Review

Nationally funded health management projects for older adults in China and the United States: Comparative analysis based on data from two principal institutions

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ABSTRACT

Objectives: To systematically summarize and compare the health management projects on the aged population funded by the National Institutes of Health (NIH) in the US and the National Natural Science Foundation of China (NSFC) in China.
Methods: All elderly-related projects from 2007 to 2022 were retrieved by searching the project titles, abstracts, and keywords such as "older adults," "elderly," "aged," "health management," and so on. Python, CiteSpace, and VOSviewer were used to extract, integrate, and visualize the relevant information.
Results: A total of 499 NSFC projects and 242 NIH projects were retrieved. For both countries, prestigious universities and institutions received the most funded projects; the projects that got the most funds were longitudinal studies. Both countries attach great importance to investment in the health management of the aged population. However, different focuses existed in health management projects for older adults in the two countries due to distinct national conditions and development levels.
Conclusions: The analysis results of this study can provide a reference for other countries with similar challenges of population aging. Effective measures should be taken to promote the transformation and implementation practice of the project achievements. Nurses can benefit from these projects and facilitate the translation of relevant research findings into clinical practice to improve nursing quality for older adults.

What is known?

- The aging of the population has become a distressing and challenging issue worldwide.
- China and the United States (US) have invested in and given some priorities to health management for the elder population.

What is new?

- This research summarized and compared the projects in health management of the aged population funded by the National Institutes of Health (NIH) in the US and the National Natural Science Foundation of China (NSFC) in China.
- Different focuses on health management projects for older adults in the two countries might be explained by national conditions and development levels.

1. Introduction

Globally, the aging population has become a distressing and challenging issue. Nearly every country in the world is experiencing growth in both the size and proportion of the aging population. According to data from the United Nations (UN), the global

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population aged 65 and over amounted to 728 million in 2020. Moreover, this number is expected to increase to more than double its present value, reaching 1.5 billion in 2050 [1]. By the standards of the UN, when the number of people aged 65 or above in a country or region exceeds 7% of the total population, it enters an aging society; when the proportion exceeds 14%, it enters a deeply aging society [2]. In the United States (US), the aging of the population began as early as the 1940s [3]. Data from the 2020 US Census Report shows that, among the approximately 330 million people in the US, 54 million are over 65. The US Census Bureau predicts that this number will grow to 74 million by 2030, and one in five people will be over 65 by 2050 [4].

Meanwhile, in China, the aging population is growing increasingly. According to the latest census results [5], by the end of 2020, there were 264.02 million people (18.7%) of the total population aged 60 and over. Among them, 190.64 million (13.5%) were 65 and over. Compared with 2010, the proportion of people aged 60 and above rose by 5.44%. Besides, the number of the elderly population in China is expected to account for 30% of the total population by 2050 according to the current growth trend. The huge elderly group and the national conditions of "getting old before getting rich" are bringing more challenges to the health management and medical system of the whole society [6].

To overcome the challenge of the aging problem, governments have paid great attention to it and taken a bunch of initiatives. In the US, the Older Americans Act was designed to protect elderly Americans from unfair discrimination in the workforce and provide protection and services [7]. Though the initial emphasis was directed more toward civil rights and recognition of the dignity of the elderly, it has become more focused on providing long-term care services over the years. Gradually, the concept of "caring for the aged is caring for yourself" is generally accepted by the American public today. In China, a series of policies have been issued, including China's Medium-and Long-Term Plan for the Prevention and Treatment of Chronic Diseases (2017–2025) [8], the Healthy China Action (2019–2030) [9], and the Outline of The Healthy China 2030 Plan [10], which all stressed the health management of the elderly. In the latest policy of 'Opinions on strengthening the work on aging in the new era' [11], the importance of caring for the aged has been emphasized again. According to this document, effectively dealing with the aging population is related to the country's overall development, the well-being of hundreds of millions of people, and social harmony and stability.

The health problems of the elder group are becoming increasingly prominent. The increase in life expectancy, the decline in physical function, and the decrease in metabolic function make aged people more likely to suffer from many diseases [12]. For example, aging increases the risk of chronic diseases such as dementia, heart disease, type 2 diabetes, arthritis, and cancer [13]. More than half of older adults over 65 have two or more high-burden multimorbidity conditions [14]. Therefore, coping with aging in health management holds significance for the world. Many governments have funded projects for aging research. The National Natural Science Foundation of China (NSFC) in China and the National Institutes of Health (NIH) in the US represent national-level research funding sources. To a large extent, health management projects for older adults funded by the two principal institutions reflect the aging population's priorities and hold illuminating significance for relevant studies. A summary and comparison of these projects will bring guidance and reference for other countries with similar challenges.

This study's main objective is to present a systematic analysis of the projects in health management of the older population in the past fifteen years. This paper explores the following questions: 1) What are the funded projects of health management study of the aged group in NIH and NSFC? 2) What are the characteristics of the projects funded by the NIH and NSFC? 3) What are their similarities and differences? 4) What is the future development trend of research on health management in older adults?

2. Methodology and data acquisition

2.1. Methodology

Python 3.8 was used for data collection and format conversion instead of large and repeated manual retrieval steps. Bibliometric and knowledge mapping visualization software of CiteSpace and VOSviewer were utilized to present the projects' distribution, characteristics, and emerging trends of aging research from different aspects. The bibliometric method reveals the research characteristics of a specific field through quantitative and statistical methods, enables the objective presentation of the discipline's research status, and thus is regarded as an important research tool in many fields. CiteSpace is a visualization software to obtain quantitative information and discover the related development trends and dynamics [15,16]. VOSviewer holds powerful functions, is user-friendly in co-occurrence analysis, and is implemented to study author and institution cooperation.

2.2. Data acquisition

Python version 3.8 was employed to acquire the information from the open data. Projects on the health management of aged people in the last 15 years were searched on NIH (https://reporter.nih.gov) and NSFC (https://isisn.nsfc.gov.cn) websites. The search terms employed to find the closest matching projects included ("older adults" OR "old people" OR "elderly people" OR "the aged" OR "the old") AND ("health management" OR "health care" OR "care" OR "nursing" OR "nursing care"). The search in NIH and NSFC was conducted in English or Chinese, and the terms were deemed equivalent by an English-major professor. All NIH branches, such as the National Institute on Aging (NIA) and the National Institute of Nursing (NINR), were included in the search.

The NIH website supports keyword searches, while NSFC only supports advanced project searches. This means when searching in NSFC, the project name, principal investigator, organization, and fiscal year are all required. Then, to identify the projects effectively and correctly, government and business websites have been combined in searching. Firstly, the projects were searched and located on a business website (https://www.izaiwen.cn), enabling keyword searching. Then, the retrieved projects got searched and checked one by one on the NSFC official website with all the required information. Two researchers searched NIH and NSFC separately and then reviewed and compared the results with each other.

Due to the acceleration of aging in the past 15 years, health problems have been increasing, and the elderly health management project has been paid more attention to. Therefore, this study recruited older population health management projects from 2007 to 2022, and the search in NIH and NSFC followed the same time span to keep consistency.

2.3. Data analysis

In the present study, VOSviewer (The Centre for Science and Technology Studies, CWTS, Leiden, The Netherlands) and CiteSpace (Chaomei Chen, Philadelphia, PA, USA) were employed to extract the relevant information on names, institutions, applicants, and keywords of the projects and represent the results through visualization maps. All visualization maps were produced automatically with the extracted data.

After data acquisition, retrieved projects were exported in Excel and downloaded on the computer. Then, project screening was undertaken by two research groups with two researchers in each group, one for NIH-funded projects and the other one for NSFC-funded projects. Two researchers determined the inclusion or exclusion of the project through the titles, keywords, organizations, and abstracts (if available). Afterward, the two groups of researchers switched, and each group screened each other's projects again. For the differences between the included projects, two groups of researchers determined together through group discussions. All the researchers had a bachelor's or above education with an English IELTS score of 6.5 or above. Projects focusing on health management for the older population from the perspective of population health management and public health were included. In contrast, basic medical studies such as genetic, molecular biology, and drug clinical trials were excluded. Afterward, the qualified projects were transferred into RefWorks format by Python version 3.8 and then input to CiteSpace and VOSviewer for further analysis.

3. Results

3.1. Number of included projects

A total of 1,404 and 6,281 projects on health management for older adults funded by NIH and NSFC in 2007–2022 were identified, respectively. After project screening, 242 projects granted by NIH and 499 projects funded by NSFC qualified for final analysis (see Fig. 1).

3.2. Temporal distribution and comparison of projects among the older population

As seen in Fig. 2, all funds in the figure have been converted into US dollars ($) for visual observation and comparison. Although the number of projects funded by NIH and NSFC has fluctuated since 2007, the overall increasing trend can be concluded based on the number of funded projects.

The number of projects in China showed a slight growth trend from 2007 to 2010, after which the number of projects increased significantly, reaching 57 in 2017. Since 2017, the number of projects has rebounded to nearly a third of its original level after a sharp decline and kept fluctuating in the following years.

The number of projects and the total amount of funding established by NIH fluctuated slightly in an oscillating pattern from 2007 to 2015. After that period, the number of projects has seen significant intermittent growth, peaking in 2022, with 42 projects

funded. Overall, the average growth rate of the number of projects in the past five years was considerable. The total amount of funding also remained high (except for 2017), with NIH investing 18,721,138 dollars in 2016, representing the largest amount of projects during 2007–2022.

3.3. Distribution and comparison of the projects and cooperation among institutions

Table 1 lists the top 10 productive institutions with the most granted projects in NIH and NSFC. As shown in Table 1, Johns Hopkins University in the US ranked at the top of the list with 17 projects. While in China, Peking University distinguished itself with 31 funded projects since 2007.

In addition, the co-occurrence of the institutions was displayed (see Appendix A). Overall, the characteristics of cooperation among institutions are far from significant, with no remarkable links.

3.4. Distribution and comparison of the project funding

The top 10 most funded projects are presented in Table 2 and Table 3. As displayed, The Baltimore Longitudinal Study of Aging ranked on the top of analyzed projects in NIH, and China Health and Retirement Longitudinal Study in NSFC, achieved the largest funding, respectively. Besides, the total amount of top 10 funding could reach $ 32,484,688 in NIH and ¥ 28,790,000 (about $ 4,050,753 according to the current exchange rate, 1 CNY = 0.1407 USD) in NSFC. Comparatively, based on the funding amounts of the top 10 projects, NIH devoted more money than China, while NIH's average funding is similar to that of NSFC.

3.5. Distribution and comparison of the keywords of the projects

The top 20 keywords in NSFC and NIH are depicted in Table 4. As shown, from the top keywords, health management, chronic disease, and elder care facilities were more significant for older adults in China, while the quality of life, nursing home and research personnel were more focused in America.

The co-occurrence mapping of the keyword networks was generated by CiteSpace (see Appendix B). Similarly, keywords for high word frequency in NIH include quality of life, nursing home, research personnel, public health, etc. Keywords for high word frequency in NSFC include older adults, aging, health management, chronic disease, etc.
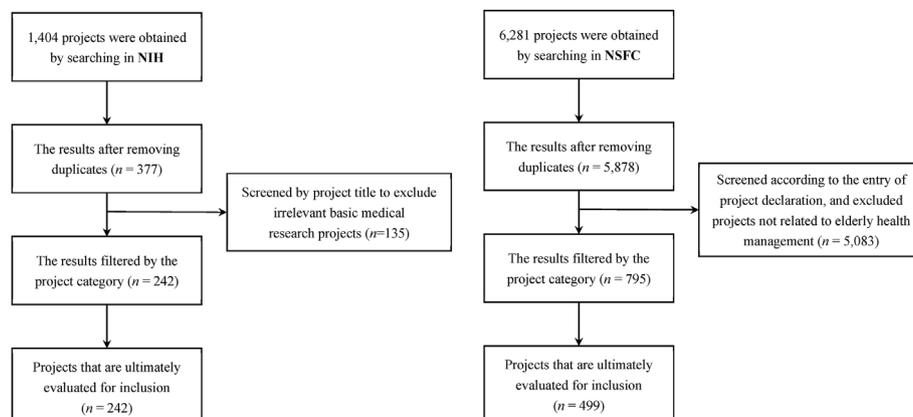

Fig. 1. Flow chart of projects obtained in the National Institutes of Health (NIH) of the United States and the National Natural Science Foundation of China (NSFC).
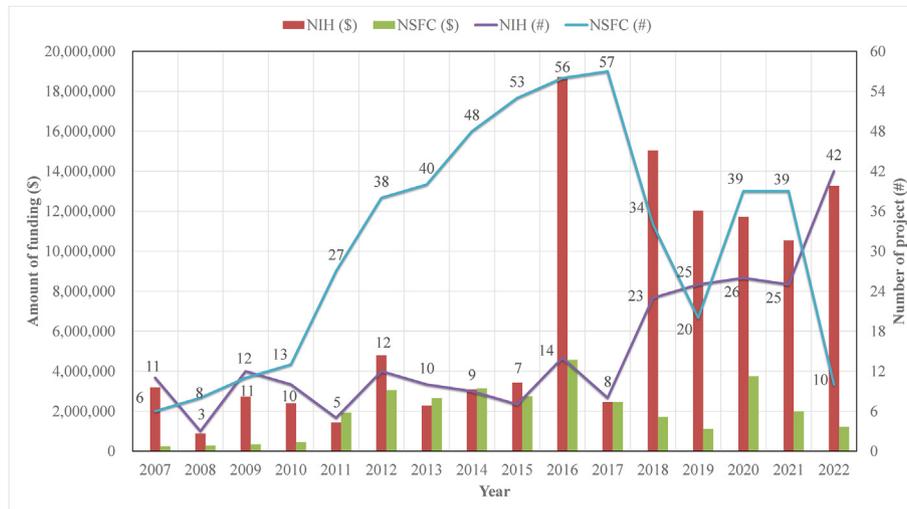
Fig. 2. The number (#) and total amount ($) per year of projects funded by the National Institutes of Health (NIH) of the United States and the National Natural Science Foundation of China (NSFC) from 2007 to 2022.

Table 1
Top 10 productive institutions with the highest number of health management projects for older adults funded by National Natural Science Foundation of China (NSFC) and National Institutes of Health (NIH) of the United States.

Sort	NSFC		Sort	NIH	
	Institution	Frequency		Institution	Frequency
1	Peking University	31	1	Johns Hopkins University	17
2	Fudan University	15	2	University of Pennsylvania	11
3	Huazhong University of Science and Technology	14	2	Weill Medical Coll of Cornell University	11
4	Tongji University	13	4	University of Washington	7
5	Tsinghua University	11	4	Indiana University-Purdue University Indianapolis	7
5	Sun Yat-sen University	11	6	Brown University	6
7	Anhui Medical University	10	6	University of Massachusetts Medical School Worcester	6
8	Renmin University of China	9	6	University of North Carolina Chapel Hill	6
8	Xiamen University	9	6	University of California, San Francisco	6
8	Southeast University	9	10	University of Alabama at Birmingham	5
8	Shanghai Jiao Tong University	9	10	University of Texas at Austin	5

Table 2
Top 10 health management projects for older adults with the largest funding in National Institutes of Health (NIH) of the United States.

Sort	Project	Institution	Amount ($)	Year	Type	Funding I/C
1	The Baltimore Longitudinal Study of Aging	National Institute on Aging	12,293,001	2016	ZIA	NIA
2	Aging, Cognition, and Hearing Evaluation in Elders (ACHIEVE) Randomized Trial	Johns Hopkins University	4,129,301	2018	R01	NIA
3	Management of Hypertension among Persons with and without Dementia in Long-Term Care	Stanford University	3,327,236	2019	RF1	NIA
4	Causes and Consequences of Healthcare Efficiency	Dartmouth College	2,507,115	2018	P01	NIA
5	The Wisconsin Longitudinal Study: As We Age	University of Wisconsin-madison	2,467,095	2012	R01	NIA
6	ORCATECH Collaborative Aging (in Place) Research Using Technology (CART)	Oregon Health & Science University	1,948,567	2016	U2C	NIA
7	The Role of Medicaid HCBS in the Post-Acute Period	University of Chicago	1,876,362	2020	RF1	NIA
8	PROVEN: PRagmatic trial Of Video Education in Nursing homes	Brown University	1,550,551	2015	UH3	OD
9	Epidemiology, transmission and immunology of COVID-19 in nursing home residents	Case Western Reserve University	1,332,423	2021	R01	NIAID
10	Pain Sensitivity and Unpleasantness in People with Alzheimer's Disease and Cancer	Vanderbilt University Medical Center	1,053,037	2019	R01	NIA

Note: ORCATECH = The Oregon Center for Aging & Technology. HCBS = home-and community-based services. I/C = Institute/Center. NIA = National Institute on Aging. OD = Office of the Director, National Institutes of Health. NIAID = National Institute of Allergy and Infectious Diseases.

3.6. Clustering and the hotspot of the projects

The cluster network mapping of high-frequency keywords was conducted by CiteSpace version 6.1.R3 and depicted in Figs. 3 and 4. The time slice was set to 1 year, and the top 50 high-frequency keywords were extracted to form clusters. In CiteSpace, the modularity and silhouette values are the two main indicators to judge the effect of spectrogram drawing [17]. The silhouette and modularity values ranged from 0 to 1, where the larger the silhouette, the more perfect the clustering. Theoretically, the

Table 3
Top 10 health management projects for older adults with the largest funding in National Natural Science Foundation of China (NSFC).

Sort	Project	Institution	Amount (CNY)	Year	Type
1	China Health and Retirement Longitudinal Study	Peking University	5,000,000	2011	the state key program
2	Healthy Aging–Basic science issues of influencing factors and effective interventions on the health of the elderly population	Peking University	3,200,000	2014	the major program
3	Research on non-interventional perception and continuous computing for the health of the elderly	Northwestern Polytechnical University	3,000,000	2013	the state key program
4	Health-related problems in older adults caused by novel coronavirus: A joint Wuhan-Stockholm evidence study	Huazhong University of Science and Technology	2,800,000	2020	the funds for international cooperation and exchange
5	A demand-oriented study of primary health care reform in China/Scotland and health inequalities in older age groups	Sun Yat-sen University	2,500,000	2020	the funds for international cooperation and exchange
6	A study on the influence of lifestyle on cognitive impairment and dementia in the elderly: Based on a Chinese-UK comparable health care tracking survey	Peking University	2,500,000	2020	the funds for international cooperation and exchange
7	Family structure, health and care in aging: predictive analysis and implications	Peking University	2,500,000	2020	the funds for international cooperation and exchange
8	UK-China Ageing Health and Social Challenges Project: Predicting and responding to the disease burden of Alzheimer's disease	Sun Yat-sen University	2,490,000	2020	the funds for international cooperation and exchange
9	Big data-driven panoramic personalized cardiovascular health management research	Shanghai Jiao Tong University	2,400,000	2016	the major research plan
10	Research on improving the health security mechanism of the elderly and the benefits of scientific management	Peking University	2,400,000	2012	the state key program

Note: 1 CNY = 0.1407 USD.

Table 4
Comparison of the top 20 keywords in health management projects for older adults funded by National Natural Science Foundation of China (NSFC) and National Institutes of Health (NIH) of the United States.

Sort	NSFC		Sort	NIH	
	Keyword	Frequency		Keyword	Frequency
1	the aged people	61	1	quality of life	120
2	aging	41	2	nursing home	101
3	health management	28	3	research personnel	97
4	chronic disease	11	4	pharmaceutical preparation	90
5	elderly care facilities	10	5	public health	73
5	community	10	6	home environment	72
7	health	7	7	self management	55
7	quality of life	7	7	evidence base	55
7	mental health	7	7	Alzheimer's disease	55
10	long-term care	6	10	high risk	54
10	built environment	6	11	impaired cognition	53
10	incapacitation	6	12	United states	52
10	prediction	6	13	cessation of life	50
10	healthcare security	6	14	chronic disease	49
10	human-computer interaction	6	14	clinical trial	49
10	cognitive aging	6	16	symptom management	46
10	health services	6	17	randomized controlled trail	45
10	model	6	17	public health relevance	45
10	countryside	6	19	protocols documentation	43
10	social capital	6	20	pilot project	41
10	economic growth	6	20	healthcare system	41
			20	discipline of nursing	41
			20	Alzheimer's disease related dementia	41

silhouette of each cluster should be above 0.7 [18].

After integrating the clustering content of the elderly hotspot projects of NIH and NSFC, respectively, 16 clusters from NIH and 20 clusters from NSFC were finally obtained. The mean silhouette of clusters reached 0.7616 for US data and 0.9207 for Chinese data, and all the silhouette values of each part are above 0.7. For another crucial parameter to measure the structural characteristics of the overall clustering network [18], the average modularity of the clustering is 0.6059 and 0.7319, respectively, indicating a preferable fitting effect.

3.7. A timeline view of the projects

The distribution of cluster analysis over timelines shows trends in the topics studied. As shown, most of the clustering results of

NSFC are short-term and jump-like. Comparatively, the centrality of NIH projects is much larger than that of NSFC and with more regularity (see Appendix C).

4. Discussion

This study analyzed the status and character of health management projects for aged people. The analysis identified numbers, amount of funding, institution, keywords, and clustering of the projects related to health management of the aging population in the US and China.

One of the interesting findings lies in the changing trend in the number of granted projects progressing with time. For the projects of NIH, a generally increasing trend could be seen on the whole. Noticeably, fluctuation occurred after 2019, when the number of
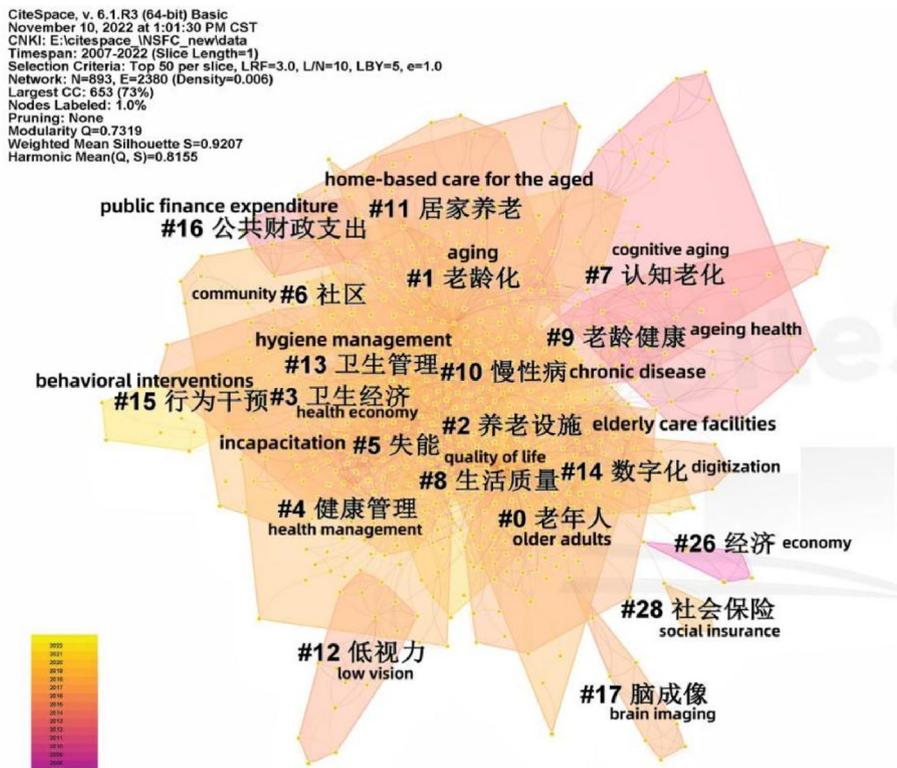
Fig. 3. Cluster network mapping of high-frequency keywords of projects in the National Natural Science Foundation of China (NSFC).
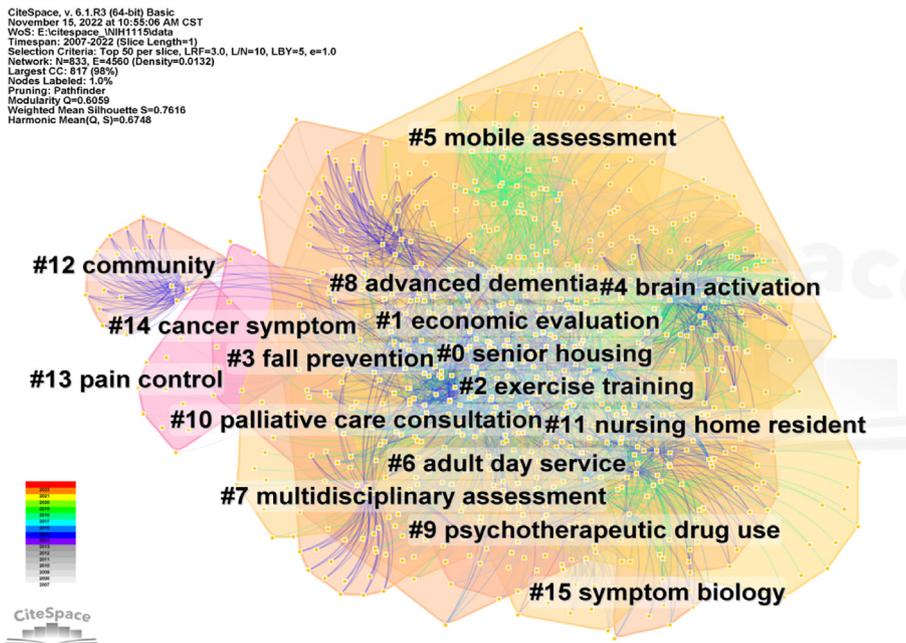

Fig. 4. Cluster network mapping of high-frequency keywords of projects in the National Institutes of Health (NIH) of the United States.

projects amounted substantially more in 2022 than in 2019. This could be associated with the increase in pension in 2019 by the US Social Security Administration and possibly priority in aging research since then [19]. For China, a fluctuating trend could be concluded where a substantial decrease occurred between 2017 and 2019 and continued to increase with fluctuation afterward. One

possible explanation for this situation would be that the "Second Child Policy" launched in 2016 [20]. After this policy issue, a fertility boom and priority in research took place afterward. Compared with the birth rate of 12.07‰ in 2015, this number reached 12.95‰ and 12.43‰ in 2016 and 2017, respectively, and then declined to 10.94‰ in 2018 [19]. Therefore, the fluctuation in the number of projects

could probably be associated with the changes in birth rate and research priority. In terms of the amount of investment, a great gap existed between NIH and NSFC, which could be associated with the economic base and research priority from the national level.

Projects with the most funding from NIH and NSFC were almost identical, focusing on the longitudinal study of the national health and aging trend. This result is expected and reflects the importance that both countries place on the older population at the national level. Similarities also lay in the projects of cognition decline related diseases like dementia and Alzheimer's disease. The growing incidence of cognitive impairment with higher life expectancy and the aging population where the statistics from the World Alzheimer Report estimated that over 55 million people were living with dementia in 2021, and this figure is expected to reach 70 million by 2030, which has aroused the attention of the US and China [21]. Meanwhile, health problems related to COVID-19 seemed to be another common thread, which is related mainly to the overwhelming impact of this global pandemic on susceptibility to all populations [22].

Regarding the type of NIH projects, the type code R01 was obvious among the top 10 projects, implying that the research project was attached to great importance in the US. Besides, as one institute of NIH, NIA supported most projects of aging. For China, the stake key program and the funds for international cooperation and exchange supported most top projects, which signifies the attitude of China toward aging and international collaboration in coping aging problem. When combining the number of projects and the funding amount, we found that although the top institutions hold more projects in NSFC, the funding was much less than that in NIH. This could be associated with the level of economic development that makes NSFC inclined to support seed projects with application potential.

The visualization of the map of keywords and the top 20 keywords offers a direct view of research interest. In China, the aging population and health problems ranked top on the agenda, reflecting that aging has gradually gotten a focus to some extent. In addition, chronic disease, elderly care facilities, and community ranked afterward, which could be associated with the fact that health problems, infrastructure and institutions were fundamental for healthy aging and should be given priority at the national level [23]. Comparatively, quality of life, research personnel, and nursing home were obvious on the map of the US projects, which could be related to the national condition. After years of exploration, America has accumulated experiences in facing the problem of aging, where more attention could be paid to the advanced needs of older adults and more specific orientations [24].

Both the US and China have given research priority to cognitive aging. Meanwhile, as a developing country, China focused more on the facilities for the older population in its aging process and aged group in the rural and urban communities for the unequal development between urban and rural areas. For many Americans, getting old means not being as energetic as the young and becoming weak when suffering from distressing and terrible diseases. Therefore, more attention has been paid to the quality of life [25] as well as self-management [26].

Cluster analysis of the keywords depicted a more recognizable picture of the project topic about the aged population—the cluster analysis classified NSFC projects into two aspects, health economics and life management. Exploring health economics holds great significance for a developing country with a huge population and limited health resources. Then, the health economy [27], social insurance [28], and public finance expenditure [29] were all echoes of the national conditions. In addition, the aged group's life management was closely related to the problems in getting old and its prerequisites, such as health management, quality of life, elderly

care facilities, and behavioral interventions. For a traditional culture of caring for the aged at home or community [30,31], community and home-based care for the aged were also evidently on the map.

Meanwhile, cluster analysis based on NIH data displayed several focuses related to particular health problems and management, including fall prevention, pain control, exercise training, and multidisciplinary assessment. Moreover, health services of older adults in institutions got increasing attention, such as day service, senior housing, and community, implying more choices for residents in the aged group [32]. Overall, both NIH and NSFC have paid attention to the health problem of the older population. With reference to the national conditions of China and the US, in comparison, more investment was paid to the major health problem and health economics of the aged group in China, whereas specific health problems and diverse healthcare services were more focused on in America.

The timeline view of the data was in accordance with the results of cluster analysis, and it is obvious that most of the clustering results of NSFC are short-term and jump-like. In contrast, the centrality of NIH projects is much larger than that of NSFC, which could be explained by the aging process and economic development of the two countries. Compared with the aging process of China, the US has been in an aging society for more than 70 years and then formulated a series of research focuses [33]. Whereas in China, the research priority depends on the population's needs and economic basis. Predictably, more comparability and similarities will emerge in a longer term.

4.1. Relevance to clinical practice

By summarizing and comparing the health management projects on the older population funded by the NIH and NSFC, the great importance of the investment in the health management of the older population was evident, which indicated that nurses should continue and strive to provide professional and quality care for this population. Moreover, the nurse needs to focus on the proposed problem and findings of these projects to promote the knowledge transformation to nursing practice and improve nursing outcomes for particular issues. Still, collaboration among scholars and nurses is encouraged to explore and provide more evidence for advanced care for the aged population.

4.2. Limitations and suggestions for future study

The study has summarized and compared the nationally-funded research on health management for the aging population in the last 15 years and compared the similarities and differences between the US and China. However, there are some limitations. First, due to no unified definition of health management of the elder and its components, the present study discussed this topic from the perspective of public health and excluded projects from basic medicine. Besides, although the keyword comparison was undertaken by software, the keywords from the NIH and NSFC systems were employed directly, which means that the keyword lists of the two systems may not be completely comparable. Therefore, certain deviations lie in the comparison conclusion of the keywords. Thirdly, only granted projects were retrieved and analyzed, whereas publications of these projects were not included in the study. Thus, the outputs of these projects need to be further explored.

5. Conclusion

By summarizing and comparing the projects granted by NIH and NSFC, similarities and disparities were found in the studies on the

health management of the aging population. Both countries have invested in and prioritized the older population. Meanwhile, different focuses have existed due to distinct national conditions and development levels. The experience of the US and China will provide a reference for other countries facing aging problems.

Funding

Data availability statement

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Some data generated or used during the study are available in a repository or online in accordance with funder data retention policies (National Institutes of Health [NIH]: https://reporter.nih.gov; National Natural Science Foundation of China [NSFC]: https://isisn.nsfc.gov.cn).

CRediT authorship contribution statement

Xiuyu Yao: Conceptualization, Methodology, Writing - original draft, Project administration. **Ziyue Zheng:** Conceptualization, Writing - original draft, Data curation. **Zemin Wang:** Conceptualization, Investigation, Resources, Data analysis. **Qiuchen Yuan:** Conceptualization, Software, Visualization. **Hui Yin:** Conceptualization, Supervision, Writing - review & editing,. **Wenhui Zhang:** Conceptualization, Validation, Writing - review & editing.

Declaration of competing interest

None. No conflicts of interest have been declared by the authors.

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Appendices. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijnss.2022.12.013.

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