



## Review article

# Successful ageing: A study of the literature using citation network analysis



Sasmita Kusumastuti<sup>a,b,\*,1</sup>, Marloes G.M. Derks<sup>b,c,1</sup>, Siri Tellier<sup>a</sup>, Ezio Di Nucci<sup>a</sup>, Rikke Lund<sup>a,b</sup>, Erik Lykke Mortensen<sup>a,b</sup>, Rudi G.J. Westendorp<sup>a,b</sup>

<sup>a</sup> Department of Public Health, University of Copenhagen, Copenhagen, Denmark

<sup>b</sup> Center for Healthy Aging, University of Copenhagen, Copenhagen, Denmark

<sup>c</sup> Department of Surgery, Section of Geriatric Oncology, Leiden University Medical Center, Leiden, The Netherlands

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## ABSTRACT

**Background:** Ageing is accompanied by an increased risk of disease and a loss of functioning on several bodily and mental domains and some argue that maintaining health and functioning is essential for a successful old age. Paradoxically, studies have shown that overall wellbeing follows a curvilinear pattern with the lowest point at middle age but increases thereafter up to very old age.

**Objective:** To shed further light on this paradox, we reviewed the existing literature on how scholars define successful ageing and how they weigh the contribution of health and functioning to define success.

**Methods:** We performed a novel, hypothesis-free and quantitative analysis of citation networks exploring the literature on successful ageing that exists in the Web of Science Core Collection Database using the CitNetExplorer software. Outcomes were visualized using timeline-based citation patterns. The clusters and sub-clusters of citation networks identified were starting points for in-depth qualitative analysis.

**Results:** Within the literature from 1902 through 2015, two distinct citation networks were identified. The first cluster had 1146 publications and 3946 citation links. It focused on successful ageing from the perspective of older persons themselves. Analysis of the various sub-clusters emphasized the importance of coping strategies, psycho-social engagement, and cultural differences. The second cluster had 609 publications and 1682 citation links and viewed successful ageing based on the objective measurements as determined by researchers. Subsequent sub-clustering analysis pointed to different domains of functioning and various ways of assessment.

**Conclusion:** In the current literature two mutually exclusive concepts of successful ageing are circulating that depend on whether the individual himself or an outsider judges the situation. These different points of view help to explain the disability paradox, as successful ageing lies in the eyes of the beholder.

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\* Corresponding author at: Department of Public Health, University of Copenhagen, Copenhagen, Denmark.

E-mail address: [saku@sund.ku.dk](mailto:saku@sund.ku.dk) (S. Kusumastuti).

<sup>1</sup> Both authors contributed equally to the work.

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## 1. Introduction

How can people age successfully? Worldwide, many people prioritize good health as an important goal in their lives [1] and some consider health and functioning in old age as a prerequisite when striving for successful ageing [2]. Growing old, however, presents us with a plethora of debilitating consequences, among which there are disabilities, cognitive decline, and loss of social relationships [3]. When we assume health to be the driving force for successful ageing while at the same time ageing is associated with an increased risk for diseases and loss of functioning, we would expect that ageing is associated with a gradual decline in wellbeing. In contrast to this expectation, previous research has shown that in many countries around the world, overall wellbeing follows a curvilinear pattern that reaches its nadir at middle age but increases thereafter up to very old age [4,5].

Why then are there so many people experiencing high levels of wellbeing despite the fact that their bodies fail? This remarkable observation has been previously described in the setting of rehabilitation. The ‘disability paradox’ indicates that people with severe physical disabilities rate their own wellbeing rather positively. This experience of wellbeing is unexpected for outsiders, but becomes understandable as people are able to adapt to their disabilities [6]. When extrapolating the disability paradox to people growing older, maintaining good physical health might not be the only necessary prerequisite when striving to be successful in old age.

To shed further light on this paradox we delved into the literature on the scholarly definition of successful ageing and the contribution of health to success in old age. To this end we conducted an innovative and combined quantitative and qualitative assessment of the literature on successful ageing.

## 2. Methods

Considering the extensive literature on successful ageing, and to get a better understanding of how the concept has evolved, we decided to analyse citation networks using CitNetExplorer software. This software programme enables us to perform a hypothesis-free and exploratory quantitative analysis, and a visualization of the citation links of the relevant scientific literature [7].

A search on Web of Science Core Collection Database was performed on all literature with “Successful Aging” or “Successful Ageing” in the title only, at the 28th July 2015. Both terms were used because they are spelled differently in the Unites States and the United Kingdom. The search resulted in 1233 articles. The full record contents of these primary articles, as well as the secondary articles that have been cited were used as input for the CitNetExplorer tool.

Clustering analysis in the citation network was performed to identify clusters of publications that are strongly connected to each other in terms of citation publications [8], forming an intellectual network. A cluster can be interpreted to represent a confined intellectual topic in the scientific literature. For all clustering analyses, the default resolution parameter (1.00) from the CitNetExplorer

programme was used. The resolution parameter determines the level of detail at which clusters are identified. The higher the value of the parameter, the larger the number of clusters that will be obtained [7]. The minimum cluster size was set to 10 publications and small clusters with number of publications below the minimum cluster size were to be merged as much as possible with other clusters. Clusters were visually identified in the citation network by using colours.

The biggest clusters were then further explored for more detailed citation networks using the ‘drill down’ feature of the CitNetExplorer software programme. The various sub-clusters were characterized with identifying the pioneering publication, the publication with highest citation score, and the most recent publication. Relevant clusters and sub-clusters were then scrutinized for in depth qualitative review of the literature and reported in a tabular format.

## 3. Results

### 3.1. Quantitative analysis

After downloading full record contents of the 1233 publications that were identified by our primary search on ‘successful aging’ or ‘successful ageing’ from the Web of Science Core Collection database, the CitNetExplorer programme identified 2638 secondary, citation linked publications. We thus obtained and analysed a citation network consisting of 3871 publications with 10,804 citation links, within the time window from 1902 through 2015.

Clustering analysis resulted into ten main clusters of publications and due to the minimum size requirement, 603 publications do not belong to a cluster. Table 1 provides citation network information for all 10 main clusters, with the clusters ordered according to cluster size, descending from the largest to the smallest cluster. As seen in Table 1, the first three clusters contain the majority of publications and citation links. The first cluster is the biggest in size with 1146 publications, 3946 citation links and 77 publications with a citation score of  $\geq 10$ . The second and the third cluster consist of 609 publications and 1682 citation links, respectively 541 publications and 1234 citation links. The other remaining seven clusters were smaller, representing less than 10% of all publications and less than 6% of the total number of citations links per cluster. It appears that the number of the 100 most frequently cited publications are within the first and the second cluster with substantially higher numbers (57 and 33 respectively) than in the third cluster (6). The seven remaining clusters only contributed with four out of the 100 most cited papers.

Fig. 1 shows a timeline-based network visualization of citation links including the 100 most cited publications. In this visualization, each circle represents a publication that is labelled by the last name of the first author, while curved lines represent citation links. The vertical axis represents a timeline and describes the year in which the article was published, with more recent publications being located below older publications. If two linked publications appeared in the same year, then the citing publication is always

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