# Analysis of Chinese Core Literatures on Protective Clothing Research

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**Abstract**

Protective clothing research is booming worldwide and has become a hotspot in academia. This paper compares the literature in Chinese Core Journals with international journals on protective clothing researches to provide framework for future study. By using the system of CiteSpace, the literatures on protective clothing were selected from CNKI and WOS databases, and knowledge visualization analysis was conducted in terms of the number of articles, clustering graph, time zone view, emergent words, timeline, etc.. The commonalities and differences between literature in Chinese Core Journals with those in international one are discussed, and the achievements in protective clothing research are summarize to providing new research perspectives. It is found that the research themes in both Chinese literature and international literature have changed in response to the social and natural environment, and the research topics on protective clothing are constantly new on the basis of the previous period; the research themes of Chinese literature focus on "emergency rescue", "thermal protection", "public safety" and "medical treatment", while the themes of international literature focus on "textile", "composite", "mechanical property", "antibacterial" and "nanoparticle".

*Keywords*: Protective Clothing; Knowledge Graph; CiteSpace; Bibliometric Analysis

Protective clothing is used to protect personnel working in a variety of workplaces from physical, chemical and biological factors in the environment [1]. Protective clothing researches affect the lifestyle of people and play a unique role increasingly, with the challenges of living environment and the exploration of the natural.

In 40 years, scholars from various countries have focused on protective clothing researches, and the research directions and achievements are rich and diverse. Thus there is a lack of overall sorting and systematic understanding on the field. The digitization of literature and the development of data analysis tools have provided convenience for quantitative analysis of literature [2]. CiteSpace software, which explores the evolution of knowledge paths from the spatial and temporal dimensions of a subject area, and display the full picture of information in the relevant literature research areas in a visual format, is ability to capture the research hot spots and trends in a specific subject area accurately [3].

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This study analysis protective clothing literature in databases of Chinese National Knowledge Infrastructure (CNKI) and Web of science (WOS). By bibliometric methods and knowledge mapping by CiteSpace system, keyword clustering, time zone view, emergent word detection, and timeline analysis on protective clothing researches could be shown, and the knowledge evolution process, hot topics, and development trends of protective clothing research in Chinese literature and international literature could be analyzed.

It should be noted that the Chinese literature analyzed in this paper are limited to the Core Journals database of CNKI, and a large number of non-core journal papers are not covered. Although the non-core literatures are large number and some of them are of high level especially in recent years, the literatures are strictly screened and represents only a portion of the literature in China. In addition, a significant number of research papers by Chinese scholars have been published in foreign journals in languages other than Chinese, so the Chinese literature referred to in this paper is not entirely equivalent to Chinese research in the relevant fields. WOS is the world's largest comprehensive academic information resource covering the largest number of disciplines, including a variety of the most influential core academic journals in various research fields [4]. The literature in WOS represent the international level and status to some extent. Therefore, this study only compares CNKI Core Journals literature and WOS literature, which to a certain extent represents but not fully equates the situation of Chinese and international research.

# 1 Research Methodology and Data Collection

## 1.1 Research Methodology

In order to comprehensively explore the background of protective clothing research in China and internationally, this paper uses a combination of bibliometric and the visualization software CiteSpace to map out relevant knowledge. In order to analyze the characteristics of the literature, comparative approach is used to find the similarities and differences between Chinese and international protective clothing research in hot topics, evolutionary lines and development trends.

## 1.2 Data Collection

The data sources in this paper are divided by language into Chinese part and English part. The Chinese literature data source was from CNKI "Chinese Academic Journals" Core Journals database, the time span of literature selection was 1992-2021, and the search was set as "core journals=Y or CSSCI journals=Y and year between(1992, 2021)and topic=protection and topic=apparel or title=protection and title=apparel and(exact match)". In order to ensure the quality of the data, the retrieved documents were further judged manually, excluding articles of clothing design works and reports, and the final derived documents number is 313.

The English literature data were obtained from the WOS core collection database. To ensure the comprehensiveness of the literature data, the search formula TS=("protective clothing") was constructed using a professional search. The search revealed that after the first international symposium on protection in Denmark in 1984 [5]., the papers on protective clothing began to

be published in large numbers. So the time span was chosen: 1984-2021, and the number of literature is 3418 after the completion of the data searching. The search results were processed by using the "de-duplication" function of CiteSpace V system to eliminate the literatures with missing information and duplicate literatures, and finally 3232 relevant studies were obtained.

# 2 Comparative Analysis of Chinese and International Protective Clothing Research Literatures

## 2.1 Analysis of Publication Growth

The curves of the number of scientific publication reflect the changes in the level of research in the field of protective clothing [6]. Fig. 1 shows the annual distribution of Chinese and international literature in the field of protective clothing, and the research on protective clothing has gone through a process from "exploration" to "rapid development".

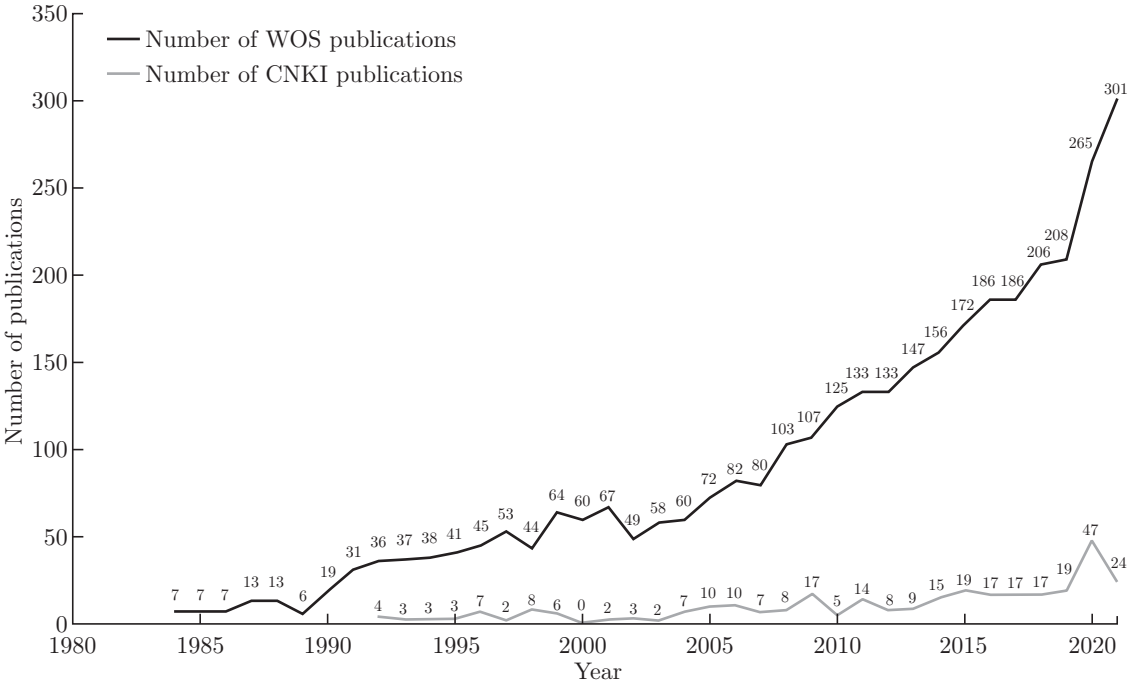


Fig. 1: Annual publications of protective clothing-related papers

On the whole, the volume of publications in protective clothing shows an obvious growth. International academic journals have paid earlier attention to protective clothing, and the volume of literature has grown rapidly, while the growth of Chinese research enthusiasm has been relatively flat with obvious increase in the past three years According to the number of publications, the international process for protective clothing can be divided into three stages: before 1991, the research literature was small quantity; from 1991 to 2006, the number of related literature gradually increased; after 2006, the number of publications increased rapidly, reflecting the gradual strengthening of research in the field of protective clothing. Protective clothing research literature in Chinese can also be divided into 3 stages: before 2003, protective clothing researches were in the preliminary stage of development, and the annual number of core literature was less than 10

and fluctuated; from 2005 to 2019, the research literature continued to increase and the number of publications showed a slow growth. Relatively speaking, although research literature in Chinese gradually increased in this stage, the annual number of publications was low. The number of the literature on protective clothing exploded in 2020, reflecting the rapid follow-up in the field of protective clothing when infectious diseases are prevalent[7, 8]. Overall, the field of protective clothing has received widespread attention from scholars.

## 2.2 Keywords Cluster of the Research Topic

Keywords can highly condense the topic of a paper, so keywords analysis of literature can provide the full picture of the research objectives [9]. By degree centrality analysis, co-occurrence calculation of high-frequency keywords detects the importance of each keyword [10]. In this study, the effect of graph clustering was evaluated by the clustering modularity index Q (Modularity Q) and the clustering contour index S (Silhouette). A Q value greater than 0.3 indicates that the structure of the network clustering module is significant. An S value greater than 0.7 indicates the high confidence level of the clustering result [11]. The results showed that the Q value of the Chinese protective clothing research atlas was 0.795 8 and the S value was 0.954 9; the Q value of the international knowledge atlas was 0.749 1, which was greater than 0.3, and the S value was 0.886 3. The clustering modules in the figure are significant and reasonably clustered, and both the clustering modules and the clustering contour index are significantly higher than the corresponding thresholds, indicating that the clustering characteristics of Chinese and international protective clothing research keyword clusters are obvious, and at the same time, the clusters are both related and different from each other, and different research directions are closely integrated and crossed, and the research scope is relatively extensive.

Fig. 2 shows separately the keyword clustering mapping of Chinese and international protective clothing literature. Each color block in the figure represents a cluster, and there are crossover situations between different clusters, which are closely related to each other [12]. The clusters with the top serial numbers cover more keywords and the number of literature is also higher. The lighter the color of the cluster blocks, the more recent the year of the corresponding concentration of research [13]. It can be observed through the plots that the area presented by each cluster covers a wide range of areas, and there is mutual coverage among multiple clusters, indicating a deeper communication among the studies. To show the keyword clustering more clearly, the keywords of the labeled categories are presented in the form of Table 1. The clustering labels are shown by the title of the relevant literature, which represents the direction of the research topic associated with it.

As can be seen from the clustering map of keywords in Chinese protective clothing research, “protective clothing” is located in the center of the network, covering a wide range, and is the most central theme word, which is closely related to “protective performance” and “safety protection”, followed by “comfort” and “firefighting clothing”, and these nodes are relatively prominent and form an obvious local center independently. The visual mapping of keywords formed 21 clustering tags that can be distilled into 3 main research areas namely: fabric research, external factors research and protective clothing research. Fabric research: including “#1 performance”, “#3 interposition aramid”, “#5 textile”, “#8 safety and protection”, “#9 Functional Fibers”, “#10 Lightweight Fabrics” and other six clusters, which are generally top-ranked and rich in content. The taking performance of fabrics is the focus of functional and comfort research [14, 15]. External

Table 1: List of Chinese and international keyword clusters

| Clustering ordinal number | China | | Foreign | |
|---|---|---|---|---|
| | Label | Keywords (select the first 3) | Label | Keywords (select the first 3) |
| #0 | Protective clothing | Protective materials; Chemical protective clothing; Garment design | Rectal temperature | Protective clothing; Body temperature; Physiological strain |
| #1 | Performance | Application research status; Nanofiber; Potential market | Skin cancer | Attitude; Risk; Adolescent |
| #2 | Load-resistant clothing | Load-resisting system; Mathematical model; Load-resisting performance | Thermal protective performance | Protective clothing; Knowledge mapping; Aegypti diptera |
| #3 | Interposition aramid | Arc protection; Fabric properties; Thermal insulation | Electrospinning | Fabrication; Adsorption; Composite |
| #4 | Thermal protection | Personal protection; Active temperature control; Immersion suit | Transmission | Protective clothing; Thermal resistance; Thermal absorptivity |
| #5 | Textiles | Composites; Fabric structures; Biochemical protection | Double blind | Skin cancer; Questionnaire survey; Ultraviolet radiation |
| #6 | Protective properties | Protective textiles; Protective equipment; Textile industry | Adolescence | Protective clothing; Indirect calorimetry; Latent heat |
| #7 | Ergonomics | Motion analysis; Protection criteria; Comfort; Aramid | Retrospective studies | Skin; Protection; Cell |
| #8 | Safety and protection | Development trends; Research status; Medical protection | Child | Health behavior; Sunscreening agents; Adaptive clothing |
| #9 | Functional fibers | Fabric surfaces; Flight suits; New fibers | Formulation | Biological monitoring; Occupational exposure; Intervention study |
| #10 | Lightweight fabrics | Outer fabric; Basic parameters; Thermal protection properties | Protection behavior | Genetic counseling; Familial Melanoma; sunscreen use |
| #11 | Thermal resistance | Thermal and humidity comfort; biological and chemical protective clothing; Warm body dummy | Nanotechnology | Protective clothing; Thermal comfort; Barrier performance |
| #12 | Moisture | Experimental methods; Application prospects; Carbon dioxide removal | Perceived sweatiness | Australia; Summer forest fires; Hand tools |
| #13 | Protection | Safety standards; Radiation safety; Conductive fibers | California group viruses | Arbovirus Infections; Arboviruses; california group viruses |
| #14 | Flame retardant | Flame retardant finishing; Blended fabrics; Flame retardant fibers | Personal heat strain monitor | Heat strain; Personal heat strain monitor; Protective clothing |

continued

| Clustering ordinal number | China | | Foreign | |
|---|---|---|---|---|
| | Label | Keywords (select the first 3) | Label | Keywords (select the first 3) |
| #15 | Design | Labor protective clothing; Shielding fabric; Hybrid textile | Sunglasses | Solar uv radiation; Sunglasses; Sun protective clothing |
| #16 | Firefighters | Firefighting protective clothing; Disaster scene | Vapor permeability index | Heat stress; Heat strain; Protective clothing |
| #17 | Emergency response | Practical performance; Protective equipment | Bicycle | Back protector device; Protective devices; Spinal injuries |
| #18 | Personal protection | Public safety; Collective protection; Human injury | Pet | Pet; Surface modification; Alkaline hydrolysis |
| #21 | Special protective clothing | Trends; Injury factors; State of the art | | |
| #25 | Disease transmission | Coronavirus infection; pneumonia; viral | | |

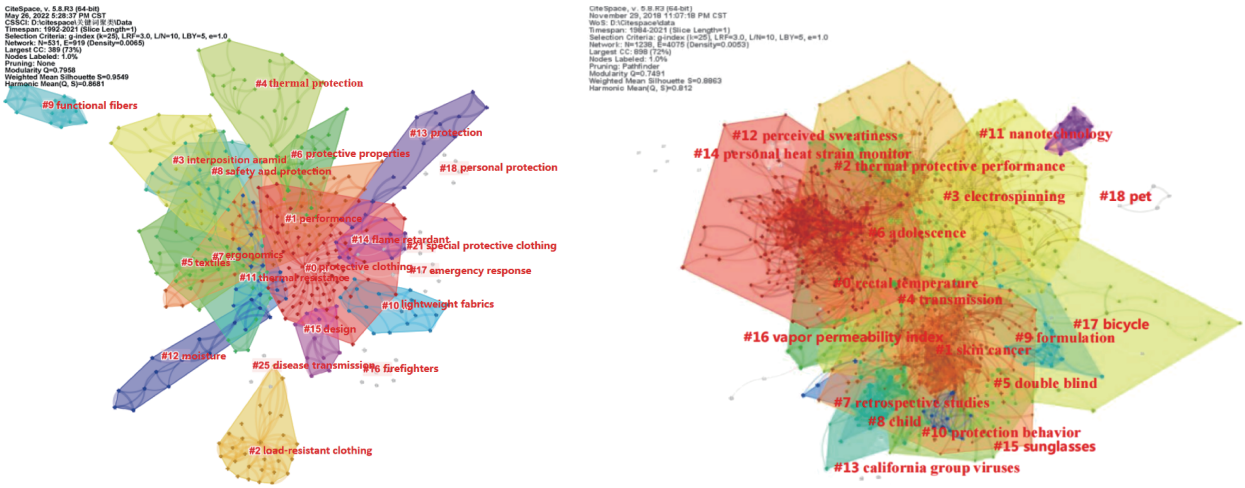


Fig. 2: The keyword clustering mapping of Chinese and international protective clothing literatures

factors study: six clusters including "# 4 thermal protection", "# 6 protection performance", "#7 ergonomics", "#11 thermal resistance", "#12 humidity", and "#25 disease transmission". The most recent year for "#25 disease transmission" is 2020, with fewer clusters and weak associations with other clusters, and medical protective clothing plays an important role in viral resistance and is a new prominent research point recently. Other clustering keywords are related to comfort. External environmental factors demand the performance of protective clothing, and research in various directions explores solutions for different hazard factors and continues to expand new application areas. Protective clothing research: including "#2 load-resistant clothing", "#15 design", "#16 firefighters", "#17 emergency rescue", "#18 Individual Protection", "#21 Special Protective Clothing" and other six clusters. In addition to professional protection, personal

protective clothing research is constantly developing, and the research space and research efforts are increasing [16,17].

From the international protective clothing research keyword clustering mapping, it can be seen that the visualization mapping of keywords forms 18 clustering tags, which can be distilled into 3 main research directions namely: daily application direction, thermal protection direction and occupational and medical direction.

One is the direction of daily application, the most important research aspect is sun protection, the clusters include "#1 skin cancer", "#5 double blind", "#7 retrospective studies", "# 10 protection behavior", "# 15 sunglasses". Other areas include "#8 child", "#17 bicycle", and "#18 pet". Research on protective clothing extends to everyday life [18, 19]. No longer limited to the special environment of professional protection, related research and industry there is huge room for development, protection performance and comfort is the current more attention to the subject.The second is the direction of thermal protection, the clusters include "#0 rectal temperature", "#2 thermal protective performance", "#4 transmission", "#12 perceived sweatiness", "#14 personal heat strain monitor", "#16 vapor permeability index" and other six clusters. From the research content, the thermal protection direction focuses on thermal protection materials, protection performance, etc. The research results focus on the heat and moisture transfer performance of clothing materials, multi-functionalization, compounding, etc [20-22]. Third, the career and medical direction, clusters include "#9 formulation", "#13 California group viruses", "#12 perceived sweatiness", "#14 personal heat strain monitor", "#16 vapor permeability index". These clusters in general rank high as new research hotspots. Research to address human exposure during operations continues to intensify [23], and medical protective clothing research fervor is increasing year by year.

The comparative analysis of the keyword clustering mapping shows that the clusters of Chinese and international literature begin to appear, last for a long time and receive different degrees of attention, and the clusters of international literature are more extensive than those of Chinese literature. Chinese and international protective clothing research share some similar themes, such as both emphasizing the comfort and expanding the multifunctionality of protective clothing; firefighting clothing-related content is an important area of protective clothing research; and research on the performance of protective clothing fabrics is being strengthened under the influence of epidemic virus transmission. Individual protection is the more important keyword in both charts and the focus of the field. The research on protective clothing for different people and uses is becoming more and more subdivided, and the specialization of protective clothing is deepening and daily expansion is becoming two directions that go hand in hand. Safety and protection performance is the fundamental of protective clothing research, the development, modification and application of new materials, the development of multiple types of fabrics, multi-function, multi-technology, aesthetic, ecological, easy, convenient, easy to take care of consumer demand and other fabric trends are the main research topics today.

## 2.3 Keyword Time Zone View

The time-zone evolution map of literature keywords can visually reflect the degree of updating and association of literature, and dynamically present the connection between hotspots and knowledge roots, thus reflecting the evolutionary trend of research [24].

Fig. 3 shows a comparative mapping of the evolution of Chinese and international protective

clothing research keywords in time zones. As seen from the evolutionary mapping, the research on protective clothing in Chinese academia started late, and the evolution is mainly divided into four stages, with representative research themes in each stage. The main keyword nodes are concentrated in 1996-2000, and there are more correlations with the keywords in subsequent years. In 1992-1996, the main research content focused on special protective clothing. 1997-2001, the research on the application of functional fibers for textile and apparel began to deepen. 2002-2006, the development and development of composite materials for apparel was launched. From 2007-2021, research on innovation and process optimization for firefighters, personal protection, emergency products, and medicine to reduce environmental impact and achieve economic benefits gradually increased, reflecting a trend of research shifting from basic theory to technology application, especially in recent years, research on protective clothing has gradually favored personal protection, emergency rescue, thermal protection, and medical treatment [25-27].

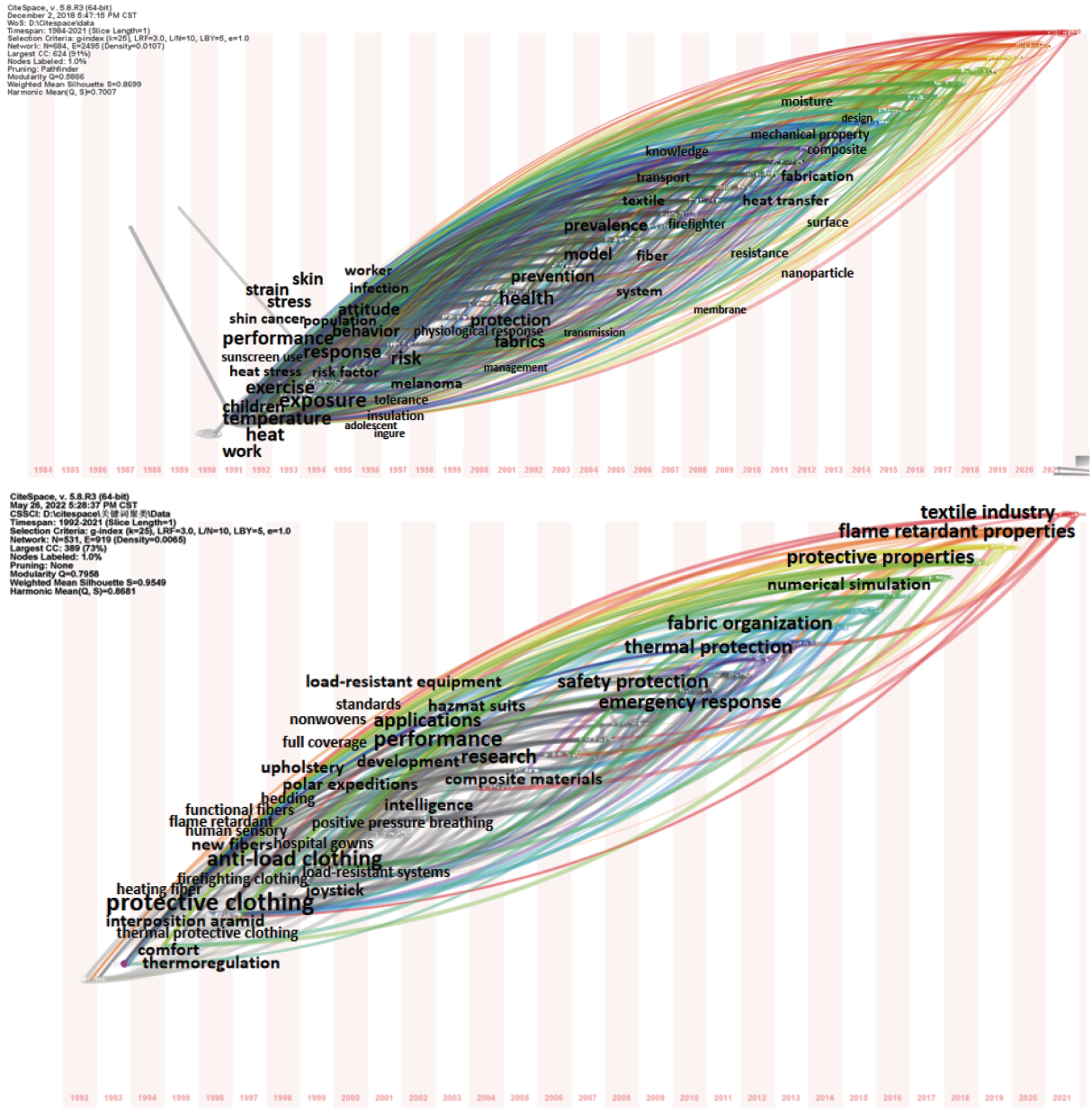


Fig. 3: Mapping of time zone evolution of Chinese and international research keywords

Before 1990, the theme of international protective clothing has been no exact direction, so there is no connecting line in the figure with the keywords in the later time periods in a mutual undertaking relationship. The main keyword nodes are concentrated in 1991-1996, which have more correlation with the later keywords. The evolution of protective clothing research as shown in the international literature is divided into four main phases, each with a representative research theme. In 1991-1996, the main research content focused on the use of textile and apparel technologies to provide protection for humans exposed to hazardous environments. 1997-2006, research on fabrics and fibers were the new research content [28,29]. Firefighting clothing-related content is an important area of protective clothing research [30]. 2007-2014 focused on thermal protective materials, protective properties, etc. 2015-2021, research topic keywords have emerged in the early period, and international academic research on protective clothing has been continuously developing.

## 2.4 Keyword Highlighting

Prominent word analysis is a software provided by CiteSpace to extract the terminology that has increased in frequency over a period of time or has received strong attention from researchers in the field, which represents the hotspots and research frontiers in the field and has a large research potential, and is an important basis for analyzing development trends [31]. This paper detects the keyword prominence rate on the basis of keyword co-occurrence analysis, and the red part of the graph indicates the stage of keyword prominence, i.e. the time when the topic becomes a research hotspot and lasts [32].

Fig. 4 shows the comparative analysis mapping of keyword prominence in the Chinese and international protective clothing literature. In terms of the intensity of emergence, the intensity of keywords emerged in Chinese literature at different times is relatively small. “Protective fabrics” and “flame retardant” were the first to appear as research hotspots; “protective performance” was significantly higher than others and was the main direction of protective clothing research; Fire and thermal protection-related research has emerged with greater intensity and is an important element of research in the protective clothing field. “Flame retardant”, “load resistant clothing” and “surgical gowns” have the longest duration of emergence. The new focuses of protective clothing research include “thermal protective clothing”, “intelligence”, “comfort”, “safety protection”, “protective materials” and “infection prevention and control”.

The keyword prominence graph of the international protective clothing literature shows that “sunscreen use” has been prominent for the longest time, and the research has been active for 14 years, indicating that scholars have been interested in its field for the longest time. The development of research topics in the literature has obvious stages, and the keyword prominence rate varies greatly in different stages. The words with high emergence are “exercise”, “acclimation” and “prevention”, among which “prevention” has been a hot topic in protective clothing research for 12 years. It is a hot topic of research in the field of protective clothing. In the past 7 years, “textile”, “surface”, “composite”, “performance”, “mechanical property”, “antibacterial”, “nanoparticle” has become a hot topic, and these keywords have been highlighted until now, and may still be a hot spot for protective clothing research in the future.

Comparing Chinese and international keyword time zones with emergent word mapping, although both studies are characterized by four stages, the contents of the research stages are different and the evolution is not synchronized; the research stages of international literature are

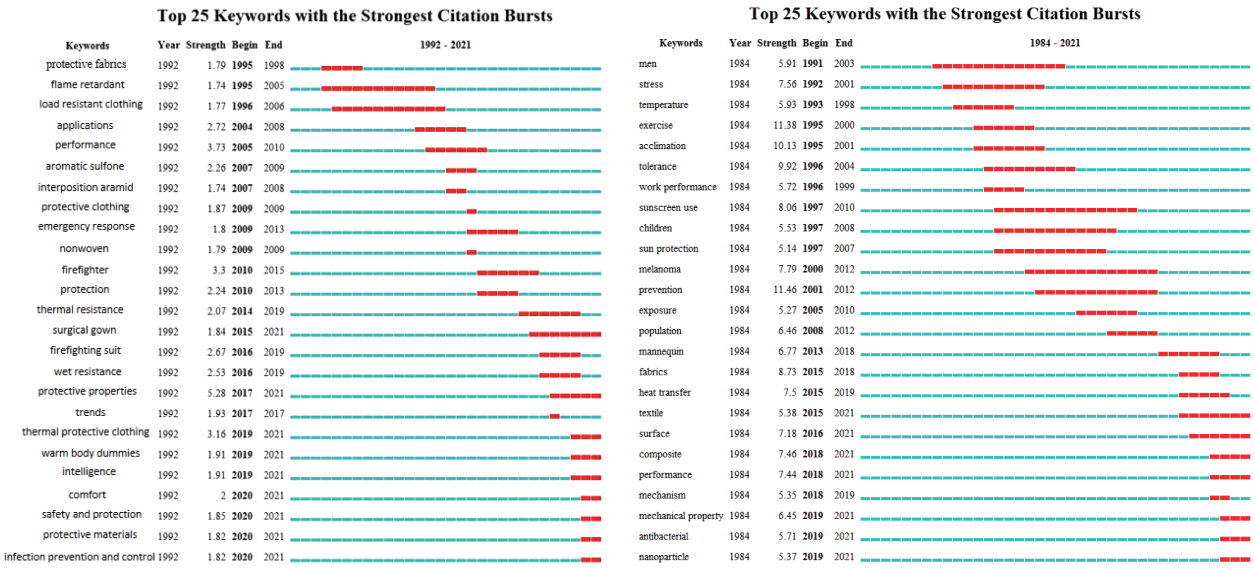


Fig. 4: Keyword prominence in Chinese and international literature

more in-depth, and the research of Chinese literature and the direction of results of international literature are convergent.

## 2.5 Keyword Timeline View

Keyword timeline mapping provides a clear picture of the evolution of research in the field by showing in detail the time span and association of keyword generation within each cluster module [33]. Firstly, we set the relevant parameters, choose "keyword" as the node type for clustering analysis, run the software to get the keyword co-occurrence map, and then perform the time line clustering on the original map. Each horizontal line represents a research topic, horizontal indicates the time, the leftmost end of the horizontal line is the emergence time of the cluster, the circle on the horizontal line represents the keywords studied in the field of the cluster, the location of the circle is the first appearance time of the keywords in this cluster, the circle represents the keywords appear across the year [34].

Fig. 5 shows the comparative analysis of keyword clustering timeline in Chinese and international protective clothing literature. There are 531 nodes and 798 nodes connected in the Chinese timeline analysis graph, with module value Q of 0.888 4 and average profile value S of 0.975 9; there are 1 238 nodes and 4 075 nodes connected in the international timeline analysis graph, with module value Q of 0.749 1 and average profile value S of 0.886 4. The two clusters are divided significantly.

Through the timeline analysis chart, we see that protective clothing research topics have been changing over time. From the timeline, the clustering trends in Chinese and international literature can be summarized in the following three states.

1) Once influential but now less concerned: The analysis of the Chinese literature timeline shows that in the cluster "#3 thermal protection", hotspots such as sports and anti-immersion clothing appeared between 1996 and 2006; hotspots such as personal protection and fireproof clothing appeared after 2007, and the distribution of such keywords is scattered and the relevance is low. Cluster "#4 thermal resistance" in firefighting clothing research has been a hot spot in the

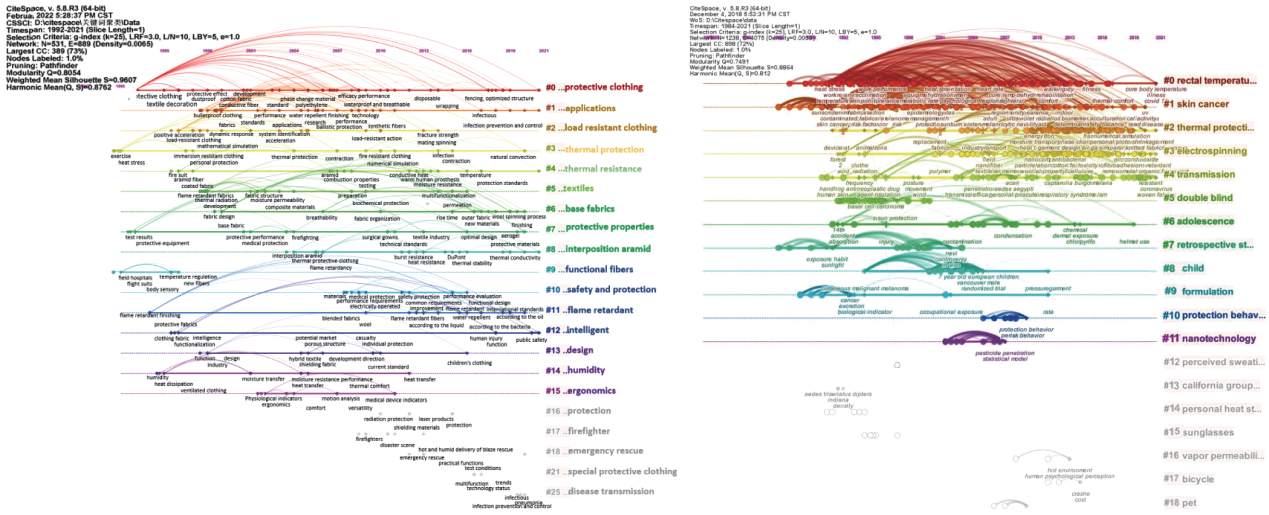


Fig. 5: Keyword clustering timeline in Chinese and international literature

field; testing, combustion performance, conductive heat, warm body dummy, wet resistance and other hot spots appeared after 2009, research tends to be on firefighting clothing transformation and upgrading development. Cluster "#5 Textiles" in the fabric structure, composite materials, multi-functional and other hot spots appeared between 1998-2016, and related areas gradually decreased in the later years. Hotspots such as thermal stability in the cluster "#8 Interposition Aramid" appeared between 1992 and 2011, and the theme gradually died out after 2012. In cluster "#15 Ergonomics", hotspots such as comfort, multifunctionality, motion analysis, and protection standards emerged after 1992, and after 2015, this theme was less relevant [35]. From the timeline diagram of international literature, it can be concluded that in the cluster "#0rectal temperature", hot spots such as heat rate and core temperature appeared between 1987 and 2007; the research content is how to maintain the heat rate and be able to resist cold; hot spots such as comfort After 2007, the focus of research has tended to be on the comfort of clothing. These keywords are more densely distributed and highly relevant. Cluster "#7 retrospective studies" addressed mainly exposed human skin. Clustering "#8 child" continued until 2003, after which studies became less relevant. The theme in cluster "#9 formulation" is to intervene in the study through instrumental testing to make the test data more accurate.

2) Started late but continued to receive attention: From the analysis of the timeline chart of Chinese literature, it can be seen that the hotspots in the cluster "#1 application" such as bullet-proof clothing, intelligence, fabrics, performance, standards, and product development appeared between 1998 and 2010, and such research has directional guidance for the subsequent development; hotspots such as infectiousness and infection prevention and control appeared after 2019. The application of protective clothing, before 2010, mainly focused on special clothing protective performance and fabric fabric performance research, after 2019, mainly for medical protection research. Cluster "#7 Protective Performance" and Cluster "# 10 Safety and Protection" have been relevant hotspots until now, the development of textile materials has been the hotspot in this field, and the research on safety and protection from special operations to medical development. Cluster "#12 Intelligence" in the clothing fabric, functionalization, market, individual protection, public safety and other hot spots appeared after 2000, the research on the intelligent structure of clothing has been the hot spot in this field, the research results began to be invested in the market application. The hot spots in cluster "#14 humidity" such as ventilated clothing,

moisture transfer, and thermal environment emerged in 1997 and have continued to develop since then. From the timeline of international literature, it can be concluded that the study of cluster "#1 skin cancer" started first, in 1987, and has continued until now. Cluster "# 2thermal protective performance" has been a hot topic of research in this field since 1990. Cluster "#3 electrospinning" research started in 1990, but the influence has been strengthened in the latter years of 2000, and the research results have focused on the multifunctionalization and compounding of clothing materials. Hotspots such as thermal comfort, individual protection, and clothing performance in cluster "#4 transmission" emerged after 1992 [36,37]. The keyword theme in the cluster "#6adolescence" evolved into daily wear clothing.

3) Protective clothing research features fast iterations and the prevalent topics change quickly: Chinese studies such as keywords in cluster "#2 Load Resistant Clothing" appeared between 1996 and 2014, and these studies did not continue to evolve and develop after they were launched. Hotspots such as fabric design in cluster "# 6 base fabric", flight suits and body feel in cluster "#9 functional fibers", and antibacterial and water repellency in cluster "#11 flame retardant", were briefly After a short period of development, the research did not continue to deepen. International studies including the cluster "#5 double blind" emerged between 1990 and 1999 with the theme of addressing the issue of skin cancer [38]. The cluster "#10 protection behavior" lasted only five years, and research on skin cancer was solved. After a short period of development of the barrier properties of fabrics in cluster "#11 nanotechnology", the research hotspot disappeared.

Protective clothing research in the international literature has good mutual support, the support association of keywords between different clusters is strong, each cluster label research area can maintain continuous in-depth research, and each research area has emerged a large number of common utilization key. Chinese protective clothing research is relatively lagging behind, with development still mainly staying at the functional requirements stage. In recent years, more intelligent and digital integration of technical tools have been introduced, but the use of these technologies is narrow, and cooperation with other areas is still limited. Both Chinese and international research hotspots in protective clothing include optimization of protective clothing materials, processes, and structures, etc.. To strengthen the comfort of clothing and to expand the individual protection are also being strengthened, while intensive research on medical protective clothing and attention to public safety issues continues.

# 3 Conclusion

This study uses CiteSpace visualization software, based on CNKI and WOS databases in the field of protective clothing, analyzes the status of Chinese and international protective clothing publications, research hotspots, research frontiers and trends, and obtains the following conclusions:

From the annual distribution of the number of publications, both Chinese and international scholars pay more attention to the research on protective clothing, and the research in China tends to slow down. From the comparative analysis of the research hotspots in protective clothing, key words such as individual protection, comfort and performance emerged from both Chinese and international studies, which reflects that the researches are gradually shifting to individual protection and fabric performance. The difference is that the international studies focus on textile technology, functional design and other aspects, explore protective clothing solutions for emerging hazards and expand new application areas. While Chinese studies concern more about emergency rescue, thermal protection, public safety and medical, etc., and the concern on medical protective

clothing and public safety issues continue.

With the enhancement of safety awareness and market expansion, protective clothing research involves more and more contents, and multi-functional, economical and application researches are also developed. Protective clothing is a cross-cutting discipline with many emerging themes. Future researches need to increase efforts in personal protection, textile technology, and functional design, and try to cross-fertilize between different fields to promote the continuous development of the protective clothing field. Protective clothing research will continue to progress in the areas of thermal protection, medical treatment, textile materials and other areas. The application of protective clothing is coming into everyday life. Along with the increase of public demand for protection, the functionality of health and safety will be combined with the design of clothing for daily needs, so that protective clothing will really enter the field of daily life. Protective clothing will be more widely used in the future, analysis on existing protective clothing research hotspots, research frontiers and trends provides a reference for further research and industrial development.

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