Changes in Research on the Senior-Friendly Layout of Medical Facilities Before and After COVID-19: A Bibliometric Analysis and Visualization Using CiteSpace and VOSviewer

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Abstract
The aggravated population aging has led to a gradual increase in people's demand for medical and health facilities, as a result of which the senior-friendly layout of medical facilities has always been a hot topic in the international academic community, especially during the outbreak of Covid-19. However, the differences in the research on the senior-friendly layout of medical facilities before and after Covid-19 based on bibliometric analysis have received little attention. In this paper, CiteSpace and VOSviewer are used to make knowledge graph comparison on the journal articles on senior-friendly planning of medical facilities collected in WOS database before December 2019 and before December 2023, so as to learn about the relevant global research during different periods and explore the characteristics of related research before and after Covid-19. It was found that due to Covid-19, the publications on related research in 2021 and 2022 increased significantly, and so did the publications in China. In the related research after Covid-19, the fields related to "community" became a hot research topic and received more attention from researchers. In summary, the research on the changes in the literature on senior-friendly layout of medical facilities before and after Covid-19 is of great significance to understanding the changes in how senior-oriented layout of medical facilities responds to public health emergency.

Keywords: Medical Facilities, Senior-Oriented Layout, Knowledge Graph Analysis

1. Introduction

With the spread of healthcare and the improvement of medical technology in the world, people are living longer than ever before, and aging is a common problem that all countries in the world have to face [1][2]. According to the data released by WHO, the percentage of people aged 65 and above is projected to double from 10% to 20% by 2050[3]. The deepening of aging has led to a gradual increase in the demand for healthcare facilities[4][5], which means that the healthcare industry needs to undergo a senior-friendly transformation.

The acceleration of aging has put forward new requirements for the senior-friendly layout of medical facilities, and has also attracted extensive attention from the academic community.

However, since December 2019, Covid-19 has spread around the world, triggering a global pandemic and health problems with serious implications for healthcare systems, people's health and lives globally[6][7]. In particular, relatively vulnerable older populations are at higher risk[8][9][10]. This situation has attracted extensive attention from the academic community and has also put forward new requirements for the senior-friendly layout of medical facilities.

During the outbreak of Covid-19 for more than three years, many scholars have conducted a large number of investigations in the field of the senior-friendly layout of medical facilities, but the research differences in this field before and after the outbreak of Covid-19 have received little attention. Therefore, based on the core collection of Web of Science database, this paper makes comprehensive use of the advantages of CiteSpace and VOSviewer software to conduct bibliometric analysis, systematically and visually analyze and summarize the literature in the field of the senior-friendly layout of medical facilities before and after the outbreak of Covid-19, and explore the following questions: What impact will the Covid-19 have on research into the senior-friendly layout of medical facilities?

2. Data Sources and Methods

2.1 Data Sources

In order to ensure the scientific and integrity of the data source, this research literature is derived from the core collection of the Web of Science (WOS) database, the source of the database is SCIE, SSCI, A&HCI, CPCI-S, CPCI-SSH. Retrieved by Topic=“medical facility distribution age friendly” or “suitable aging medical facility distribution” or “medical allocation age friendly” and “suitable aging medical allocation”, the time span is not limited, in“English”, and the retrieval time is December 17, 2023. Literature types were "article" and "review". After removing duplicates by using the NoteExpress software to remove duplicates, 850 English records were obtained.

2.2 Research Method

This research is based on the literature data of the research area of the senior-friendly layout of medical facilities. It used two kinds of bibliometric analysis tools, VOSviewer and CiteSpace, to perform quantitative analysis on the relevant literature on the Web of Science to form the corresponding knowledge map, so as to obtain the evolution paths of the relevant research, latest progress, frontier hotspots, and future development trends[11][12][13].

3. Result

3.1 Trend Analysis of Literature Publication

The annual distribution of the number of published articles can reflect the research level and development of the discipline[14]. The number of published articles on the senior-friendly layout of medical facilities through the English literature searched in the WOS database is shown in Fig.1. As can be seen from the figure, from 1970 to 2002, the number of relevant studies published was relatively limited, but showed a trend of slow growth. Between 2002 and 2019, the annual number of publications in this phase is generally higher than in the previous phase, and the trend shows a more rapid and robust trend. So far in 2019, under the impact of the covid-19, the number of articles published in this field has shown an explosive growth in 2021 and 2022. As of the date of the literature search for this paper, December 17, 2023, it was found that the number of publications in 2023, while declining compared to 2021 and 2022, was still higher than the number of publications before the covid-19.

Overall, it appears that between 1970 and December 17, 2023, the publication of studies related to this field has shown a gradual growth trend and has gone through three more distinct phases.

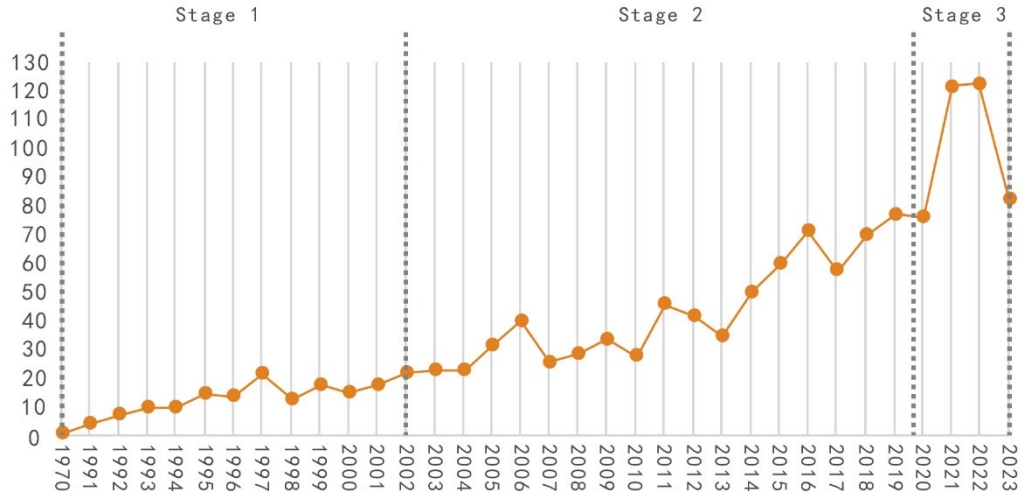


Figure 1. Annual publication volume of studies related to the senior-friendly layout of medical facilities in the foreign language literature

3.2 Analysis of National Cooperation Network

Based on the partnership between the authors, the researcher used VOSviewer and CiteSpace to visualize and analyze data on the country's cooperation and influence.

3.2.1 Based on Relevant Literature From 2019 and Earlier

Between 1970 and 2019, a total of 55 countries have participated in studies related to the senior-friendly layout of medical facilities. When the publication threshold was set at five, 21 countries reached this threshold.

According to Tab. 1, sorted by the number of articles published, 138 articles were published in the United States, which was significantly higher than other countries. The number of published articles in the United States accounted for 27.6% of the total number of published articles in this field, and the centrality was 0.29. Explain that as of 2019, the United States is at the center of the national cooperation network. It is followed by China, with a total link strength of 19.

Table1. Information on the top 10 major research countries by number of published articles from 1970-2019

Rank	Country	Publication	Total link strength	Centrality
1	USA	138	23	0.29
2	China	43	19	0.06
3	Japan	31	5	0.00
4	Canada	28	6	0.09
5	Italy	24	14	0.28
6	Australia	23	16	0.09
7	Israel	22	3	0.01
8	England	21	12	0.23
9	France	20	12	0.11
10	Netherlands	18	16	0.15

3.2.2 Based on Relevant Literature From 2023 and Before

By 2023, the number of countries involved in relevant research in this area increases from 55 to 72. When the threshold for the number of publications is similarly set at five, 29 countries reach this threshold. It shows that the research related to the senior-friendly layout of medical facilities has received more attention from more countries and has obtained fruitful research results. Combined with Tab. 2, it can be seen that the United States leads with 202 publications, while China follows with 157 publications. These two countries accounted for 25.25% and 19.63%, respectively, of the total number of articles published in the field. As can be seen in Tab. 1, the number of articles published in China prior to the Covid-19 outbreak accounted for only 8.6% of the total number of articles published in the field. It can be seen that although China is relatively late in carrying out research on the senior-friendly layout of medical facilities for the aging, it has become one of the major research countries in this field by virtue of the number of articles published in recent years, and has had an absolute cooperative influence. The remaining countries were Japan (46 publications, 0.02 centrality), Canada (41, 0.09), Italy (39, 0.31), the United Kingdom (37, 0.11), Australia (36, 0.04), Germany (36, 0.03), the Netherlands (33, 0.13), and South Korea (31, 0.00).

Table 2. Information on the top 10 major research countries by the number of published articles from 1970-2023

Rank	Country	Publication	Total link strength	Centrality
1	USA	202	72	0.32
2	China	157	44	0.07
3	Japan	46	9	0.02
4	Canada	41	20	0.09
5	Italy	39	35	0.31
6	England	37	32	0.11
7	Australia	36	37	0.04
8	Germany	36	18	0.03
9	Netherlands	33	37	0.13
10	Korea	31	2	0.00

3.3 Capturing and Categorizing Research Hotspots

3.3.1 Analysis of Research Hotspots Before Covid-19

Keywords capture the core idea of the article, through the research of keywords in a certain field, we can quickly grasp the hotpots in the field[15]. In this study, VOSviewer is used for keyword visualization. Where nodes in the knowledge graph represent keywords, the larger the node, the more frequently the keyword appears, and the lines between the nodes represent the co-occurrence of specific keywords. The colors on the graph range from blue to yellow, revealing the research hotspots at different times.

Through the analysis of the keyword knowledge graph (Fig. 2), it can be found that by 2019, the whole keyword knowledge graph is dominated by high-frequency phrases such as "Elderly", "Care", "Management" and "Access", forming a radial pattern. With each keyword appearing 5 times as the threshold, a total of 138 high-frequency keywords were obtained. Combined with CiteSpace, the occurrence time and centrality of various high-frequency keywords were analyzed, and the first 10 keywords were shown in Tab. 3.

As seen in Fig. 2 and Tab. 3, "Elderly (total citations: 86)", "Care (48)", "Age (37)", "Population (34)", "Prevalence (34)", "Health (34)", "Risk (34)", "Health-care (31)", "Access (29)", " Impact (29)" and other high-frequency keywords constitute representative terms in the field. In the co-occurrence network graph, these high-frequency keywords are also key hub nodes, which together with other nodes around them form the hot frontier research topics in the field over the years.

In order to refine the research hotspots in this field more intuitively and effectively, the author used the unique clustering density map function of VOSviewer to visualize the keyword co-occurrence clustering results (Fig.2). In a density map, the density of an element depends on the number and weight of its neighboring elements. The brightness from weak to strong indicates that the clustering density increases gradually. That is, the frequency of keyword co-occurrence increases, and the popularity of related research topics increases[15]. As can be seen from the figure, keywords such as "health", "risk" and "prevalence" converge around "elderly" to form a region with high density, "access" and its surrounding keywords also form a high-density area.

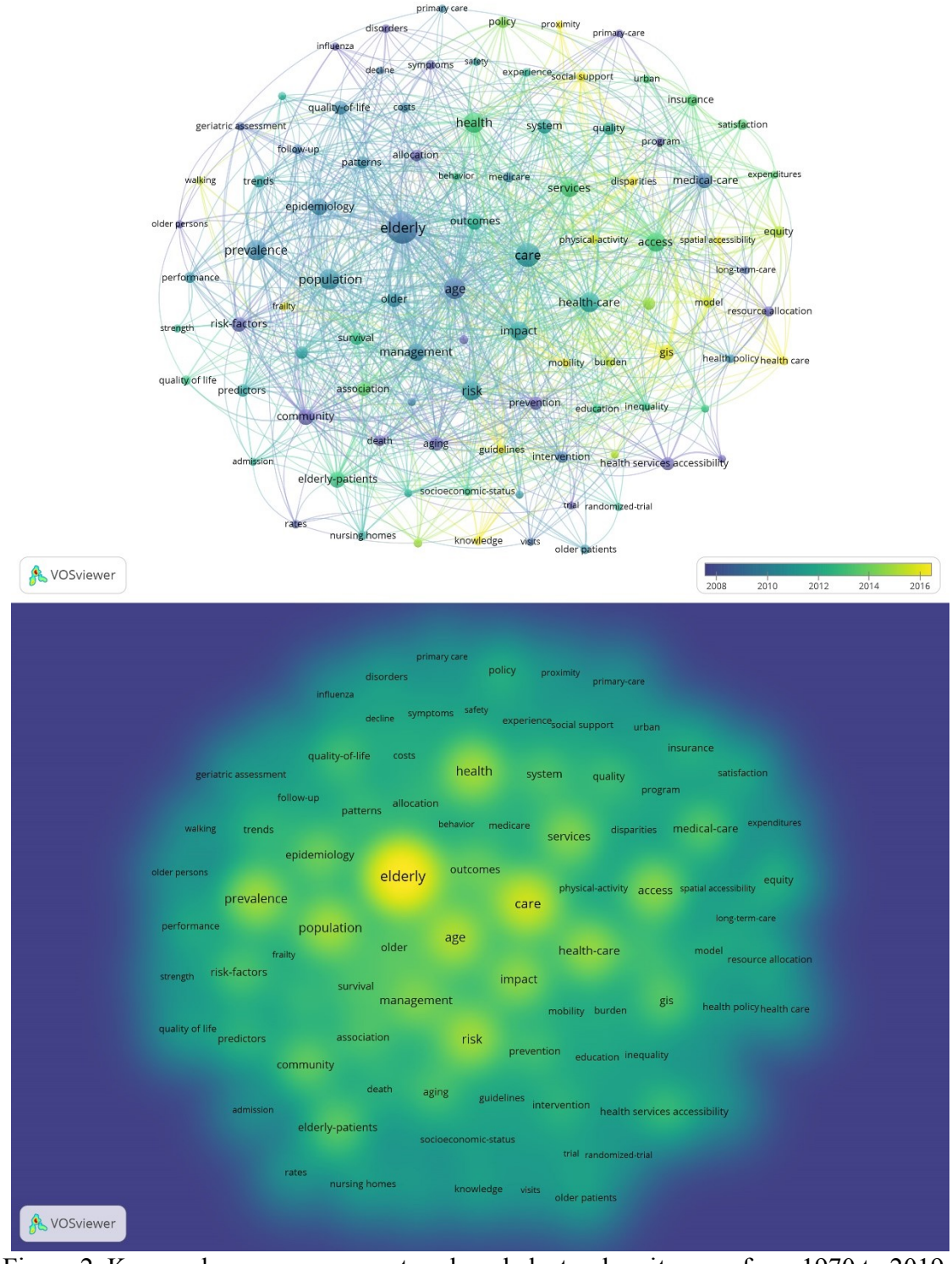


Figure 2. Keyword co-occurrence network and cluster density map from 1970 to 2019

Furthermore, according to the clustering results of all keywords and combined with professional knowledge, four cutting-edge hot categories in the field of senior-friendly layout of medical facilities at this stage can be extracted, which are as follows: (1) Service status of medical facility layout for the elderly, (2) medical behavior of the elderly, (3) senior-friendly layout of medical facilities supported by methods and models, (4) senior-friendly health policy and management (Tab. 4).

Table 3. The top 10 keyword information of the same occurrence times from 1970 to 2019

Rank	Keyword	Cite	Total link strength	Centrality	Time of First Occurrence
1	Elderly	86	292	0.25	1993
2	Care	48	183	0.22	1992
3	Age	37	129	0.17	1992
4	Population	34	148	0.08	2005
5	Prevalence	34	138	0.08	1994
6	Health	34	130	0.02	2000
7	Risk	33	136	0.11	1998
8	Health-care	31	115	0.06	1997
9	Access	29	143	0.07	1998
10	Impact	29	134	0.07	1996

Table 4. Cluster induction of keyword co-occurrence from 1970 to 2019

Research hotspot categories	Contains the main keywords
（1）Service status of medical facility layout for the elderly	Access；Services；Accessibility；Disability；Inequality；Urban；Equity；Elderly Population；Demand；Gender-Differences；Rural；Socioeconomic Inequalities；Allocation；Age Distribution；Areas；Income Inequality；Populations…
（2）medical behavior of the elderly	Behavior；Mobility；Physical-Activity；Transportation；Preferences；Choice；Cross-Sectional Studies；Follow-Up；Cost-Effectiveness；Behavioral-Model；Randomized-Trial; Regression；Controlled Trial；Andersen Model…
（3）senior-friendly layout of medical facilities supported by methods and models	Model; Program；GIS ; Spatial Accessibility; Technology；Geographic Information Systems；Big Data；Geographically Weighted Regression；Structural Equation Model；Dynamics；Program；Transmission；Distance；Tests；Scale…
（4）senior-friendly health policy and management	Management；Insurance；Health Policy；Social Support；Policy；Health Insurance；Health Outcomes；Support；Admission；Cooperative Medical Scheme；Health Care System…

3.3.2 Analysis of Research Hotspots After Covid-19

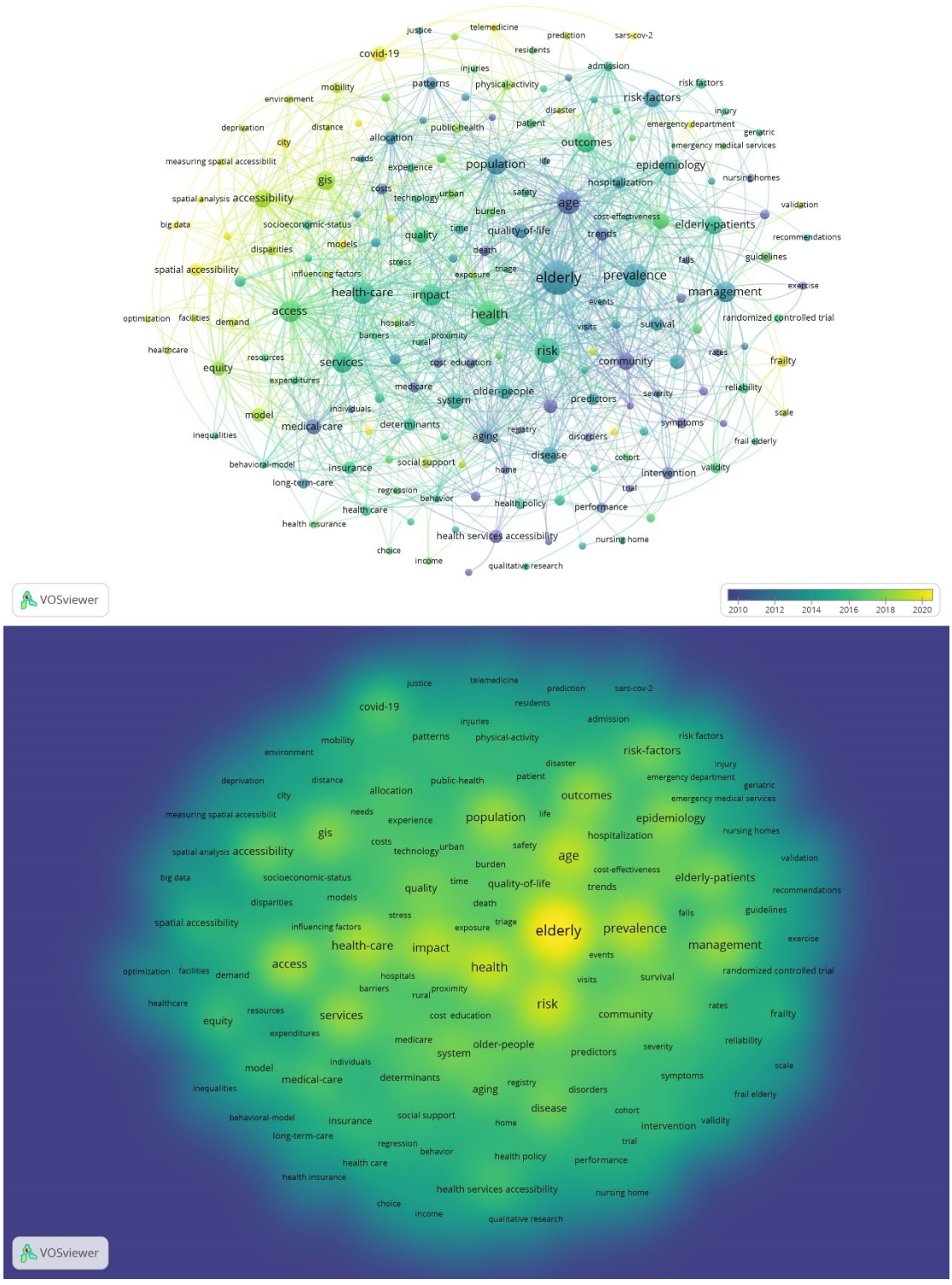
By 2023, the keyword occurrence threshold is also set to 5 times, and a total of 269 high-frequency keywords are obtained. By comparing the keywords in Tab. 3 and Tab. 5, it can be found that the high-frequency keywords in this research field did not change significantly before and after the Covid-19. It is noteworthy that since 2020, the word Covid-19 has appeared in the keyword knowledge graph, and the node size can be seen that the keyword has occupied a heavier weight in the research field of the senior-friendly layout

of medical facilities in recent years. Similarly, the Prevalence of prevalence of keywords such as "Risk", "Community", "Telemedicine" and "Big data" has increased significantly.

Table 5. The top 10 keyword information of the same occurrence times from 1970 to 2023

Rank	Keyword	Cite	Total link strength	Centrality	Time of First Occurrence
1	Elderly	126	566	0.16	1993
2	Care	69	332	0.19	1992
3	Risk	66	293	0.14	1998
4	Health	63	290	0.03	2000
5	Prevalence	59	315	0.09	1994
6	Age	58	247	0.17	1992
7	Impact	52	275	0.06	1996
8	Access	51	290	0.07	1998
9	Health-care	51	226	0.05	1997
10	Population	45	246	0.08	2005

The cluster density map from 1970-2023 is obtained by Vosviewer software (Fig. 3). It is found that some keywords in 2023 have changed in popularity on the basis of 2019, and some new keywords have also appeared. Then, two new keyword categories are summarized through re-combing: (1) community senior-friendly medical and elderly services, (2) elderly response to urban public health crisis (Tab. 6).



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（2）medical behavior of the elderly	Behavior；Mobility；Physical-Activity；Transportation；Preferences；Choice；Cross-Sectional Studies；Follow-Up；Cost-Effectiveness；Behavioral-Model；Randomized-Trial; Regression；Controlled Trial；Andersen Model…
（3）senior-friendly layout of medical facilities supported by methods and models	Model; Program；GIS；Spatial Accessibility; Technology；Geographic Information Systems；Big Data；Geographically Weighted Regression；Structural Equation Model；Dynamics；Program；Transmission；Distance；Tests；Scale…
（4）senior-friendly health policy and management	Management；Insurance；Health Policy；Social Support；Policy；Health Insurance；Health Outcomes；Support；Admission；Cooperative Medical Scheme；Health Care System…
（5）community senior-friendly medical and elderly services	Community；Telemedicine；Telehealth；Primary-Care；Home；Nursing Home；Late-Life；Long-Term-Care；Environment；Walking；General-Practice；Physicians；Health Service Utilization；Facilities；Quality-Of-Care…
（6）elderly response to urban public health crisis	Risk；Prevalence；Covid-19；Big-data；Aging Society；Public-health；Trends；Pneumonia；Prediction；Countries；Perceptiveness；Challenges；Coronavirus；Sars-Cov-2；Sars; Intervention …

4. Discussion

4.1 The Impact of the Covid-19 on Trends in Literature Publishing

In terms of the publication trend of literature, the number of published articles in the field of the senior-friendly layout of medical facilities showed a gradual increasing trend from 1970 to December 17, 2023, and went through three stages, namely, the initial exploration stage from 1970 to 2002, and the steady development stage from 2002 to 2019. And the stage of rapid growth again since 2019.

4.1.1 Stage One: Initial Exploration Stage (1970-2002)

Since the 1960s, Western countries have gradually entered the aging society, and the relevant research on senior-friendly has gradually emerged. After Wylie first mentioned in his study in 1970 that medical facilities need to pay attention to senior-friendly[16], other scholars

gradually began to put their perspective on this research field. However, during the period of 1970-2002, the related research topics were relatively limited, and the number of researchers in this field was also small, which was still in the initial stage.

4.1.2 Stage Two: Steady Development Stage (2002-2019)

In 2002, the World Health Organization (WHO) released the report "Active Aging: Policy Framework", which emphasizes the development of a range of accessible health services for older persons. The report recommends that organizations prioritize actions to ensure healthy aging, as older people need more convenient medical services and the spatial layout of basic public health services needs to be further optimized[17][18]. In addition, the spread of SARS from Asia to the world in 2002 has also urged scholars to pay considerable attention to medical services for the elderly[19][20]. Then, 2002 is taken as an inflection point to further raise the research heat on how to pay attention to the needs of the elderly in the layout of medical resources.

4.1.3 Stage Three: Rapid Growth Stage (2019 to Date)

The Covid-19 that swept the world at the end of 2019 has impacted and reshaped the existing urban public facilities configuration and management model, and the elderly, as a susceptible group in the epidemic, have been focused by scholars again. Therefore, 2019 has become a new inflection point in the research on the senior-friendly layout of medical facilities, and led the overall research to continue to deepen. Among them, the number of published articles in 2021 and 2022 showed explosive growth, and the level of published articles in 2023 returned to a steady development state.

In general, the outbreak of covid-19 has made scholars pay more attention to research related to the senior-friendly layout of medical facilities, but the spread of the covid-19 has greatly affected the work of researchers, especially in the early stage of the epidemic, pushing the development of scientific research to a higher level of difficulty. Therefore, as can be seen from the development trend of the annual number of publications, the number of publications in 2020 is slightly lower than that in 2019. However, starting from 2021, after a year of buffering and precipitation, many scholars have successively carried out research in related fields, and research results have witnessed explosive growth. With the World Health Organization declaring on May 5, 2023 that COVID-19 no longer constitutes a "public health emergency of international concern," the number of publications has fallen back to a level that matches the pre-outbreak growth trend.

4.2 The Impact of the COVID-19 on National Partnerships and Research Contexts

In terms of national cooperation and research context, from 1970 to 2019, a total of 55 countries participated in the relevant research on the senior-friendly layout of medical facilities. From 1970 to 2023, a total of 72 countries participated in the study, an increase of 17 before the covid-19. In the order of research, the United States is one of the first countries to publish relevant research, and its research foundation is solid. Regardless of the outbreak of the covid-19, the United States occupies the core position of the national cooperative relationship network with its absolute advantage in the number of articles. And among the western countries such as Britain, Canada, Italy, etc., and among the Asian countries, Japan is also relatively early in the research. According to Tab.1 and Tab. 2, Japan, Canada, Italy, the United Kingdom and Australia still maintain a leading level in the research on the

senior-friendly layout of medical facilities, although the rankings are successively, the gap between them is not large, and the impact of the epidemic is relatively small.

4.3 The Impact of the COVID-19 on Research Hotspots

It can be seen from the research hotspots that before the covid-19 in 2019, most of the international discussions were on the medical services and behaviors of the elderly, among which keywords such as "services", "access" and "gis" together with other nodes around them formed the hot frontier research topics in this field. By clustering many keywords collected and combining with professional knowledge, four categories of hot topics related to the senior-friendly layout of medical facilities during 1970-2019 can be extracted, which are as follows:

4.3.1 Service Status of Medical Facilities Layout for the Elderly

Through literature review, it can be seen that most literatures in this category study the relationship between facilities and the elderly from a quantitative perspective, and most of them pay attention to the correlation between facilities allocation and elderly public participation, physical health status, individual travel preference, etc., and pay insufficient attention to the distribution characteristics of the elderly population.

4.3.2 Medical Treatment Behavior of the Elderly

Researchers found that literatures in this category tend to classify the attributes of the elderly in detail, including age, marital status, disability, behavioral ability, etc. At the same time, the factors that influence the elderly's medical treatment behavior are also diverse, including but not limited to the choice of medical treatment location, service price, and medical service providers. Most of these literatures are discussed from the perspective of public health, and the discussion from the perspective of urban planning needs to be strengthened.

4.3.3 Senior-Friendly Layout of Medical Facilities Supported by Method and Model

Through the review of this category of literature, it can be found that scholars have a variety of optimization models and approaches when discussing the suitability of facilities for aging. Most of them first quantify the accessibility of public resources such as medical service facilities based on time geography, and then propose various optimization schemes with additional conditions.

4.3.4 Senior-Friendly Health Policy and Management

Through literature review, it can be found that the research on senior-friendly health policies and management covers a wide range, and is more inclined to the social support system for the elderly and the basic medical insurance system.

However, after the Prevalence of the epidemic, scholars gradually increase their attention to terms such as "Risk", "Community" and "Prevalence", and form new keyword categories, including:

4.3.5 Older People Respond to Urban Public Health Crises

The researchers found that the literature in this category focused on many emergent public health issues and discussed how the government should deal with the impact of public health crises on cities and communities, such as how the government should establish a crisis response system for the elderly and how to improve their health crisis awareness and ability.

4.3.6 Community Medical and Elderly Care Services

When discussing community aging medical and elderly care services in foreign journals on senior-friendly layout of medical facilities, they mainly focus on primary medical protection, community medical and nursing service resource integration, and layout of senior-friendly medical and health care facilities in communities.

It can be seen that under the influence of the covid-19, the research focus of the international academic community has gradually shifted from the medical service model for the elderly to how to establish a safe and effective system for the elderly to cope with sudden urban public health crises, as well as the planning and layout of community medical facilities, which may become a new trend in the follow-up research on the senior-friendly layout of medical facilities.

5. Conclusion and Prospect

This paper comprehensively uses CiteSpace and VOSviewer software to conduct bibliometric analysis, taking 2019 and 2023 as the time nodes for search, and analyzes the studies on the planning and layout of senior-friendly medical facilities in the WOS database, revealing the changes of relevant studies before and after the outbreak of Covid-19.

From the perspective of literature publication trend, since 1970, the annual number of published articles in the research field of planning and layout of aging medical facilities has shown an overall upward trend, which can be roughly divided into three stages: Initial exploration stage (1970-2002), steady development stage (2002-2019), and rapid growth stage again (2019-2023).

From the perspective of research hotspots, four cutting-edge hot issues in this research field were formed by grasping and classifying research hotspots before the covid-19: (1) Service status of medical facilities layout for the elderly, (2) Medical treatment behavior of the elderly, (3) senior-friendly layout of medical facilities supported by method and model, (4) senior-friendly health policy and management.

After the outbreak of the covid-19, scholars pay increasing attention to the study on how to cope with public health emergency by the senior-friendly layout of medical facilities. Taking keywords such as "Risk", "Community" and "Prevalence" as the core issues, the prevalence of this epidemic is prevalence "sits on two new hotspots: (5) Older people respond to urban public health crises, (6) Community medical and elderly care services.

The above discussion provides a reference for the layout of senior-friendly layout of medical facilities in future cities. In the later stage, it is necessary to improve the service level of community aging care and strengthen the government's ability to deal with urban public health crisis, so as to adapt to the rapidly changing health security situation.

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