences and Medical Sciences	41 (1.97)	6.053	Geriatrics & Gerontology (Q3) Gerontology (Q1)
8. Aging Clinical and Experimental Research	33 (1.59)	3.638	Geriatrics & Gerontology (Q3)

Notes: IF: impact factor

[a] Data from the 2020 edition of Journal Citation Reports

Journal	No. of publications (%)	IF[a]	JCR ® Category
9. Clinical Interventions in Aging	33 (1.59)	4.458	Geriatrics & Gerontology (Q2)
10. Journal of Alzheimer's Disease	33 (1.59)	4.472	Neurosciences (Q2)
Notes: IF: impact factor			
[a] Data from the 2020 edition of Journal Citation Reports			

Collaboration analysis

Country collaboration analysis

The node type of "Country" was selected to analyze the degree of collaboration among countries / regions in cognitive frailty research. The collaboration network map of countries / regions is demonstrated in Figure 2, in which the top 20% of most occurred items were selected from each slice. Totally 87 countries / regions had contributed to research on cognitive frailty from 2013 to 2021. The United States published the largest number of papers in this research area (n = 505), accounting for 24.31% of the total publications, followed by Italy (n = 240) and England (n = 192). The top three countries published 937 papers in terms of cognitive frailty, accounting for 45.11% of the total publications. With high centrality, the United States (0.35), Italy (0.13), and Australia (0.13) made great contributions to this research field and closely cooperated with other countries / regions. According to the burst detection, China was found to be the most recently emerging country that focused on cognitive frailty research.

Institution collaboration analysis

By selecting the node type of "Institution", we analyzed the degree of collaboration among institutions in this research field. Each node represents one institution that published more than 15 papers related to cognitive frailty. The National Center for Geriatrics and Gerontology made the greatest contribution to this research topic and published 69 articles or reviews (3.13%), followed by Johns Hopkins University (n = 42, 1.90%) and Dalhousie University (n = 40, 1.81%). As for the centrality, Università Cattolica del Sacro Cuore (0.19), King's College London (0.13), University of Sydney (0.12), Karolinska Institutet (0.12), and National Center for Geriatrics and Gerontology (0.11) represented the major turning points, acting as bridges linking other institutions. Furthermore, the greatest number of bursts in cognitive frailty research was University of Alberta (4.56), which is a public research university located in Canada. Figure 3 presents the collaboration network of institutions publishing papers on cognitive frailty during 2013 – 2021.

Author collaboration analysis

A scientific co-authorship network can provide information on the influential authors and potential collaborators and can helped researchers to establish collaborative relationships. The node type of “Author” was selected for conducting the author collaboration analysis. Figure 4 illustrates the collaboration network of authors who published at three papers related to cognitive frailty during 2013 – 2021. The centrality of all authors was less than 0.1, indicating that the collaboration among them was weak.

Regarding the productivity, Shimada H. was identified as the most prolific author with 37 articles, followed by Doi T. (n = 28) and Tsutsumimoto K. (n =27). These three authors all come from Japan and collaborated with each other.

Document co-citation analysis

By selecting the “Reference” as the node type, a document co-citation analysis was conducted. A total of 69,148 valid references were extracted and a network consisting of 755 nodes and 3,437 links was visualized, as shown in Figure 5. The network was divided into 16 clusters, which were automatically labeled by choosing keyword terms as the labelling source and log-likelihood ratio (LLR) as the standard algorithm. The largest cluster (#0) was cognitive frailty, followed by cognitive impairment (#1), intrinsic capacity (#2), clinical frailty scale (#3), category fluency test (#4), and physical frailty (#5). The modularity Q was 0.648 and the mean Silhouette score was 0.886, suggesting that the cluster results were reasonable.

The citation, centrality, and burst strength were considered when identifying the representative publications on cognitive frailty. The 15 representative references are listed in Table 2. No.1 to No. 10 are the top 10 most cited references. Two references with high centrality (No.1 & 11) indicate close interrelationships among the nodes. Nine references (No.1 – 4, 6, 12 – 15) with the strongest burst strength, especially the article Different cognitive frailty models and health- and cognitive-related outcomes in older age: from epidemiology to prevention, can be adopted to disclose the cognitive frailty research frontiers and trends.

Table 2
Fifteen representative references in terms of citations, centrality, and bursts

No.	Count	Centrality	Strength	Reference	Year	Begin	End
1	126	0.12	26.58	Clegg et al. [20]	2013	2015	2018
2	109	0.01	27.16	Kelaiditi et al. [5]	2013	2016	2018
3	92	0.02	18.96	Robertson et al. [2]	2013	2015	2018
4	83	0.00	18.00	Morley et al. [1]	2013	2015	2018
5	73	0.06	7.54	Feng et al. [21]	2017	2018	2021
6	59	0.03	15.23	Shimada et al. [22]	2013	2015	2018
7	58	0.01	10.26	Ruan et al. [23]	2015	2018	2021
8	56	0.06	5.87	Shimada et al. [24]	2016	2018	2019
9	55	0.01	4.86	Solfrizzi et al. [25]	2017	2019	2021
10	54	0.02	6.30	Feng et al. [26]	2017	2018	2021
11	13	0.11	4.77	Lee et al. [27]	2011	2013	2016
12	36	0.00	16.15	Boyle et al. [4]	2010	2013	2015
13	26	0.00	14.33	Ávila-Funes et al. [28]	2009	2013	2014
14	48	0.01	13.43	Panza et al. [29]	2018	2019	2021
15	35	0.03	12.27	Collard et al. [30]	2012	2015	2017

Keyword co-occurrence analysis

To illustrate the hotspots of cognitive frailty research, we conducted a keywords co-occurrence analysis by changing the node type to “Keyword”. To avoid potential misunderstanding, some similar keywords were combined. For example, older people, elderly people, older adult, and older person were merged into older adult; cognitive decline and cognitive impairment was merged into cognitive impairment. The network of co-occurring keywords with 213 nodes and 1,932 links is shown in Figure 6. Bigger nodes indicate higher co-occurrence frequency, and the links reflect the co-occurrence relationship. The most frequently occurred keyword was older adult (count = 591), followed by cognitive impairment, frailty, risk, dementia, prevalence, mortality, health, and Alzheimer’s disease.

Burst keywords were detected to analyze the hotspots and frontier of cognitive frailty research. We identified the top 20 keywords with the strongest citation burst, as shown in Figure 7. Of them, disability shows the highest burst strength, reaching 9.61. Cognitive frailty, dysfunction, model, and American

college were keywords with recent citation bursts, and randomized controlled trial achieved the longest burst duration from 2013 to 2017.

Discussion

To the best of our knowledge, this is the first study to systematically analyze the status, hotspots, and emerging trends / frontiers of global research on cognitive frailty through bibliometric and visual analysis. Our results showed that cognitive frailty has attracted increasing research interests since 2013 and this trend is projected to continue, as indicated by the increase in the number of annual publications on this research topic. By analyzing sources of the publications, it can be inferred that the global research on cognitive frailty has formed a core group of journals since nearly one-fourth paper were published on the top 10 journals.

The United States, Italy, England, and Australia are the leading countries in cognitive frailty research, as evidenced by the large number of publications and the high centrality in the country collaboration network. Moreover, more than a half of the top 10 prolific institutions were from these countries. These results are roughly consistent with previous bibliometric studies among older people [31, 32]. When conducting burst detection, China was found to be the most recently emerging country that focused on cognitive frailty research. Results in this study to a certain extent indicated that health care practitioners and researchers in China has begun to focus on cognitive frailty research. Previous studies have reported that cognitive frailty could increase the risk of adverse health outcomes (e.g., dementia, falls, disability, and mortality) among older people [8, 10–14], which may further increase the health care expenditure and threaten their quality of life. Faced with the largest number of older people worldwide, Chinese scholars are suggested to continue to pay attention to cognitive frailty research in the next few years, especially in collaboration with the productive institutions from the above-mentioned developed countries. In addition, this study found that the most three prolific authors in cognitive frailty research were Shimada H., Doi T., and Tsutsumimoto K., who can be considered as the potential collaborative authors.

Document co-citation analysis and keyword co-occurrence analysis were conducted to reveal the structure and hotspots within the knowledge domain of cognitive frailty. As indicated, the predictive value of cognitive frailty on health-related outcomes is one popular topic [11, 14, 25, 33–37]. Apart from the risk of dementia, mortality, and disability, some studies focused on surgical patients and had examined the predictive effect of combined preoperative assessment of frailty and cognitive function for postoperative complications (e.g., delirium, long hospital stay) [34, 35]. Another popular research topic is investigation of the prevalence of cognitive frailty in people with different characteristics, including nursing home residents [38]. The third popular topic is the biomarkers of physical and cognitive function among older people, such as testosterone deficiency [39]. Moreover, researchers had paid much attention on the preventive interventions / programs for cognitive frailty including resistance exercise training [40], mHealth brisk walking intervention [41], Baduanjin [42], and multi-domain interventions [43–45].

Regarding the representative references for cognitive frailty research, the paper Frailty in elderly people published by Clegg et al. seem to have laid the foundation for this research area [20], as evidenced by the highest frequency of citation. Another two landmark publications entitled Cognitive frailty: Rational and definition from an (I.A.N.A./I.A.G.G.) International Consensus Group [5] and Frailty and cognitive impairment—A review of the evidence and causal mechanisms [2] served as pivotal points of cognitive frailty research since they officially defined cognitive frailty and outlined some mechanisms that underpin the interaction between physical frailty and cognitive decline, respectively. Additionally, an Italian longitudinal study published in 2017 that estimated the predictive role of reversible cognitive frailty on dementia and all-cause mortality [25] and a comprehensive review of different cognitive frailty models and health- and cognitive-related outcomes published in 2018 [29] were identified as two references of the most recent bursts. In terms of the burst keywords, disability showed the highest burst strength, indicating that the association between cognitive frailty and disability may be extensively studied. Meanwhile, the keywords with recent citation bursts suggest the research frontier of cognitive frailty, which need more attention from elderly practitioners and researchers in the coming years. For example, although different cognitive frailty models (e.g., potentially reversible cognitive frailty model) have been proposed [40, 46], a new model from the psychosocial and behavioral perspective can be examined in future studies as evidenced that cognitive frailty is associated with various psychosocial and behavioral factors [46].

Although the results of this study have provided valuable information to future cognitive frailty researchers and practitioners, one limitation should be considered when interpreting the findings. This study searched the publications of the WoSCC database only. It was impossible to include all papers related to cognitive frailty. However, this database is considered the most authoritative one that contains the world's leading scholarly journals. While this study is the first bibliometric analysis of cognitive frailty research, scholars who want to deeply delve into this field are suggested searching other databases to identify more relevant publications.

Conclusions

This study provides a comprehensive bibliometric analysis of cognitive frailty research. A variety of visualized networks offer an in-depth understanding of the countries / regions, institutions, authors, hotspots, and research frontiers. For cognitive frailty researchers and practitioners, this study provides accurate information regarding potential collaborative authors and institutions. Moreover, this study has identified the hotspots and frontiers in this research area, which can be considered in future studies.

Abbreviations

IANA / IAGG: International Academy on Nutrition and Aging and the International Association of Gerontology and Geriatrics

WoSCC: Web of Science Core Collection

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and materials

All data generated or analyzed during this study are included in this published article and its supplementary information file.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

ZH and XW contributed to the study conceptualization, while YZ, YL, and XR contributed to data acquisition and analysis. ZH interpreted the data and drafted this manuscript with revisions from XW and MW. All authors read and approved the final manuscript.

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Figures

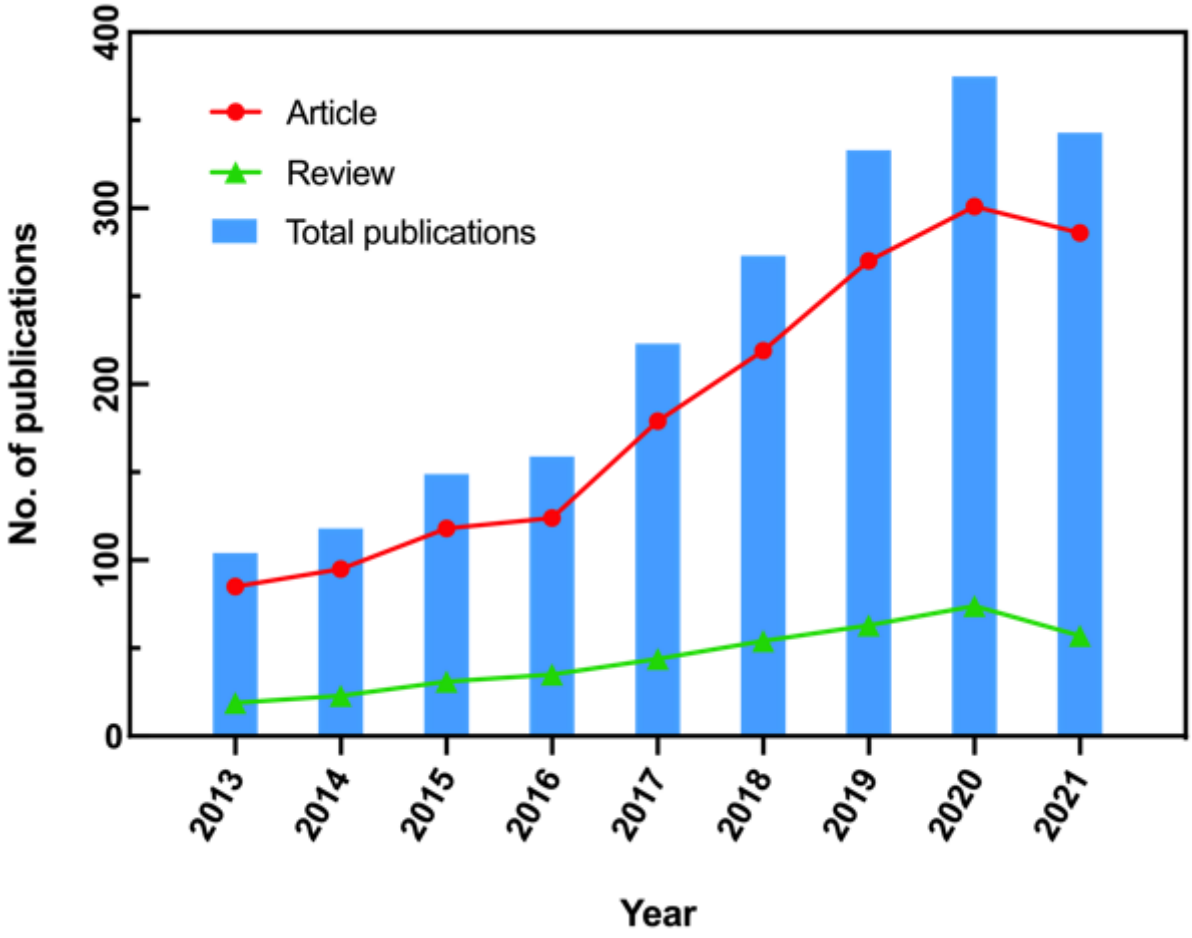

Figure 1

Number of publications on cognitive frailty in the Web of

Science Core Collection database from 2013 to 2021

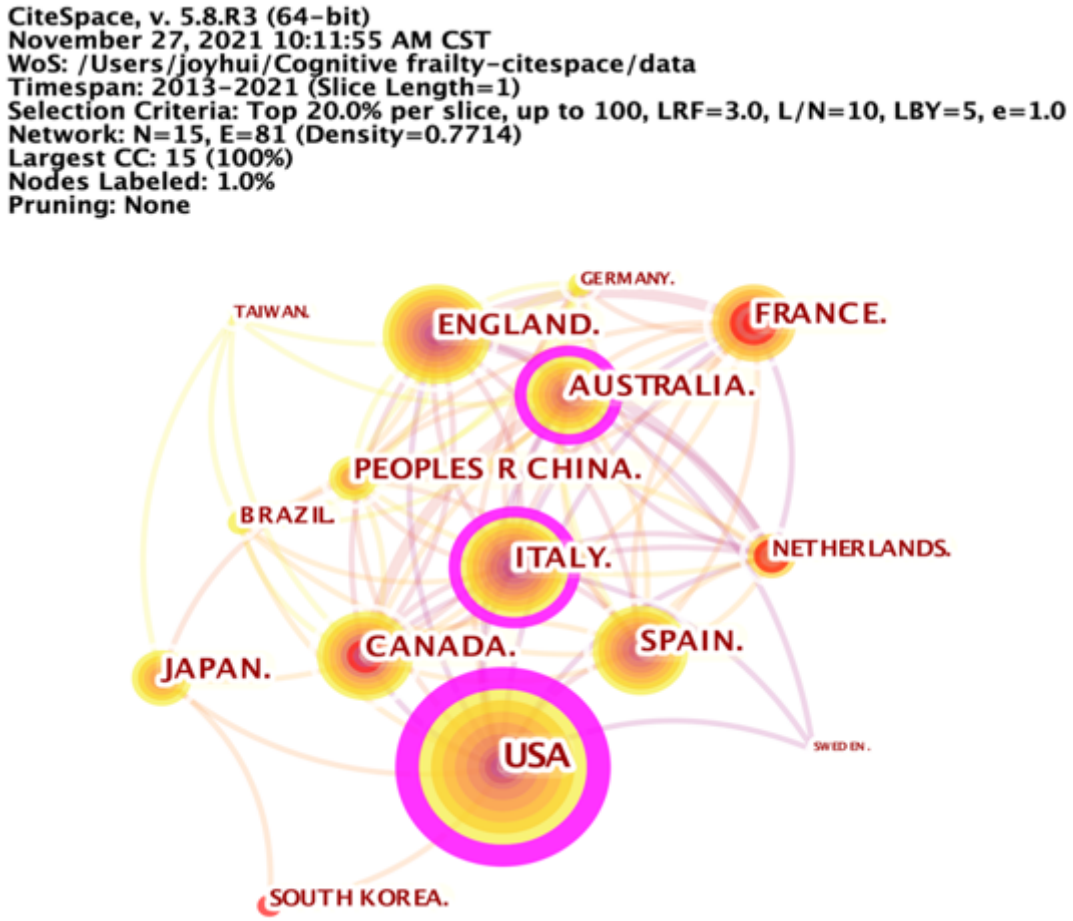

Figure 2

Collaboration network of countries / regions

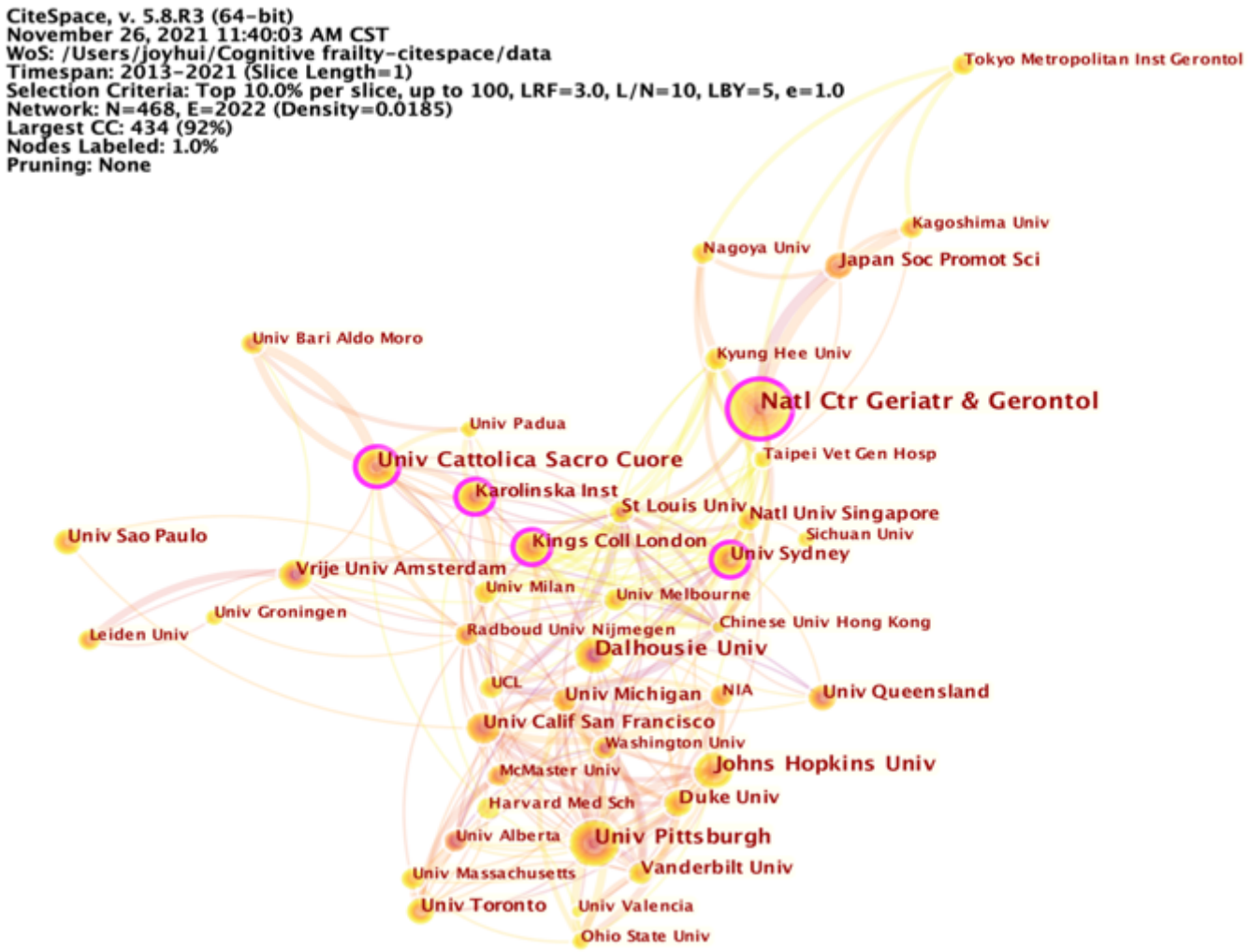

Figure 3

Collaboration network of institutions

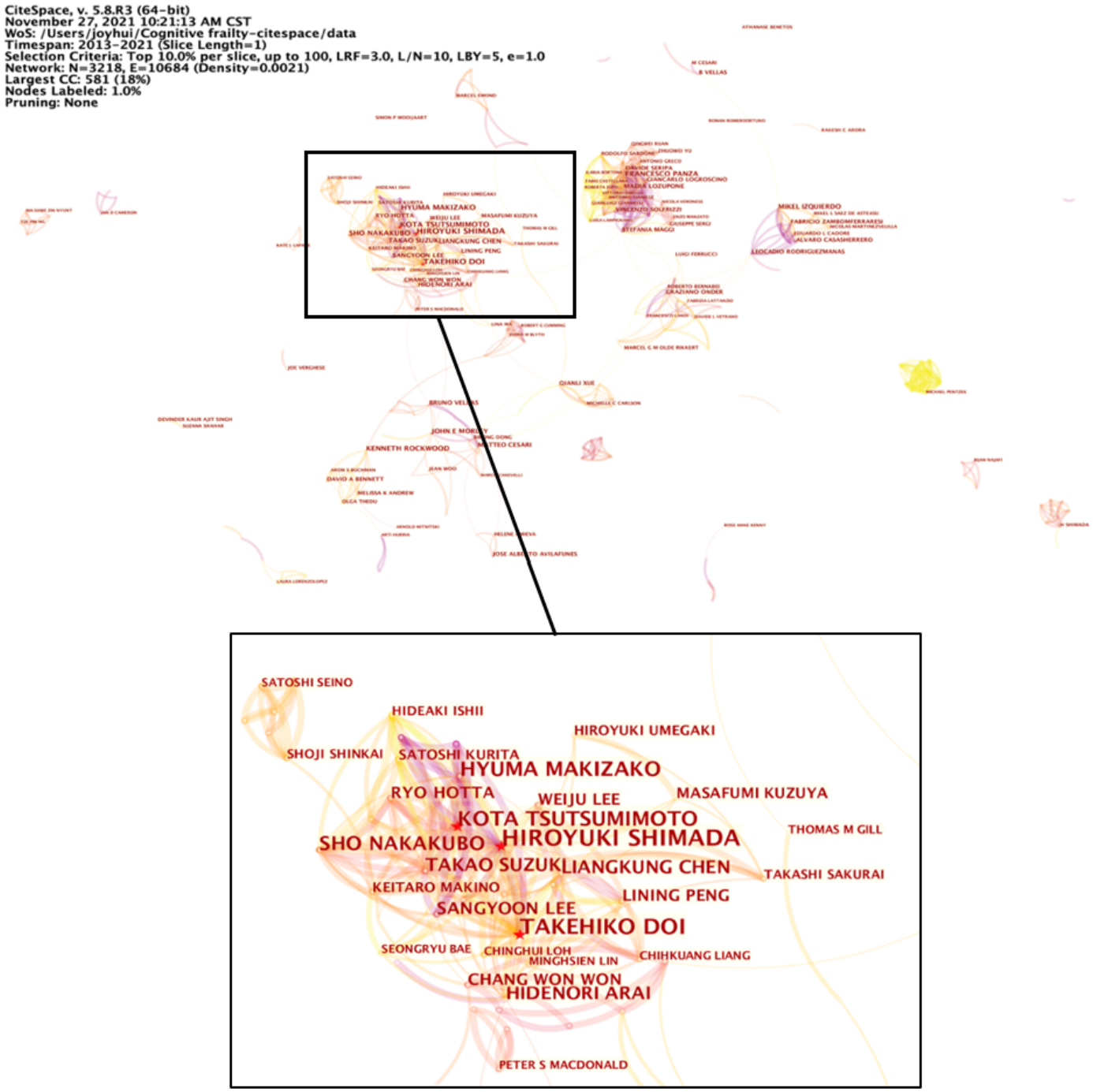

Figure 4

Collaboration network of authors

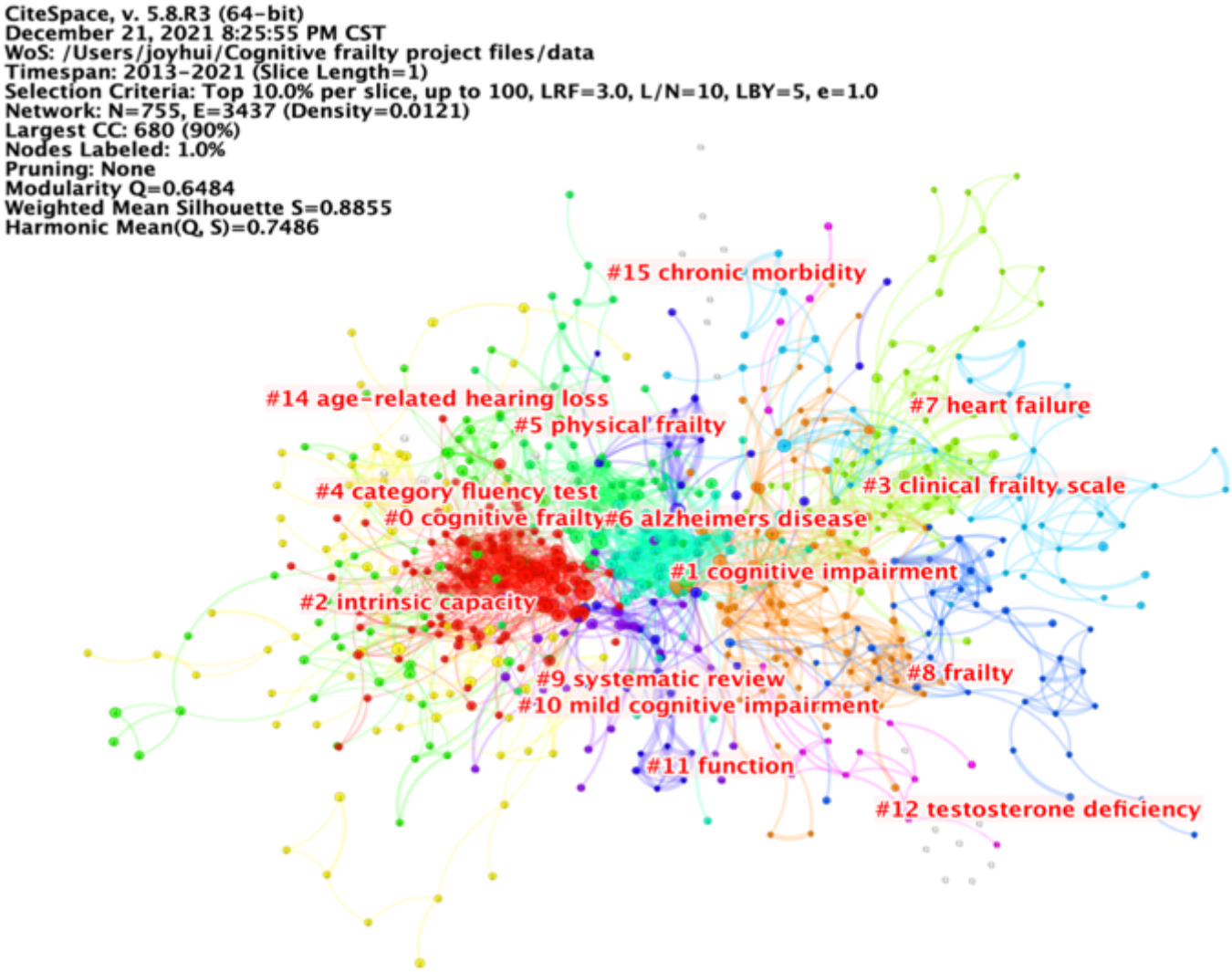

Figure 5

Document co-citation network in cognitive frailty research

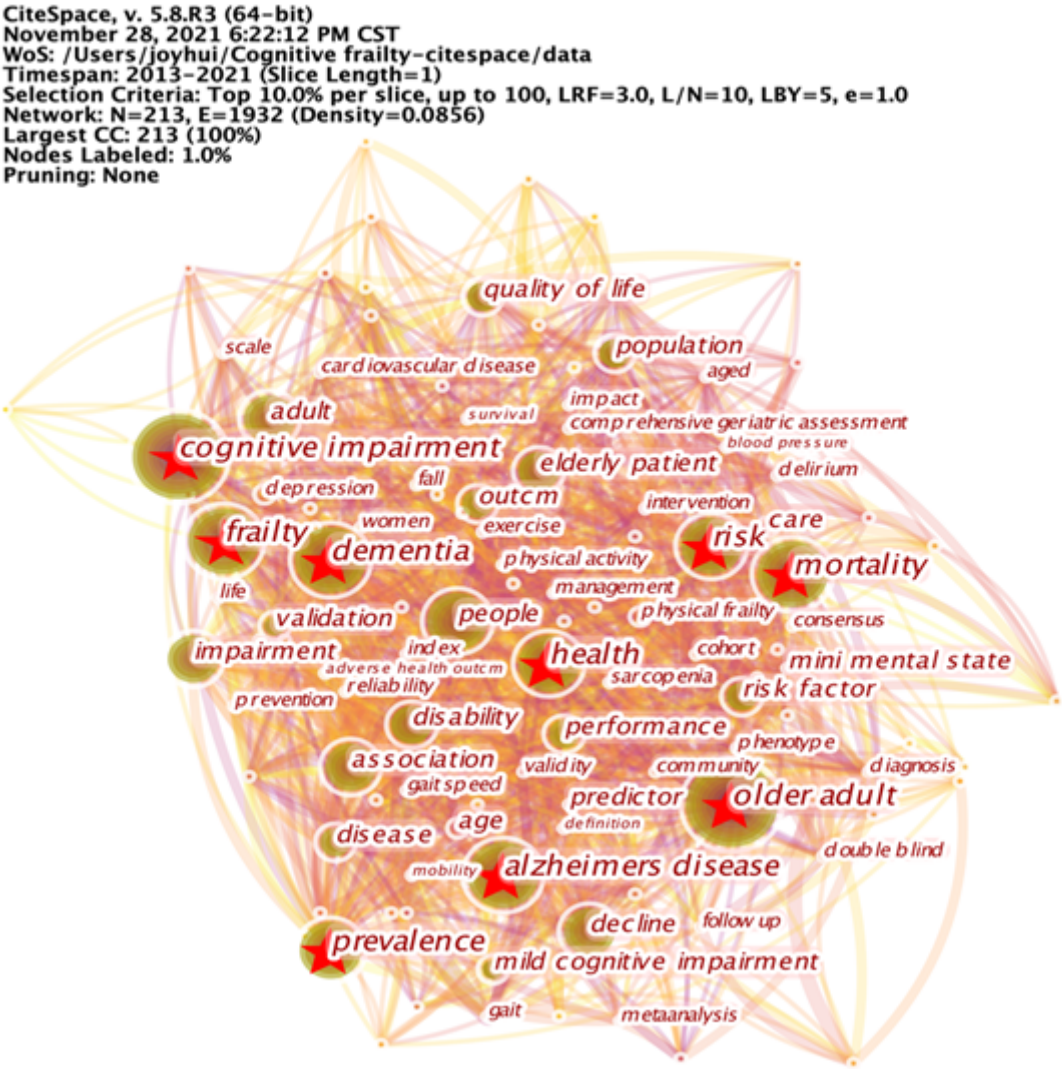

Figure 6

Network of co-occurring keywords

Keywords	Year	Strength	Begin	End	2013 - 2021
disability	2013	9.81	**2013**	2015	
womens health	2013	8.11	**2013**	2016	
randomized controlled trial	2013	6.76	**2013**	2017	
functional decline	2013	5.44	**2013**	2015	
women	2013	4.61	**2013**	2014	
double blind	2013	4.47	**2013**	2016	
united states	2013	4.01	**2013**	2014	
nursing home resident	2013	5.64	**2014**	2015	
elderly people	2013	8.77	**2015**	2018	
heart failure	2013	4.35	**2015**	2016	
trial	2013	5.17	**2016**	2017	
physical function	2013	4.96	**2016**	2017	
alzheimer disease	2013	4.55	**2016**	2018	
decision making	2013	3.97	**2016**	2017	
cohort	2013	5.47	**2017**	2018	
resident	2013	3.95	**2017**	2018	
cognitive frailty	2013	5.75	**2019**	2021	
dysfunction	2013	4.35	**2019**	2021	
model	2013	4.05	**2019**	2021	
american college	2013	3.75	**2019**	2021	

Figure 7

20 keywords with the strongest citation burst