Concise Review

Operationalisation of Successful Ageing in the Oral Health Context: A Citation Analysis

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ABSTRACT

Objectives: The rapidly ageing world has placed considerable demands on health and social care. To address this, the World Health Organization (WHO) and United Nations (UN) have declared action for this decade (2021–2030) to promote healthy ageing. Operationalisation of successful ageing in the oral health context in terms of its dimensions and their interconnectedness was determined.

Methods: A citation analysis was conducted following a scoping review to determine oral health's relationship with 5 key dimensions of successful ageing. This included examining the occurrence and co-occurrence amongst dimensions and over time. Specific consideration of citations by country, journal type, and authors through overlay visualisation was performed to map their interconnectedness.

Results: The scoping review identified 263 publications covering 1730 specific terms. There was a growing interest in successful ageing in the oral health context, mostly in the past decade (2010 onwards; 65.8%, 173 publications). The dimension of key consideration was "health and ADLs" (activities of daily living); this dimension appeared in 97.3% of publications (n = 256) and was found earliest to emerge, with the greatest link strengths compared to other dimensions. Country-level variations in citation data were observed, and there was good citation interconnectedness between them. Key oracles for dissemination have been medical rather than dental-specific journals. Amongst authors, there was considerable interconnectedness in the field.

Conclusions: Findings highlight how successful ageing in the oral health context has been studied, with implications for addressing the significance of oral health to older peoples' lives in line with the WHO and UN's agenda. Citation analyses identified the "known unknowns" area for further consideration, and these findings have the potential to inform how dental research may best move forward with the successful ageing agenda to bring about translational impact.

Introduction

The world's population is ageing quickly, evidenced by an increase in the absolute number and proportion of older people. Older populations place challenges on health and social services globally, in particular amongst low- and middle-income countries, where most of the world's older population lives.[1] To address this, the United Nations and World Health Organization have declared action for this decade (2021–2030) to promote healthy ageing and foster greater improvements in the lives of older people, their families, and their communities.[2] Central to their plan of action is integrated care (including dental care), with specific consideration for those in long-term care. A specific challenge is related to the measurement, monitoring, and evaluation of the United Nations Decade of Healthy Ageing agenda.[3]

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Traditionally, clinical assessment of health status has been used to determine health care needs and outcomes from health care services. In the oral health context, monitoring changes in tooth loss, occlusal support, dental caries, periodontal disease, and other oral conditions amongst older people have provided valuable insight into the challenges ahead.[4] However, these clinical measures in themselves are limited, particularly in advocating for the importance of oral health and oral health care to older people's lives, especially in fostering integrated care. Moreover, the assessment of patient-/person-reported outcomes, particularly health- and oral health–related quality of life, has evolved over the past decades to provide understanding of the physical and psychosocial attributes of oral health and dental care.[5] However, even such quality-of-life assessment are limited in providing insight into the broader impact of oral health in the lives of older people, their families, and society.

A key impact measure is mortality, and there is ample evidence of increasing life expectancy and survival associated with improvements in health status, health care, and social care.[6] We acknowledge that increased life expectancy is not universal and gross inequalities exist between and within countries. An increasing body of evidence has emerged on the relationship between oral health status and mortality rate. Oral cancers (oral cavity and lip cancer) have long been noted to have poorer survival rates than many other cancers, owing to deficiencies in its early-stage detection and limited success of treatments.[7] More recently, evidence from a systematic review highlights the association between tooth loss (number of missing teeth/number of remaining teeth) and cardiovascular disease mortality.[8]

Poorer oral health amongst older people has been found to be associated with poor general health and morbidity.[9] Older people typically experience poorer oral health. In many cases, their oral disease remains untreated or is managed only when it is care-seeking is motivated by pain, with limited oral rehabilitation, especially in long-term care homes.[10] However, the focus on morbidity in itself, whilst linking how oral health is an integral part of general health, provides limited understanding of the value and impact of oral health and oral health care on the lives of older people and their functioning within society. In assessing the broader impact of health and health care in older people's lives, the concepts of "healthy ageing," "active ageing," "productive ageing," and "successful ageing" have been proposed.[11–14] Often these concepts/terms are used interchangeably, as there is a notable lack of consensus regarding their dimensions and associated taxonomies.[15] There is much debate around whether the concepts are elusive or tangible entities and how best they can be operationalised if they are to be measured.[15] Urtamo et al's[16] model of 5 dimensions of successful ageing is more comprehensive in comparison to Fernández-Ballesteros'[17] model of 3 dimensions of successful ageing. The 5-dimension model provides a useful framework of how these concepts are related and how they can be operationalised to provide a broader understanding of how they relate to social and psychological adaptation processes in later life.[16] Under the umbrella of successful ageing, the dimensions of active ageing, healthy ageing, and productive ageing exist, as shown in Figure 1.

A citation analysis of the medical literature has proved useful in identifying interest in the concept of successful ageing and which domains of health and functioning contribute

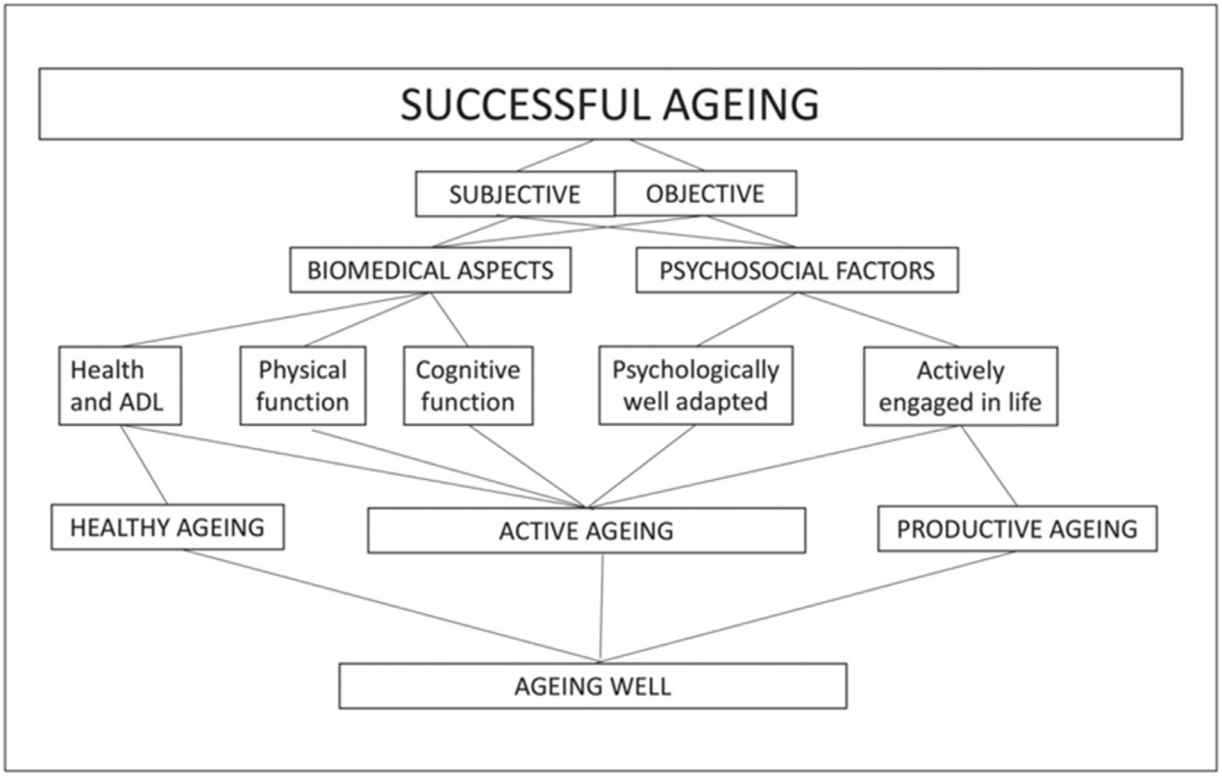

Fig. 1 – The dimensions of successful ageing.
Adopted Urtamo et al.[16]

to successful ageing.[18] We aimed to conduct a citation analysis of successful ageing amongst the dental literature, examining the emergence of the concepts (dimensions and terms) over time and their interconnectedness as measured by the frequency of occurrence and co-occurrence of dimensions, geographic areas where the concepts are being studied, and the links amongst publications (journal- and author-based citation). This citation review has the potential to provide a first step towards understanding how successful ageing is and can be operationalised in the oral health context, with implications for assessing how oral health status and oral health care contribute to successful ageing and the United Nations agenda.

Methods and methods

Identification of successful ageing publications

The broad search terms of Urtamo et al's[16] model of "successful ageing" (Figure 1) were applied across 5 electronic databases: PubMed, MEDLINE ProQuest, Embase Ovid, PsycInfo, and Cochrane Library - Cochrane Database of Systematic Reviews. Following the screening, 263 publications relating to "successful ageing" were identified in a scoping review registered on PROSPERO (#CRD42021232668: https://www.crd.york.ac.uk/prospero/display_record.php?RecordID=232668).[30] Details of the screening, identification and reporting using the PRISMA framework as part of a scoping review can be obtained in a previous related publication, Figure 2.[30] Titles and abstracts of the included publications were searched again in the Scopus database to perform citation analysis, and where these elements were missing (19 publications), they were manually added to enable comprehensive analysis.

Bibliometric data analyses

The bibliometric data were analysed using VOSviewer to visualise networks of the term "successful ageing" amongst oral health publications.[19] First, a map was created based on the Scopus text data of all titles and abstracts using VOSviewer to identify the occurrence and co-occurrence of terms, and the map was exported as a VOSviewer thesaurus file. The identified terms were then classified according to Urtamo et al's[16] framework of 5 dimensions of successful ageing[17]: (1) health and activities of daily living (ADLs), (2) physical function, (3) cognitive function, (4) actively engaged in life, and (5) psychologically well adapted in later life.

Second, a map resulting from textual citation analysis was created based on these classified terms, specifically related to mentions of the 5 dimensions of successful ageing. An "overlay visualisation" was applied to provide insight into the occurrence and co-occurrence of mentions of the 5 dimensions with respect to the time period of publication, as represented by the average publication year, with lighter colours denoting more recent publications and larger circles denoting higher numbers of publications. Link strength, a measure of strength of co-occurrence of between mentions of dimensions, was also determined (ie, frequency count of co-occurrence between mentions of each of the dimensions amongst publications). Link strength was reported as a positive numeric value, with a higher value representing a stronger link. Following that, a map of bibliographic citation analysis was produced to determine the profile based on (1) country (from author affiliations), (2) journal of publication (source title), and (3) key authors. Prior to analyses, consistency of terms for country, journal, and authors was checked and amended where necessary. In the analyses, a default setting of 25 as the maximum number of countries per publication was selected. When choosing thresholds, 1 was selected as the minimum number of publications of a country and 0 was selected as the minimum number of citations of a country. In citation analysis, the relatedness of items (country, journal, and key authors) is determined based on the number of times they cite each other. Larger circles in the maps denote higher numbers of citations, and circles with the same colours indicate their connectedness.

Results

Trends in publication of successful ageing related to oral heath

Amongst the 263 included publications, approximately two-thirds were published in the past decade (2010 onwards; 65.8%, 173 publications) and most were published from 2015 onwards (61.9%, 107 of 173 publications). Approximately a quarter of publications (27.0%, 71 publications) were published between 2001 and 2010. Fewer than 1 in 10 (7.2%, 19 publications) were published prior to 2001. Based on the Scopus text data of all titles and abstracts of the included publications, 5358 terms were identified; amongst these terms, 1730 (32.3%) terms relating specifically to the 5 dimensions of successful ageing were classified. The dimensions *health and ADLs* and *actively engaged in life* emerged earlier, with average publication years of 2012.1 and 2012.9, respectively (Figure 3). The average publication year for *physical function* was 2013.3. Publications related to the dimensions of *psychologically well adapted in later life* and *cognitive function* emerged later, with average publication years of 2013.9 and 2014.8, respectively.

Occurrences and link strength of terms relating to successful ageing in oral health

The key dimensions reported were related to *health and ADLs* (256 mentions in 97.3% of publications), followed by *physical function* (134 mentions in 51.0% of publications). *Psychologically well adapted in later life* (88 mentions in 33.5% of publications), *actively engaged in life* (76 mentions in 28.9% of publications), and *cognitive function* (75 mentions in 28.5% of publications) had fewer mentions (Table 1). Not only did *health and ADLs* have the most mentions, it also had the greatest co-occurrence (strongest link) with other dimensions, ranging from 69 (*cognitive function*) to 130 (*physical function*), with a total link strength of 362. *Physical function* also ranked second highest in co-occurrence with other dimensions (range, 40–130; total link strength, 261), followed by *psychologically well adapted in later life* (range, 26–88; total link strength, 203), *actively engaged*

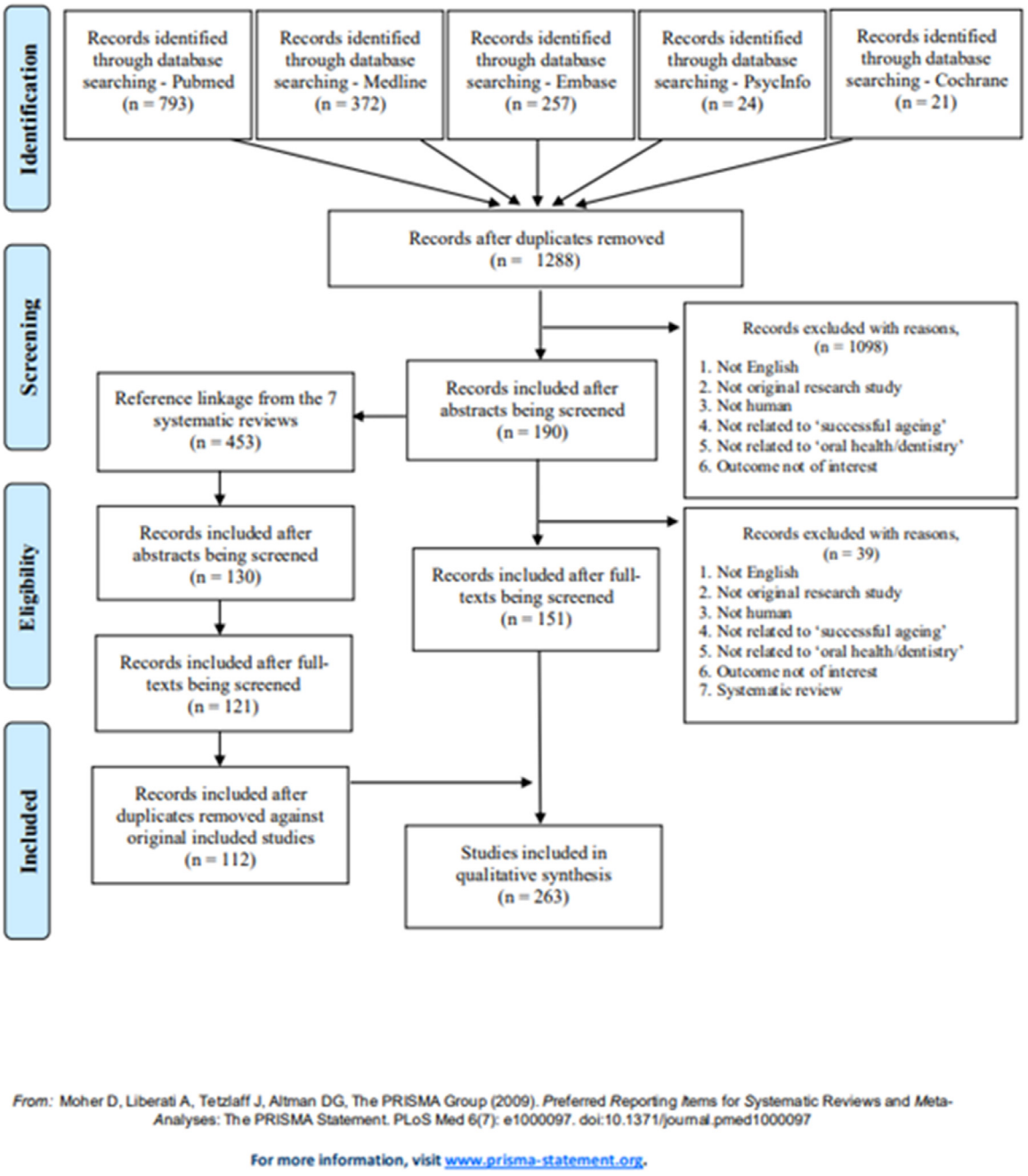

Fig. 2 – PRISMA flow diagram.
Adopted from McGrath et al.[30]

in life (range, 17–75; total link strength, 171), and *cognitive function* (range, 17–69; total link strength, 153).

Source and citation records of publications relating to successful ageing in oral health

Authors from 48 countries were identified from the included publications. The vast majority of publications related to successful ageing were from authors in the US (n = 73), followed by Japan (n = 64) and the United Kingdom (n = 26) (Table 2). The citation count from US authors exceeds 5800, more than double that of Japanese authors (n = 2272) and UK authors (n = 1941). Figure 4 illustrates the number of citations of 34 countries with connected publications. Publications from US authors had the strongest connection, with a total link strength of 446 citations, considerably higher than that for Japanese (n = 250) and UK authors (n = 182).

Included publications were published in 119 journals, with 86 journals connected in citations. Most frequently, publications were in journals that were not dental-specific: *Journal of Nutrition, Health & Aging* (26 publications, 468 citations), *Journal of the American Geriatric Society* (19 publications, 1406 citations), and *PLoS One* (9 publications, 321 citations). Amongst dental journals, the most frequent venue for publication was

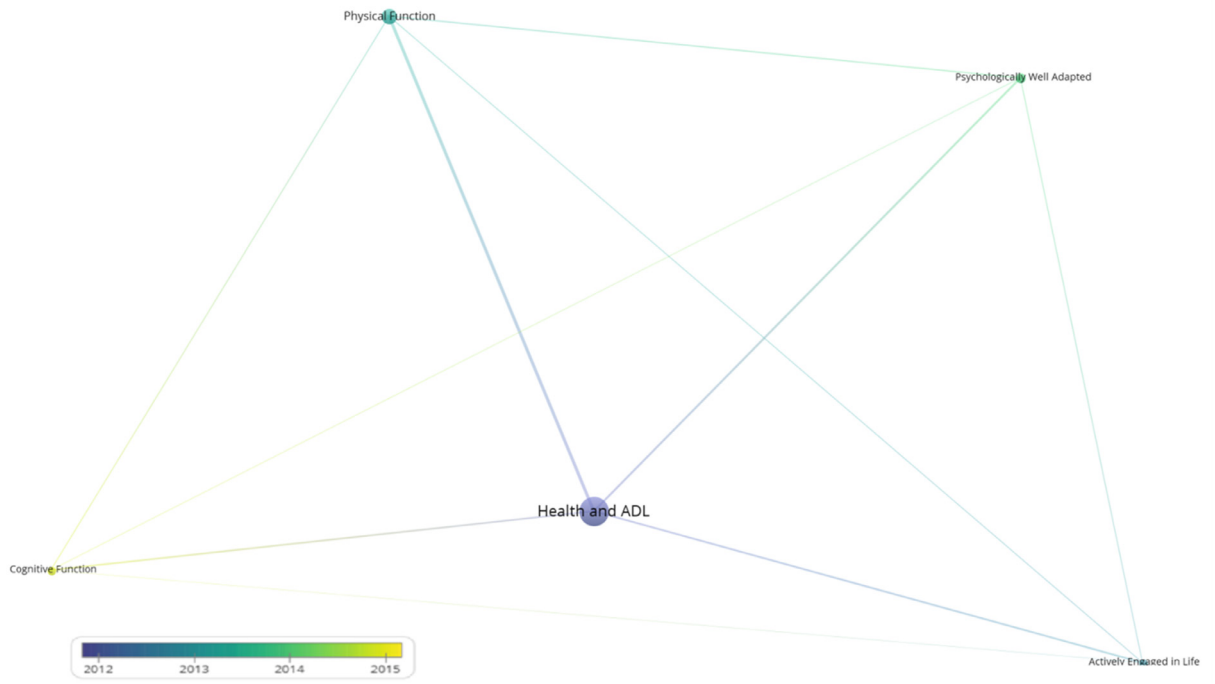

Fig. 3 – Dimension citation map by number and year of publication.

Table 1 – Link strength amongst the 5 dimensions of successful ageing.

Dimension (occurrence)	Link to other dimension	% (No.)
Health and ADLs (97.3%, 256)	Physical function	35.9% (130)
	Psychologically well adapted in later life	24.3% (88)
	Actively engaged in life	20.7% (75)
	Cognitive function	19.1% (69)
	Total link strength	**362**
Physical function (51.0%, 134)	Health and ADLs	49.8% (130)
	Psychologically well adapted in later life	19.2% (50)
	Cognitive function	15.7% (41)
	Actively engaged in life	15.3% (40)
	Total link strength	**261**
Psychologically well adapted in later life (33.5%, 88)	Health and ADLs	43.4% (88)
	Physical function	24.6% (50)
	Actively engaged in life	19.2% (39)
	Cognitive function	12.8% (26)
	Total link strength	**203**
Actively engaged in life (28.9%, 76)	Health and ADLs	43.9% (75)
	Physical function	23.4% (40)
	Psychologically well adapted in later life	22.8% (39)
	Cognitive function	9.9%[17]
	Total link strength	**171**
Cognitive function (28.5%, 75)	Health and ADLs	45.1% (69)
	Physical function	26.8% (41)
	Psychologically well adapted in later life	17.0% (26)
	Actively engaged in life	11.1%[17]
	Total link strength	**153**

ADLs, activities of daily living.

Journal of Dental Research (15 publications, 1929 citations), *Gerodontology* (10 publications, 420 citations), and *Community Dentistry and Oral Epidemiology* (8 publications, 425 citations) (Table 2, section B; Figure 5).

Altogether, 1255 authors were identified from the included publications, 1024 of whom were connected. Frequency of publication and citation by key authors in any of the 5 dimensions of successful ageing are presented in Table 2 (section C) and Figure 6. The most frequently appearing author publishing on successful ageing was Weyant RJ (7 publications, 295 citations), followed by Yamashita Y (6 publications, 528 citations), Sheiham A (5 publications, 724 citations), Furuta M (5 publications, 286 citations), Newman AB (5 publications, 282 citations), and Soini H (5 publications, 147 citations). Details of coauthorship are presented in the Appendix.

Discussion

Citation analyses are increasingly used to provide an overview of an emerging research area and have a role in illustrating interest in operationalisation of and interconnectedness patterns in many ways, including by type of study.[19] This citation analysis provides insight into research relating to successful ageing in the oral health context, the dimensions and terms used, and the trend of their emergence over time. Moreover, link strength between dimensions and total link strength provide insights into co-occurrence of dimensions. The country and journal maps provide a visual overview of the dominance and networking amongst researchers by their institutional countries and journals of publication.

To capture relevant publications relating to successful ageing, a broad search of terms relating to Urtamo et al's[16]

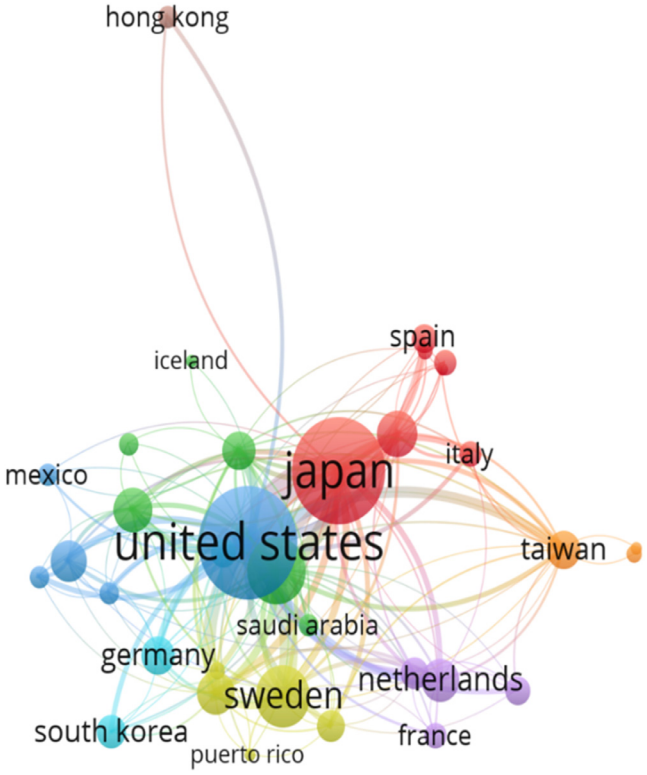

Fig. 4 – Country map by number of citations in connection.

model of "successful ageing" were applied across 5 electronic databases. As different citation analysis programmes are compatible with different databases, Scopus was used because of its comprehensiveness, although several titles and abstracts had to be manually input.[20] A large number of terms (>5000) were identified, and approximately a third could be classified according to the 5 dimensions of *health and ADLs*, *physical function*, *cognitive function*, *actively engaged in life*, and *psychologically well adapted in later life* using a successful ageing outcome terms classification.[17]

The vast majority of publications (approximately two-thirds) were published in the past decade (2010 onwards), highlighting the growing interest in the topic and the need to express the relationship between oral health/oral health care and older people's lives in line with the World Health Organization and United Nations agenda.[3] The most widely identified and earliest dimension to emerge was *health and ADLs*. This could in part be attributed the array of an aspect within the dimension and reflects the considerable focus on how oral health/oral health care are related to general health. Of note, 2 aspects within this domain were prominent: longevity (mortality/survival) and nutrition. As aforementioned, there is increasing evidence that tooth loss (number of missing teeth/numbers of remaining teeth) is associated with survival/mortality rates, controlled for age, other sociodemographic factors, and general health status.[8] A possible pathway of oral health status and mortality is related to the second most common aspect: nutrition. There has long been an interest in and a growing body of evidence on the relationship between oral health status and nutrition. Tooth loss and occlusal imbalance have been shown to be associated with poor appetite, restricted diets, and risk of malnutrition, especially protein energy–related malnutrition.[21] To this end, the importance of the delivery of oral care in conjunction with personalised dietary counselling has been advocated to maximise the benefits of oral rehabilitation.[22]

In terms of individual link strength between dimensions, the strongest links were *health and ADLs* with other dimensions and highest with *physical function*. Physical function itself as a dimension frequently occurred (in approximately half of publications) and had the second highest link strength with other dimensions. Physical function and in particular gait speed and imbalance are of key concern, in that it has

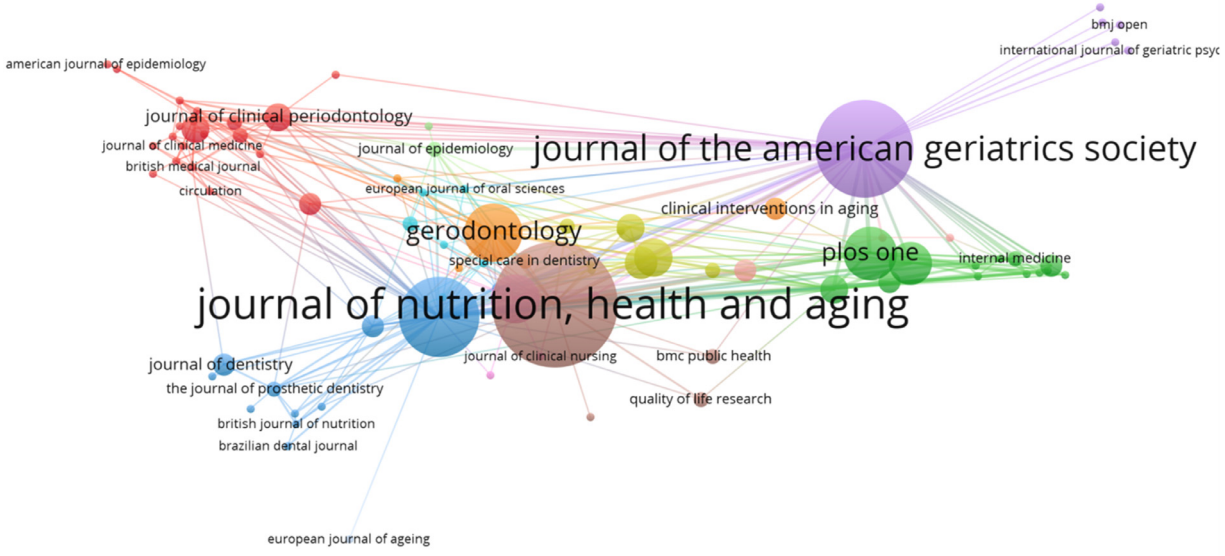

Fig. 5 – Journal map by number of citations in connection.

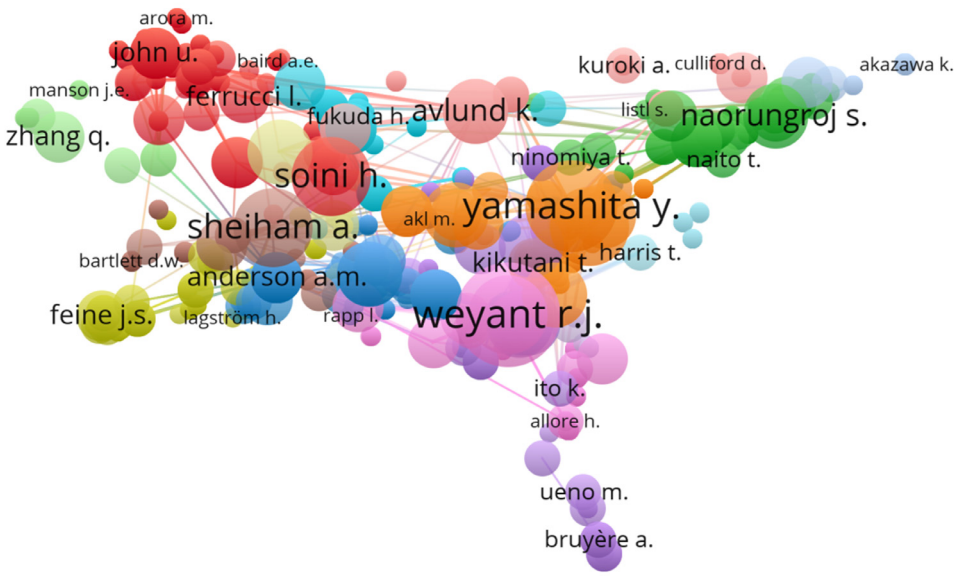

Fig. 6 – Author map by number of citations in connection.

Table 2 – Rank of key countries, authors, and journals with the number of publications and citations.

Subjects	No. of publications	No. of citations
A. Country		
United States	73	5832
Japan	64	2272
United Kingdom	26	1941
Sweden	22	906
Finland	13	497
Brazil	12	261
China	11	360
Netherlands	11	215
Canada	10	446
B. Journal		
Journal of Nutrition, Health and Aging	26	468
Journal of the Americal Geriatrics Society	19	1406
Jounral of Dental Research	15	1929
Gerodontology	10	420
PloS One	9	321
Community Dentistry and Oral Epidemiology	8	425
BMC Oral Health	7	104
International Journal of Environmental Research and Public Health	6	17
Nutrients	5	40
Journal of the American Dental Association	4	597
C. Author		
Weyant RJ	7	295
Yamashita Y	6	528
Sheiham A	5	724
Furuta M	5	286
Newman AB	5	282
Soini H	5	147
Yoshida M	4	565
Miyazaki H	4	332
Akifusa S	4	328
Avlund K	4	230
Holm-Pedersen P	4	230

been shown to be related to accidents, falls, and fractures with detrimental consequences and accelerates decline amongst older people.[23] Tooth loss and the pattern of tooth loss (loss of posterior occlusal support) have also been shown to be associated with falls and fractures in community-dwelling elders.[24] Loss of teeth and imbalance in occlusion/occlusal support have been reported to be associated with overall physical functioning. It has been postulated that the association between oral health and falls may be mediated by compromised occlusal support and occlusal force with physical motor functions such as gait speed.[25]

Another area of interest is the association between oral health status and cognition; albeit that in citation analysis its emergence (average publication year) was the more recent amongst all the dimensions and generally lower link strength. There is a growing body of evidence of the relationship between oral health status (principally tooth loss) and cognitive decline amongst older people (memory, complex attention, and executive function).[26] Various potential pathways on how tooth loss may contribute to cognitive decline have been proposed, including through comprised nutrition (poorer central nervous system functioning), less somatosensory, and/or chronic inflammation. However, evidence of the benefits of oral rehabilitation/care on the cognitive state is lacking.[27]

Overlay visualisation via the mapping of bibliographic citations identified that the US and Japan were the most common countries where studies took place. Japan has long had an interest in ageing—given its rapidly ageing population and its being the oldest population in the world—and has been the site of numerous cohort studies of ageing and frailty.[28] The overall visualisation map by country of the first author's affiliation identified positive citations and connections between countries, with implications from translating evidence from the local to the global.[20] In terms of the avenue of

dissemination, the key journals were medical rather than specifically dental. Publishing outside of the dental arena is likely an important way to draw attention to the significance of oral health and health care in successful ageing. It also may relate to the novelty of considering oral health aspects in more establishing ageing cohorts, albeit frequently limited in what oral health aspects are considered.[29] Mapping the number of citations with connections amongst authors was interesting in that it illustrated much interconnectedness and potential for cross-fertilisation of ideas and concepts. These findings are an important aspect of facing the challenges ahead in promoting successful ageing in the oral health context.

A potential limitation of this citation review is that it was based on the findings of a scoping review that only considered papers published in the English language. Nevertheless, these findings have potential for future researchers and the agenda of successful ageing as a whole, as it provides a useful picture of the current trend of terms and dimensions relating to successful ageing in the oral health context.

Conclusions

This citation analysis provides evidence of the growing interest in successful ageing in the oral health context, especially in the past decade. To date, the focus has primarily been on the relationship between oral health and general health, namely mortality and nutriton. However, there is evidence of high link strength and interconnectedness between the focus on *health and ADLs* with other dimensions of successful ageing. For the most part, studies have been conducted in the US and Japan, but there were positive citations and interconnectedness with many other countries. Key venues for dissemination were journals specific to medicine rather than dentistry. Amongst authors, there is considerable interconnectedness of articles in the field. The citation analyses identified the "known unknowns" areas for further consideration, and these findings have the potential to inform how best dental research may move forward with the successful ageing agenda.

Author contributions

Colman McGrath: conceptualisation; supervision of scoping review; methodology of citation review; interpretation of results; and writing and editing. Rita P. C. Suen: conduct of scoping review; methodology of citation review; interpretation of results; and writing and editing. May C. M. Wong: methodology of citation review; interpretation of results; and writing and editing. Andy W. K. Yeung: methodology of citation review; interpretation of results; and writing and editing. Gerry McKenna: conceptualisation; supervision of scoping review; interpretation of results; and writing and editing. Ciaran Moore: conduct of scoping review; interpretation of results; and writing and editing.

Conflict of interest

None disclosed.

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.identj.2024.04.018.

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