

## **THEMES AND POLICIES ON POPULATION AGEING: A BIBLIOMETRIC APPROACH**

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**Abstract.** The profound transformations that have occurred in many developing and, above all, developed countries have led to changes in the structure of populations worldwide. Currently, scientific communities are discussing how these components of population change impact and interact with social and economic conditions, medical situations and cultural factors, to shape the characteristics and dynamics of ageing. The ageing of the population poses several challenges for policymakers in many regions and countries. The labour market, health and welfare systems are some of the social contexts in which it is possible to act to face new demands of an increasingly less balanced population. This creates the need to identify possible responses within scientific communities to construct a knowledge-based institutional reaction (in terms of policies) in line with the profound changes taking place. Therefore, the aim of this article is to explore the scientific production on population ageing through bibliometric techniques to analyze scientific productivity and extract the main themes. The explorative approach allows us to intercept the main topics of discussion within the relevant communities of scholars. Through bibliometric analysis, statistical tools are applied to perform a quantitative study of the scientific production of a certain period (1985-2022), in journal articles and their metadata (e.g. authors, affiliations, citations). We extract research topics using the text-mining methods contemplated within the bibliometric approach. The results concern the identification of scientific orientations and trends useful for policy making. In particular, the results relate the number of publications in the analysed time span, author profiles and latent concepts.

### **1. Introduction**

Population ageing is an ongoing process in which the proportion of older individuals systematically increases over time, while the share of the adult and young population declines. Generally speaking, the current ageing process reflects the combined effects of declining fertility rates and increasing life expectancy. Understanding the actual ageing structure of populations is crucial for policymakers, researchers, and organizations to address the multifaceted challenges and opportunities associated with this demographic trend shift.

Scientific studies provide valuable insights into the ageing processes of the population in many regions and/or countries. A comprehensive analysis conducted

by the United Nations (2019) examined global demographic trends and projected future population ageing patterns. The study revealed that the proportion of individuals aged 60 years and older has been steadily increasing worldwide, while the proportion of younger age groups, particularly children, has been declining. These findings highlight the magnitude of population ageing and its implications for various geographic areas.

Scientific research plays a crucial role in understanding these implications and guiding effective strategies to address the challenges and leverage the opportunities presented by population ageing. By considering the findings and recommendations from these studies, policymakers and stakeholders can develop comprehensive approaches that promote healthy and active ageing, ensure the provision of quality healthcare, and support the well-being of ageing populations.

The scientific contributions to understanding population ageing have a strongly multidisciplinary foundation. This is because the phenomenon and its implications can be studied from various perspectives. Demographers and statisticians have contributed by providing data-driven insights into population trends and projections, aiding in the understanding of population ageing dynamics (e.g. Harper, 2014; Lutz et al. 2019). Technological researchers, as explored by Mitzner et al. (2010), have examined the role of technology and innovation in supporting ageing populations through assistive devices, remote healthcare, and smart environments. In the field of health and medicine, e.g. studies by Beard et al. (2016) have examined the health policies needs and healthcare systems of ageing populations. Economists and labour market researchers, such as Bloom et al. (2014), have investigated the economic consequences of population ageing and proposed strategies to address the changing workforce dynamics. Sociologists and social scientists have focused on various topics and, among them, intergenerational relationships and social support networks (Silverstein, 2011). Psychologists and cognitive scientists, as evidenced by the work of Fernández-Ballesteros et al. (2013), have examined the cognitive and psychological aspects of ageing, identifying factors that contribute to successful ageing and interventions to enhance mental well-being. Policy researchers and governance experts, as seen in studies by the European Commission (2018), have informed the development of policies and frameworks to address the implications of population ageing, including social protection, pension systems, and active ageing initiatives.

This variety of scientific contributions needs to be the subject of further analyses to organize its outcomes and direct them towards specific practices and policies.

The aim of this article is to propose an automatic and systematic review of the existing literature on population ageing by examining the scientific output and identifying the most relevant scientific topics that could be relevant to political and policy actions, specifically focusing on science mapping.

## **2. Brief literature review**

The phenomenon of the ageing of the population poses very cross-cutting challenges within scientific production. Researchers propose different focuses based on their investigation field, particularly focusing on policy recommendations and analyses of economic and social contexts (e.g. Reynaud and Miccoli 2019; Christensen et al. 2009; Bloom et al. 2011).

This creates the need to identify possible responses within the scientific communities that can be proposed as social policies to create an institutional response in line with the profound changes taking place (e.g. Teitelbaum, 2015 Skirbekk, 2022).

We need a methodological approach that allows us to carry out the principal themes and map the scientific production. Mapping scientific knowledge plays a critical role in comprehending a subject through literature review, synthesis of research findings, and identification of future research directions. Bibliometric methods offer a systematic and reproducible approach by employing statistical measurements of scientific production, researchers, and activities (Aria et al., 2020). These methods are widely utilized to assess the impact of fields, researchers, papers, and journals, as well as to pinpoint research gaps, trends, and opportunities (Aria and Cuccurullo, 2017). In particular, our study utilizes science mapping as a prominent technique to unveil both the structural and cognitive patterns within the field (Aria et al., 2020). Science mapping empowers us to identify, visualize, and analyze the themes and trends in population ageing research, both in a contemporary and historical context, avoiding redundancy (Callon et al., 1983; Cobo et al., 2011). This methodological approach was already used in the field of healthcare studies. Sarto et al. (2015) conducted a comprehensive mapping of research on governance in healthcare organizations by analyzing keywords from 91 articles published between 1985 and 2010. The study aimed to examine the impact of specific settings on the field of healthcare governance. Belfiore et al. (2022) conducted a review of scientific articles and patents pertaining to the Internet of Things (IoT) in healthcare. Their investigation encompassed both the research domain and practical applications, providing insights into the advancements in this field. We have two main research questions: RQ1. What are the main topics of scientific production on population ageing?; RQ2. What is the longitudinal evolution of the identified conceptual framework (and subsequent description of how the themes change)?

### 3. Methodological strategy: the bibliometric approach

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) model, as proposed by Moher et al. (2009), has been used to retrieve scientific publications. This provides a comprehensive framework that outlines the inclusion and exclusion criteria for selecting articles in a systematic literature review, ensuring transparency and reproducibility of the selection process. Figure 1 shows the PRISMA chart with the filter used for each step of data preparation.

In order to retrieve articles, we accessed the Web of Science (WoS) indexing database, specifically the Science Citation Index Expanded (SCI expanded) and the Social Science Citation Index (SSCI) Web of Science Core Collections, which are maintained by Clarivate Analytics. We constructed a query using both English terms commonly used to describe the topic: "aging" and "ageing."

The query used for the document search was as follows: ((TS=("population ag\*"))). In the WoS database, the TS tag searches for query terms in titles, abstracts, and keywords fields of indexed documents. Quotation marks were employed to retrieve records with exact term sequences, while asterisks served as wildcards to capture term variations.

The data collection took place in early February 2023. We refined the search by selecting only articles, proceedings papers, review articles, and book chapters published in English from 1985 to 2022. The time range was based on the date of the first documents published and inserted in the WOS database to the most recent publication. We collected bibliographic data, including titles, abstracts, author names, keywords, and cited references. The documents were exported to PlainText format and screened by two selectors (AS and LD) to include only documents coherent with the query.

The initial documents' numerosity was 22,178, we excluded records without abstracts and those focusing on detailed medical procedures or practices, we retrieved a total of 4,594 documents (Figure 1).

We used bibliometric analysis to examine the conceptual structure of publications within a specific scientific field, enabling the generation of clusters that provide a comprehensive overview of diverse research in the field (Börner et al., 2003). To conduct the analyses on the entire collection, we employed the bibliometrix R open-source package (Aria and Cuccurullo, 2017), which facilitates quantitative research in scientometrics and bibliometrics.

Two complementary methods, namely co-occurrence network analysis and thematic mapping, were utilized to explore the conceptual structure. These approaches facilitated the identification of relationships among terms, key research themes, and their development over time. The degree of similarity between

publications was determined by the extent of shared keywords, indicating their association within shared research field.

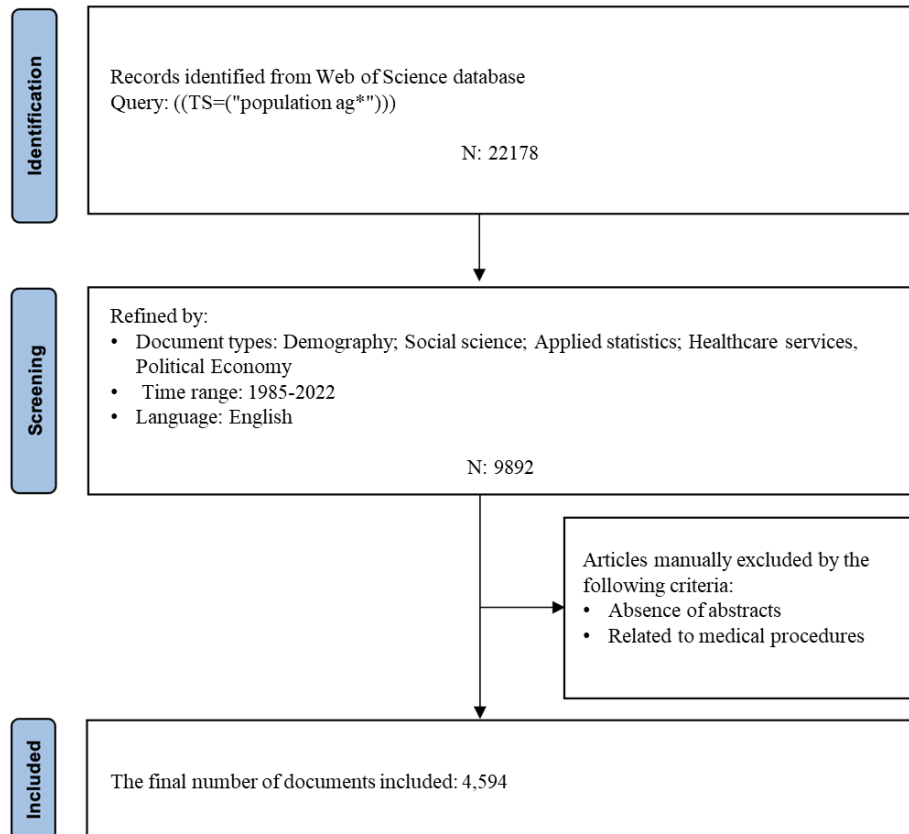
Co-occurrence network analysis (Wang et al., 2019) specifically captured themes represented by sets of terms extracted from documents, such as author and journal keywords. This technique quantified the frequency of term co-occurrence in the document collection and normalized the results using the association index proposed by Van Eck and Waltman (2009). The resulting co-occurrence matrix was represented as an undirected weighted network. Community detection, performed using the Walktrap algorithm (Pons and Latapy, 2006), identified strongly linked groups of terms sharing common characteristics or playing similar roles within the network (Aria et al., 2022).

Thematic mapping, a two-dimensional representation of network findings proposed by Cobo et al. (2011), was employed to plot the identified themes. The x-axis measured Callon centrality, indicating the level of significance that a theme holds within the research field, while the y-axis measured Callon density, reflecting the degree of theme development (Callon et al., 1983). This combination of measures enabled the identification of four types of topics based on their location on the map.

The first quadrant represented highly significant and well-developed motor themes. The second quadrant comprised isolated or niche themes with limited external links, resulting in low centrality and limited importance for the broader research field. The third quadrant encompassed emerging or declining themes, indicating weak or marginal development. The fourth quadrant identified basic and transversal themes that cut across different research areas, to distinguish the emergent and decline themes we need to observe the evolution of the map during the time range selected.

Each theme was represented as a network cluster on the map, with the bubble name indicating the word with the highest occurrence within the cluster, and the bubble size representing the proportion of word occurrences within the cluster.

By employing these methodologies, the study mapped the conceptual structure of the collected scientific documents, revealing significant research topics and trends in the field of population ageing.

**Figure 1** - PRISMA diagram of the selection process.

Source: our elaboration on WOS data.

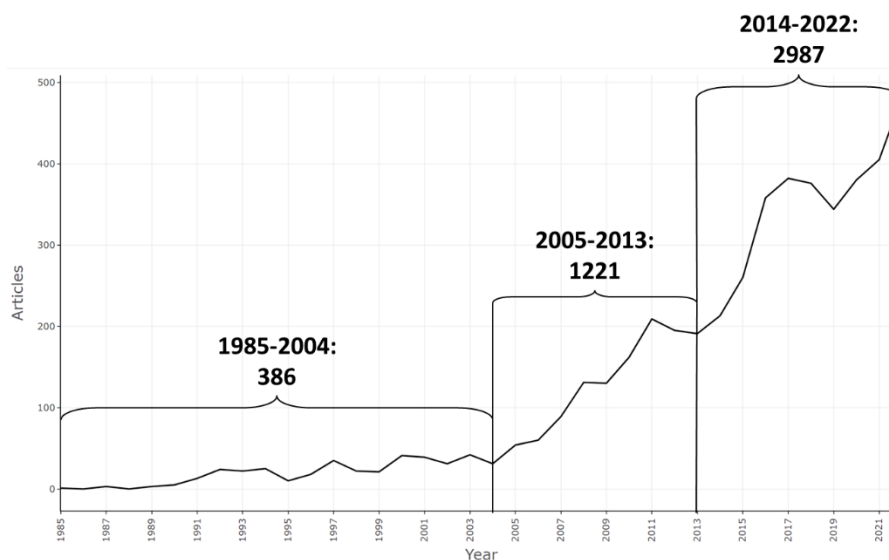
## 4. Results

### 4.1. Temporal evolution of the scientific production

The initial information extracted from the utilized library allowed us to outline a descriptive overview of the analyzed corpus. There are 2,295 sources, a relatively high number considering the applied filters, this can suggest that there are a high number of journals interested in the theme. The average number of citations per document amounts to approximately 12.86, high activity in the community about this field. The total number of authors is 10,081, with 1,081 documents having single authors.

Figure 2 displays the growth of scientific production over the examined time interval for this analysis, with an overall annual growth rate of 18.17%. The general trend was divided into 3 period-subtrends considering the increasing of papers production. As can be observed, the production remains relatively constant between 1985 and 2004, albeit with a slight increase. The total number of documents produced within this range amounts to 386. Subsequently, between 2005 and 2013, there was a significant surge in production, resulting in 1,221 papers. The final portion of the trend shows a further increase in the number of documents produced during this period, reaching 2,987 texts. We have identified these intervals as temporal thresholds on which to focus the study of the longitudinal evolution of discussion topics.

**Figure 2 - Scientific production over the years.**



Source: our elaboration on WOS data.

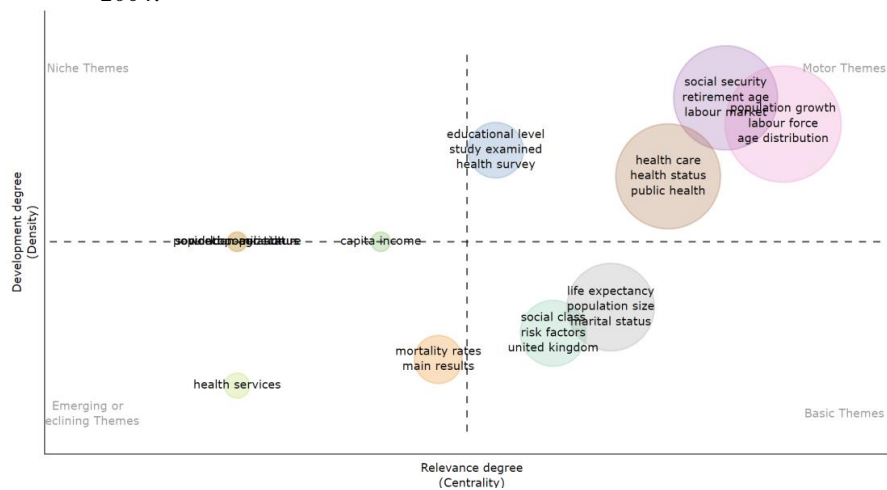
#### 4.2. Temporal evolution of thematic

As stated previously, we have divided the text collection into three different intervals, allowing us to study the evolution of topics based on the diverse results obtained from the analyses (Figures 3, 4 and 5). The outcomes are commented on by considering the different positions of the topics within the three thematic maps.

In the first map (Figure 3), the motor themes are 4 and they relate to population growth, social security, healthcare and educational level. In the opposite quadrant

(emerging or declining themes), we find 2 emerging themes such as health services and mortality rates, which present an interesting contrast as they both pertain to the healthcare domain but follow distinct directions. As cross-cutting (“basic”) themes, we find 2 topics: life expectancy and social class, highlighting the intersectionality of these topics, which are discussed in multiple fields. The topics between niche and declining quadrant (capita income, mortality rates and word population) have few documents associated, for this reason we don’t consider them enough influential in our analysis.

**Figure 3** - Thematic map of studies on population ageing. First temporal threshold 1985-2004.



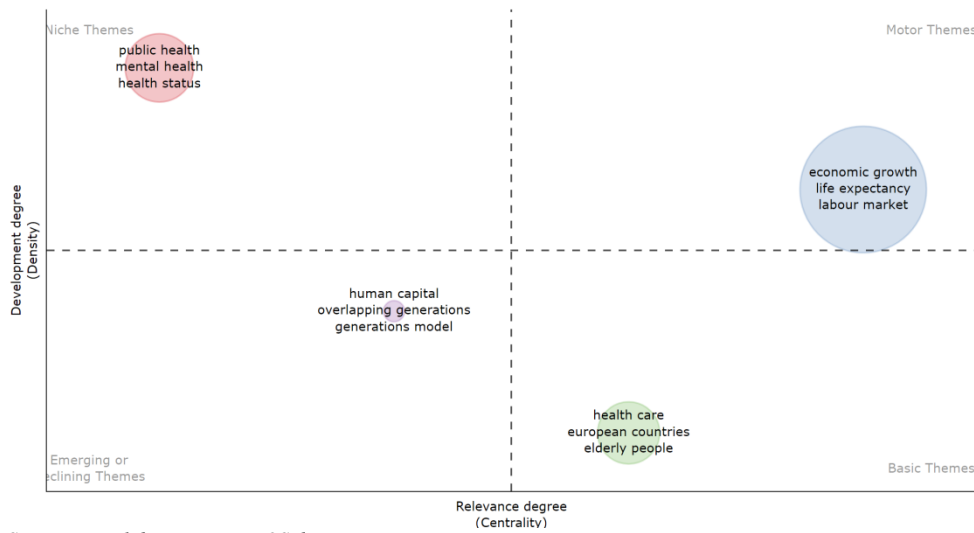
Source: our elaboration on WOS data.

The second map represented (Figure 4), presents a reduction in the number of extracted themes, totalling four. The motor theme is represented by economic growth and the labour market, while in the opposite quadrant, we find the discourse on human capital and intergenerational overlap. It is interesting to consider how, in the years of the second interval, the issue of human capital was essentially an emerging theme. Healthcare represents a basic theme, a matter for discussion among communities, while public healthcare services and mental health constitute niche topics.

In recent years (Figure 5), we see a further reduction of themes in 3. The healthcare keywords converge into a single theme situated in the central area of the map, while economic growth remains the motor theme. Among the emerging themes, there are several works focused on sustainable growth and climate change.

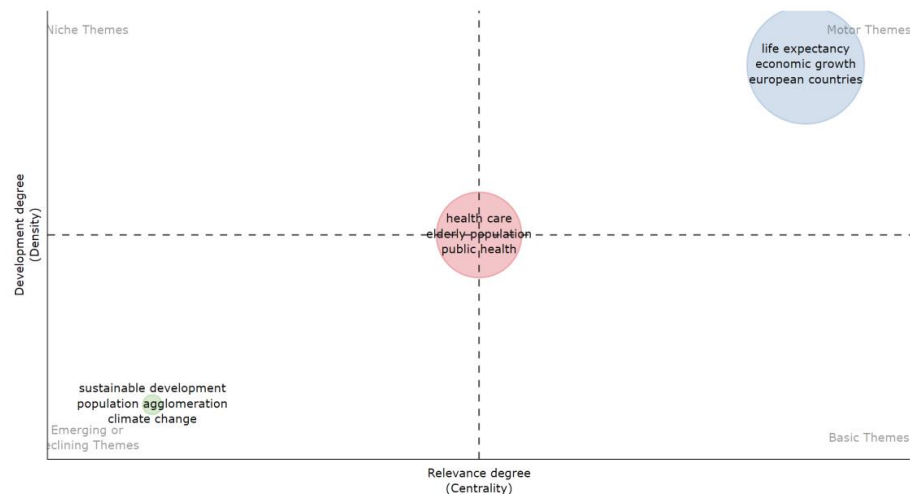


**Figure 4** - Thematic map of studies on population ageing. First temporal threshold 2005-2013.



Source: our elaboration on WOS data

**Figure 5** - Thematic map of studies on population ageing. First temporal threshold 2014-2022.



Source: our elaboration on WOS data

## 5. Conclusions and discussions

This paper presents an investigation into the main directions pursued by scientific research on the topic of population ageing. The first result of the analysis that we consider important to discuss is the specialisation of the discourse around this concept. Over the years, we observe a progressive increase in the number of documents produced by scientific communities, but a narrowing down of the topics addressed. This process of specialization indicates a gradual concentration of scientific discussion around specific themes, thereby losing the general connotation that previously characterized it. There is a tendency to focus on fewer topics, the keywords shown in the outcome involve areas such as economic growth and public and private healthcare.

This leads us to reflect on another noteworthy conclusion: over the analyzed years, healthcare-related topics tend to converge, eventually forming a single central semantic block within the constructed framework. Health services bear the greatest weight in this block, encompassing prevention, healthcare treatments for improving physical well-being, and all forms of care services. The domains of public and private healthcare are also present, indicating a progressive emphasis on the services provided in both sectors.

Lastly, there emerged the dimension related to sustainable progress and the issue of climate change. This analysis reveals a particular and growing attention from the community towards these two major contemporary global challenges. These relevant topics intersect in the discussion of vulnerability, healthcare policies, as well as environmental policies such as urban planning and regulation.

This preliminary study highlights the interdisciplinary nature of the phenomenon under investigation and leads the way for future research that will investigate these aspects with more in-depth analytical methodologies.

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