A Study on Online Health Information Seeking Behavior of Older Adults Based on Evolutionary Dynamics (Postprint)

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Date: 2024-10-06T00:00:00+00:00

Abstract

[Purpose/Significance] Analyzing the current status of online health information seeking among older adults and understanding its hotspot topics and evolutionary trends holds significant importance for meeting and improving the health information needs and health literacy levels of older adults, as well as promoting the high-quality development of elderly health services. [Method/Process] This study employs the DTM model to conduct dynamic topic mining and analysis on Sina Weibo posts from 2016 to 2023, examining aspects including topic evolution, topic semantic evolution, and topic information entropy trends. [Results/Conclusion] Topics such as “geriatric diseases,” “technology-enabled elderly care,” “dietary therapy and health preservation,” “mental health,” and “social care” exhibit notable evolutionary patterns. Older adults demonstrate substantial interest in health information types including common geriatric diseases, physical medical care, social assistance and elderly care, and daily necessities to meet their needs and obtain information. Topics including “geriatric diseases,” “exercise and health care,” “high-risk factors,” and “medical fraud” show stable semantics. The information entropy trends of “exercise and health care,” “daily living safety,” and “virus transmission” remain relatively stable, while the information entropy of “medical literacy,” “epidemic control,” “cultural and sports tourism,” and “balanced diet” exhibits a diffusion trend, and the information entropy of “high-risk factors,” “dietary therapy and health preservation,” “financial traps,” and “medical fraud” demonstrates a convergence trend.

Full Text

Preamble

Journal of Library and Information Science in Agriculture
DOI: 10.13998/j.cnki.issn1002-1248.24-0254

Research on Online Health Information Seeking Behavior of the Elderly Based on Evolutionary Dynamics

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Abstract: [Purpose/Significance] Analyzing the current state of online health information seeking among the elderly, and understanding its thematic hotspots and evolutionary trends, is of great significance for meeting and improving the health information needs and health literacy levels of older adults, and for promoting high-quality development of elderly health services. [Method/Process] This study employs the DTM model to conduct dynamic topic mining and analysis of Sina Weibo posts from 2016 to 2023, examining topic evolution, semantic evolution, and information entropy trends. [Results/Conclusions] Significant evolution was observed in topics including "elderly diseases," "technology-enabled elderly care," "dietary health," "mental health," and "social care." Elderly users demonstrate considerable attention to health information categories such as common age-related illnesses, physical medical care, social support and respect for the elderly, and daily living necessities to satisfy their needs. The semantics of topics like "elderly diseases," "exercise and health," "high-risk factors," and "medical fraud" remain relatively stable. The information entropy of "exercise and health," "daily safety," and "virus transmission" shows stable trends, while "medical literacy," "epidemic control," "cultural and sports tourism," and "balanced diet" exhibit diffusion trends, and "high-risk factors," "dietary health," "economic traps," and "medical fraud" show convergence trends.

Keywords: evolutionary dynamics; the elderly; health information seeking; topic evolution; DTM model; information behavior

CLC Number: G252; R-055
Document Code: A
Article ID: 1002-1248 (2024) 05-0065-14
Citation: GAO C L, JIANG L Y*. Research on online health information seeking behavior of the elderly based on evolutionary dynamics[J]. Journal of Library and Information Science in Agriculture, 2024, 36(5).

0 Introduction

The "14th Five-Year Plan for Healthy Aging" outlines that by 2025, elderly health service resources will be more rationally allocated, establishing a comprehensive, continuous, and urban-rural integrated elderly health service system. This will create a more friendly social environment for healthy elderly living, better satisfy the health needs of older adults, and continuously improve their awareness of core health information and health literacy levels. In October of the same year, the 20th Party Congress report emphasized prioritizing people's health in development strategies and improving health promotion policies. The Law on the Protection of Rights and Interests of the Elderly defines elderly persons as citizens aged 60 and above. According to the 53rd "Statistical Report on China's Internet Development," as of December 2023, China's non-Internet user population reached 317 million, with those aged 60 and above comprising 39.8% of this group—the primary demographic of non-users. Multi-dimensional efforts from government, society, enterprises, families, and individuals are needed to help older adults bridge the digital divide. This includes accelerating the upgrade of age-friendly products, promoting new technologies for elderly care and assistance, building a digital feedback atmosphere where patience and companionship are key, and encouraging individuals to embrace digitalization through "new silver" guiding "old silver." Under the guidance of the Ministry of Industry and Information Technology, 2,577 websites and APPs have completed age-friendly and accessibility renovations, and over 140 million smartphones and smart TVs have been upgraded for elderly-friendly use, making intelligent life more accessible and barrier-free.

As the elderly population grows and living standards improve, older adults' health concepts are transforming, and their demand for online health information seeking is increasing. This study obtains relevant data from Sina Weibo on elderly online health information seeking, employs the DTM dynamic topic model to analyze text content, and mines the types of health information, behavioral motivations, and influencing factors of elderly online health information seeking. This research aims to assist relevant Chinese departments in providing personalized online health information seeking services and improving the health information literacy of older adults.

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1 Literature Review

As shown in , scholars have reviewed foreign health information seeking behavior research from perspectives of age, race, and residence to explore research themes. From a phenomenological perspective, semi-structured interviews have revealed that elderly health information seeking patterns can be divided into proactive and forward-looking types. Through systematic review of domestic and international health information behavior research literature, scholars have traced the clear development trajectory from "medical informatics" to "health

informatics," then to "consumer health informatics," and finally to "health information behavior research." Further 归纳 of research themes in this field has clarified the scope of health information behavior studies. Research teams have used experimental methods to explore the specific impact of conflicting health information on users' health information seeking behavior. Other scholars have investigated users' online health information seeking behavior, proposing three behavioral patterns: incidental acquisition, problem-solving, and long-term attention, while analyzing the characteristics and influencing factors of each pattern. Additionally, from dual perspectives of health literacy and information retrieval ability, researchers have analyzed the role of information media in users' health information seeking processes. Scholars have also examined elderly health information literacy and health information seeking behavior.

Multiple studies have comprehensively analyzed influencing factors of online health information seeking behavior. One study extracted 16 influencing factors of online health information seeking behavior and introduced an integrated decision-making laboratory method-interpretive structural model to analyze hierarchical logical relationships and action paths among factors. Another study, based on the ELM model, constructed a research model of influencing factors for community users' health information seeking behavior through questionnaires, revealing various factors affecting user behavior. For elderly user groups, semi-structured interviews with 24 older users were conducted, and grounded theory was used to extract five internal and external influencing factors to construct a theoretical model of influencing factors for elderly users' online health information seeking behavior. Meta-analysis has further explored the moderating effects of influencing factors on online health information seeking. To better grasp user needs, the TAM model was used to construct a model of influencing factors for information sharing and seeking behavioral intentions in online health communities, exploring factors affecting users' simultaneous implementation of these two behaviors. Based on the "Information-Motivation-Behavior" skills model (IMB model), another study analyzed the internal mechanisms and influencing factors of middle-aged and elderly online health information seeking behavior during public health emergencies. Internationally, qualitative methods have explored the behavioral motivations of elderly online health information seeking, as well as their acceptance of online health information seeking, potential utilization, and possible barriers. These studies have focused not only on influencing factors and obstacles but also on information sources, aiming to support medical and health decision-making for the elderly. In summary, existing research has concentrated on health information seeking motivations, patterns, and influencing factors, exploring elderly health management needs, disease prevention and response, and lifestyle improvements, revealing the patterns and characteristics of elderly information seeking behavior, and understanding how health information influences individual health decisions, health behaviors, and health outcomes. This study utilizes the DTM dynamic topic model to conduct in-depth analysis of elderly online health information seeking from three perspectives: topic evolution, topic semantic evolution paths, and topic information entropy trends.

2.1 Research Design

First, this study obtains data on elderly online health information seeking from the Sina Weibo platform. Second, the text content and timestamps in the data are used as corpus data. After data cleaning, different time windows are divided chronologically. Third, a DTM model is constructed to identify research topics, obtaining "topic-word matrices" and "document-topic matrices." Finally, topic intensity calculations, identification and analysis of hot topics in elderly online health information seeking, visualization of topic intensity evolution trends, and fine-grained analysis of topic keyword evolution paths are performed sequentially. The specific process is detailed in [Figure 1: see original paper].

2.2 Related Methods

DTM is a topic model based on LDA that performs topic modeling on text data and discovers topic changes over time. DTM introduces time as a hidden variable into the LDA model, enabling the model to model topic evolution. Specifically, DTM divides text data into multiple time slices, each corresponding to an LDA model, and these LDA models are connected by sharing topic distributions. During training, DTM simultaneously considers text data from the current time slice and the previous time slice to discover topic evolution. For example, scholars have used datasets from the Library and Information Science (LIS) field through the DTM model to quantify word-based semantic distribution and change characteristics in topic evolution. Other studies have used DTM to analyze U.S. artificial intelligence strategy reports, mining stage strategic focuses and topic evolution trends of U.S. AI strategy from a temporal dimension. Additionally, for patent text data in the energy technology field, DTM has been used to reveal the development status of disruptive technology topics. Scholars have also selected relevant research literature on domestic and international discourse power, using DTM for topic mining to compare and analyze the current status and differences in discourse power research.

In information theory, information entropy is an important tool for quantifying system uncertainty, providing an effective method to measure a system's degree of disorder or order. Initially proposed by Shannon, information entropy is now widely applied in various fields, including evolutionary model improvement, risk analysis and evaluation, and evaluation weight coefficients. Its calculation formula is shown in (1):

$$H(X) = -k \sum_{i=1}^{n} P(x_i) \log P(x_i)$$

where P_i satisfies: $0 \leq P(x_i) \leq 1$ $(i = 1, 2, ..., n)$, and k is the proportionality coefficient. In a complex system, the higher the uncertainty of an attribute's value, the stronger the chaotic characteristics exhibited by the system. In this case, the information entropy value of that attribute increases correspondingly, meaning the amount of valuable information it can provide decreases, thereby reducing the attribute's importance in overall analysis. As a precise and efficient measurement tool, information entropy has been widely and deeply applied in various fields such as cluster analysis, outlier detection, and uncertainty quantification, fully demonstrating its unique value in processing complex system information.

3.1 Data Sources

Social media platforms are hubs for online information where individuals express information needs and conduct online health information seeking through big data push. As one of China's most popular social media platforms, Sina Weibo has a considerable number of active users who can strengthen social interactions through following, commenting, reposting, and private messaging. Weibo information updates rapidly, is convenient to share, and has strong timeliness. This study selects Sina Weibo as the data source, using "elderly health" as the search term to obtain 237,654 relevant posts through web crawler technology. The data collection period spans from January 1, 2016, to December 31, 2023, including two attributes: Weibo content and publication time.

3.2 Data Processing

This study examines the annual data volume of online health information seeking-related posts on Sina Weibo from 2016 to 2023, which can be roughly divided into a startup phase, development phase, and stable phase, as shown in [Figure 2: see original paper]. To balance the data volume across time windows as much as possible, this study divides the data into three time windows: the startup phase (2016-2018, 20,535 posts), the development phase (2019-2020, 65,394 posts), and the stable phase (2021-2023, 117,285 posts).

This study performs text data cleaning and preprocessing, mainly including removing stop words, special symbols, and numbers; converting text into token form; building a custom dictionary; and deleting advertisements unrelated to elderly health. This ensures the cleaned text data aligns with research content, ultimately obtaining 203,214 valid data entries. The Jieba library in Python is used for word segmentation, with a user-defined dictionary loaded to prevent incorrect splitting of certain terms. Functional words and low-information-density vocabulary in documents are added to the word bag, which reduces the efficiency and quality of topic modeling, so these are filtered out using the Harbin Insti-

tute of Technology stop word list supplemented with manually screened stop words.

This study uses LDA to determine the optimal number of topics by calculating coherence. Perplexity is widely used in LDA models to determine the optimal topic number k and serves as an important standard for judgment. This study calls the perplexity function in the Gensim package to determine the best topic number k. As shown in [Figure 3: see original paper], according to the calculation results, when the number of topics reaches 20, the LDA model achieves the best extraction effect.

4.1 Research Theme Results

Based on the DTM model's "topic-topic word matrix," this study compares topics and topic word probabilities across years, selects the top 10 keywords that best represent each research theme, and 归纳 s corresponding topics. Research themes of elderly online health information seeking mainly concentrate on 20 topics including "elderly diseases," "economic traps," and "exercise and health care," as detailed in . The types of health information elderly users focus on include physical medical care, property safety protection, social assistance and care for the elderly, joint epidemic prevention and control, and daily necessities.

4.2.1 Theme Evolution Analysis

Theme river maps are primarily used to represent changes in events or topics over time. They consist of different colored ribbon-like river branches, with each branch encoding different events or topics, and the width of river branches encoding values in the original dataset. River width indicates topic intensity—the wider the river, the greater the topic intensity and popularity. This study uses a river map to display the temporal changes in research popularity of various themes in elderly online health information seeking, as shown in [Figure 4: see original paper].

Themes 0 "Elderly Diseases," 12 "Technology-Enabled Elderly Care," 14 "Dietary Health Care," 17 "Mental Health," and 18 "Social Care" show high research popularity. In daily life, elderly individuals tend to focus more on physical health information needs, such as how to maintain physical health and prevent diseases. However, in special situations or events, the mental health of the elderly also requires greater attention. Relevant departments emphasize elderly mental health, conducting mental health status assessments and follow-up management for common mental disorders and psychological behavioral problems such as depression and anxiety, and providing psychological counseling, emotional relief, and grief comfort services for the elderly, especially those with special difficulties. Therefore, the elderly use online social media platforms

to find support and identity and interact with others. During this process, they may encounter mental health-related information. Online social media platforms not only provide opportunities for the elderly to communicate and interact with others but also influence their online health information seeking behavior. When elderly individuals see health information or experiences shared by others on social media, they may become interested and want to learn more.

Themes 1 “Economic Traps,” 5 “Epidemic Control,” 7 “Medical Fraud,” 13 “Virus Transmission,” 16 “Epidemic Travel,” and 19 “Medical Health” show an overall trend of first increasing then decreasing in popularity. Among them, themes 1 “Economic Traps,” 5 “Epidemic Control,” and 16 “Epidemic Travel” increased from 2016, peaked in 2020, then declined sharply and stabilized. Theme 7 “Medical Fraud” increased from 2016, peaked in 2018, then slightly declined and stabilized. Theme 13 “Virus Transmission” peaked in mid-2017, then slightly declined and stabilized. Theme 19 “Medical Health” peaked at the end of Q1 2017, then declined sharply and stabilized. Due to the COVID-19 pandemic in 2020, the global economy suffered a severe blow, making economic trap issues more prominent and epidemic control gradually receiving attention. With the global spread of the pandemic, research popularity on epidemic control strategies and methods peaked in 2020. Daily travel was closely related to transportation and travel restrictions during the pandemic. Due to virus mutation and winter-spring climate factors, the scope and scale of epidemic transmission could further expand, and the prevention and control situation remained severe and complex, requiring strategic determination and scientifically precise epidemic prevention and control measures. The government and society must adapt to the characteristics of rapid virus transmission, take faster and more decisive measures to curb epidemic spread, and concentrate efforts on fighting key regional epidemic battles. The elderly evaluate and perceive the usefulness and risk of online health information seeking through their personal value systems, which are typically based on life experience, cultural background, and personal beliefs. The elderly pay more attention to the quality and reliability of health information to protect life, health, and safety. The physical condition of the elderly is one of the main reasons for their attention to health information. With age, the physical condition of the elderly gradually declines, requiring more medical care and attention. Therefore, they place greater emphasis on health-related information and hope to improve their quality of life through such information. Additionally, life security and property safety are also important concerns. Since the launch of the special campaign against elderly care fraud, the national special campaign office, together with relevant departments across the country, has adhered to legal crackdowns, standardized rectification, and publicity education, fighting a comprehensive battle against elderly care fraud. The elderly need to ensure their quality of life and property safety to guarantee their later years. Therefore, they need to understand relevant policies and regulations and how to protect their property and rights.

Themes 2 “Exercise and Health Care,” 3 “High-Risk Factors,” and 6 “Cultural and Sports Tourism” maintain moderate and stable popularity from 2016

to 2023 without significant changes. Themes 4 "Medical Literacy," 8 "Daily Safety," 9 "Balanced Diet," 10 "Traditional Chinese Medicine Health Care," 11 "Disease Diagnosis and Treatment," and 15 "Visual Impairment" have lower but stable popularity. The elderly maintain interest in healthy lifestyles and physical exercise, aligning with the integrated development trend of health tourism and sports tourism. Although their attention to these themes is not as high as the previous ones, they still have certain research value and application prospects within their respective fields. Research on themes such as "Medical Literacy" and "Disease Diagnosis and Treatment" helps improve public health awareness and medical standards, while research on "Daily Safety" and "Balanced Diet" helps improve people's quality of life and health status. Focusing on key populations such as the elderly and key themes including reasonable diet, scientific exercise, "salt reduction, oil reduction, sugar reduction, healthy oral health, healthy weight, healthy bones" (referred to as "three reductions and three healths"), the state continuously innovates concepts, perspectives, and models for health science popularization, organizes and plans health-related theme publicity and education activities, continuously enhances the influence of publicity activities, and creates a boom in health literacy promotion. The elderly perceive the usefulness and risk of information obtained through online health information seeking. Online health information seeking provides an important channel for the elderly to obtain health information, but this process also involves certain risks. The elderly may encounter unreliable, inaccurate, or even false information, which may mislead them and cause unnecessary losses. Therefore, the elderly's perceived usefulness and perceived risk directly affect their online health information seeking behavior.

4.2.2 Theme Semantic Evolution Analysis

This study adopts a word vector-based topic analysis method to deeply investigate the thematic evolution trends of elderly online health information seeking. First, the word2vec model is used to transform a large number of topic words into high-dimensional vectors. The word2vec model learns the context information of text, representing each word as a high-dimensional vector. Semantically similar words cluster together in these vectors, capturing semantic relationships between words. Second, the t-SNE algorithm is employed for linear dimensionality reduction. t-SNE is a non-linear dimensionality reduction algorithm that can reduce high-dimensional data to low dimensions while preserving local relationships between data points, facilitating subsequent clustering and visualization operations. Finally, the K-means algorithm is used to cluster word vectors. K-means is a distance-based clustering algorithm that assigns data points to the nearest cluster by calculating the distance between each data point and various cluster centers. This study performs clustering based on the cosine distance between word vectors, which reflects directional differences between word vectors and better captures semantic relationships between words. Different semantic

concept word clusters are obtained, and changes in word clusters indicate the evolution trends of elderly online health information seeking themes. Evolution trend characteristics reflect the distribution of themes across different semantic concepts, as shown in [Figure 5: see original paper].

Theme 0 "Elderly Diseases," Theme 2 "Exercise and Health Care," Theme 3 "High-Risk Factors," Theme 7 "Medical Fraud," and Theme 14 "Dietary Health Care" have concentrated semantic concepts. For example, the semantics of Theme 0 "Elderly Diseases" are concentrated in cluster4, cluster6, cluster7, cluster12, cluster16, and cluster17. The semantic trends of cluster16 and cluster7 changed in 2021: cluster16 continued to decline to around 0.5 by 2023, while cluster7 continued to rise by 0.1 through 2023. Other word clusters remained relatively stable.

Themes 1 "Economic Traps," 4 "Medical Literacy," 5 "Epidemic Control," 6 "Cultural and Sports Tourism," 9 "Balanced Diet," and 16 "Epidemic Travel" have dispersed semantic concepts with significant changes. For example, Theme 16 "Epidemic Travel" semantics are concentrated in cluster2, cluster3, cluster5, cluster6, cluster10, cluster16, cluster17, cluster18, and cluster19. Among them, cluster3 continued to rise to 0.4 from 2017 to 2021, remained stable through 2022, then continued to rise. The semantic change trends of cluster2 and cluster5 were 曲折, while cluster16 and cluster19 remained relatively stable from 2016 to 2023. By the end of 2018, the population aged 60 and above reached 250 million, with an average life expectancy of 77.0 years in China. The health status of Chinese elderly is not optimistic: the average healthy life expectancy in 2018 was only 68.7 years, with elderly individuals living more than 8 years on average with diseases. The proportion suffering from one or more chronic diseases is as high as 75%, with nearly 190 million patients and over 40 million disabled or partially disabled elderly individuals. Health is the foundation for ensuring the independence and social participation of the elderly, and promoting healthy aging is a long-term solution to actively respond to population aging. The demand for health services among the elderly is increasingly urgent. Accordingly, the themes of elderly online health information seeking changed significantly in 2018, showing multi-level and diversified development that promotes the fairness and accessibility of elderly health services.

4.2.3 Theme Information Entropy Analysis

This study reveals the development process of elderly online health information seeking themes through the rising or falling trends of information entropy, which reflects changes in thematic semantic concept distribution, as shown in [Figure 6: see original paper]. The 20 themes from 2016 to 2018 showed stable trends, with obvious upward trends from 2018 to 2019, and varying degrees of upward or downward trends from 2019 to 2023.

Themes 2 "Exercise and Health Care," 8 "Daily Safety," 12 "Technology-

Enabled Elderly Care," and 13 "Virus Transmission" show overall stable trends, indicating that the health information needs of the elderly regarding exercise and health preservation, daily life convenience and safety, and virus and flu prevention remain in a continuously stable state.

Themes 4 "Medical Literacy," 5 "Epidemic Control," 6 "Cultural and Sports Tourism," 9 "Balanced Diet," 11 "Disease Diagnosis and Treatment," 15 "Visual Impairment," 16 "Epidemic Travel," 18 "Social Care," and 19 "Medical Health" show overall upward trends. During the pandemic, elderly individuals faced unprecedented difficulties due to travel restrictions and home quarantine. Tourism activities, as an important form of leisure and entertainment, were greatly restricted. However, as the pandemic eased and prevention and control measures were gradually lifted, many elderly individuals began to replan their travel itineraries, eager to go out and appreciate natural beauty and experience different cultures. Based on strong demand for tourism, the elderly have regained the joy of life and, to some extent, improved their medical and health literacy. Furthermore, the elderly's attention to social care and support for the elderly is also expanding. The elderly desire more social attention and care, particularly in medical, health, and life aspects. This increasing attention not only reflects the growing awareness of the elderly to protect their own rights and interests but also demonstrates society's increasing emphasis on and care for the elderly group. The elderly's attention to medical and health information, cultural tourism and health sports, daily dietary balance, and social care for the elderly is in an expanding state, reflecting changes in lifestyle and needs of the elderly in the context of the pandemic. The elderly have begun to pay more attention to their physical health status and pursue higher quality lifestyles while expecting more social attention and care. This transformation not only has important implications for the development of the elderly themselves but also poses new requirements and challenges for social progress and development.

Themes 0 "Elderly Diseases," 3 "High-Risk Factors," 14 "Dietary Health Care," 1 "Economic Traps," 7 "Medical Fraud," 10 "Traditional Chinese Medicine Health Care," and 17 "Mental Health" show overall downward trends. Among them, Themes 0 "Elderly Diseases," 3 "High-Risk Factors," and 14 "Dietary Health Care" show continuous downward trends; Theme 1 "Economic Traps" shows a stable then declining trend; Theme 7 "Medical Fraud" shows an upward then downward then stable trend; Themes 10 "Traditional Chinese Medicine Health Care" and 17 "Mental Health" show downward then upward trends. During public health emergencies, the elderly showed extremely high attention to changes in the control system and the protection of their legitimate financial rights and interests. Therefore, the elderly closely monitored various control measures and policy adjustments issued by the government and their potential impacts. As the pandemic was effectively controlled, medical fraud decreased with the gradual clarification of medical data and the medical situation, and the legitimate financial rights and interests of the elderly were effectively protected. However, as the pandemic ended, the elderly's attention to medical health gradually decreased. The elderly gradually relaxed their vigilance against diseases,

believing the pandemic was over and their health status was effectively protected. It is worth noting that this relaxed mentality may increase the risk of disease among the elderly, so they still need to maintain attention to and prevention of common elderly diseases. The attention of the elderly to health concepts such as medicinal food supplementation, common elderly diseases and risks, physical and mental health, and economic property safety is in a convergent state. The elderly are gradually returning to normal life rhythms and social patterns, and their attention to health concepts and economic property safety has correspondingly decreased. However, the elderly still need to maintain attention to and emphasis on these issues to ensure their physical, mental, and economic safety.

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5 Conclusion

This study obtained post data related to elderly health information seeking on the Sina Weibo platform from 2016 to 2023. After preprocessing, a large text dataset was obtained, and the DTM model was applied for topic modeling. In terms of topic evolution, this study observed the activity level of each theme at different time points to analyze temporal changes. For topic semantic evolution, this study deeply analyzed the keyword composition and semantic connotations of each theme at different time points, using semantic analysis techniques to reveal the evolutionary trajectory of each theme at the semantic level. Regarding topic information entropy trends, this study calculated the information entropy value of each theme at different time points and analyzed their changing trends. By comparing information entropy values at different time points, the characteristics and differences of public opinion in different periods were revealed.

(1) From the perspective of topic evolution, the focus of elderly online health information seeking has undergone different change processes. In the early stage, the elderly mainly focused on information related to "cultural and sports tourism," "technology-enabled elderly care," and "mental health," which are directly related to their physical and mental health. However, with social development and the continuous increase in the elderly population, the elderly's attention to social factors such as "social care" has gradually increased. Social factors have a significant impact on elderly online health information seeking. Social support, interaction, and identity are crucial for the mental health of the elderly. Additionally, the degree of social care and respect for the elderly affects their participation and satisfaction with online health information seeking. Technical factors are also important influences. The elderly's perceived usefulness and perceived risk of technology affect their participation and satisfaction.

(2) From the perspective of topic semantic evolution, themes such as "elderly diseases," "exercise and health care," "high-risk factors," "medical fraud," and "traditional Chinese medicine health care" show relatively concen-

trated semantics. Elderly diseases are direct challenges faced by the elderly, making the search for and acquisition of related information particularly important. Exercise and health care and traditional Chinese medicine health care are important ways for the elderly to pursue healthy lives, shaping their focus points and needs for online health information to a certain extent. Themes such as "economic traps," "medical literacy," "epidemic control," "cultural and sports tourism," and "epidemic travel" are more dispersed and show significant changes in semantic concepts. Economic traps may involve investment, financial management, and elderly security, while medical literacy relates to how the elderly correctly understand and use medical information and make health-beneficial decisions in daily life. Through their perceived value ability, the elderly search for and obtain health information online—that is, their assessment and cognition of their own resources, knowledge, and skills directly affect their focus, participation, and satisfaction with online health information seeking.

(3) From the perspective of topic information entropy trends, the information entropy trends of themes such as "exercise and health care," "daily safety," "technology-enabled elderly care," and "virus transmission" are relatively stable, indicating that these themes have consistently occupied important positions in elderly online health information seeking without obvious changes or fluctuations. The information entropy trends of "medical literacy," "epidemic control," "cultural and sports tourism," and "balanced diet" show diffusion trends. The information entropy trends of "elderly diseases," "high-risk factors," and "dietary health care" show convergence trends. The theme information entropy trends of elderly online health information seeking vary across topics, with different themes showing different changes and evolution processes. To better understand the needs and concerns of the elderly, further in-depth research on the information entropy trends of various themes is needed, and corresponding measures should be taken according to the characteristics of different themes to improve the quality and effectiveness of elderly online health information seeking.

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Note: Figure translations are in progress. See original paper for figures.