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# RESEARCH HOTSPOTS AND TRENDS IN CHILDREN'S FURNITURE DESIGN: LITERATURE REVIEW USING CITESPACE

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**Abstract. Purpose.** To conduct a bibliometric analysis of research on children's furniture design, identify key research hotspots and emerging trends, and provide insights to guide future research and development in this field.

**Methodology.** The research employs CiteSpace, a sophisticated bibliometric visualization tool, to analyze academic publications on children's furniture design sourced from the both the CNKI (China National Knowledge Infrastructure) and Web of Science database. The analytical approach encompasses co-occurrence analysis of keywords, co-citation analysis of references, and burst detection to elucidate emerging trends.

**Results.** The analysis is anticipated to reveal significant research clusters within the domain of children's furniture design, identify key influential authors and seminal publications, and uncover emerging research fronts. Visualizations will be generated to illustrate the knowledge structure and evolution of the field. Subsequently, through a thorough literature analysis, the study will synthesize the primary research trends and hotspots in children's furniture design, thereby providing a strategic pathway for future research endeavors in this area.

**Scientific novelty.** While previous studies have predominantly focused on specific aspects of children's furniture design, this research offers a comprehensive bibliometric overview of the field, presenting a data-driven perspective on research hotspots and trends. This holistic approach allows for a more nuanced understanding of the field's development and current state.

**Practical significance.** The findings of this study have the potential to guide researchers, designers, and manufacturers in identifying promising research directions and market opportunities in children's furniture design. Furthermore, the detailed analysis of research trends will provide valuable insights to scholars in the field of children's furniture, enabling them to conduct more targeted and in-depth research in this domain.

**Keywords:** design, furniture design, product design, children's furniture, CiteSpace, bibliometric analysis, research trends, design trends, visualization.

## INTRODUCTION

Children's furniture design represents a specialized domain that synthesizes principles from ergonomics, child psychology, safety engineering, and aesthetic theory. As the significance of cultivating appropriate living and learning environments for children gains increasing recognition, there has been a commensurate surge in research within this field. However, the evolutionary trajectory and future directions of this domain remain ambiguous. In this context, bibliometric analysis emerges as a potent methodological tool for mapping the intellectual structure of the research field and identifying emergent trends.

This study aims to employ CiteSpace, a widely adopted bibliometric visualization tool, to conduct a comprehensive analysis of the research literature pertaining to children's furniture design. Subsequently, we will critically examine and analyze seminal works in the field of children's furniture, synthesizing their findings to elucidate developmental trends through a systematic literature review. Through this multifaceted approach, we seek to uncover key research themes, identify influential works, and delineate emerging trends within the field. The resultant insights from this analysis have the potential to provide valuable guidance for researchers, designers, and manufacturers operating within the children's furniture industry, informing both theoretical advancements and practical applications.

## ANALYSIS OF PREVIOUS RESEARCH

Existing research on children's furniture in China focuses on the practical function, appearance and technology of the furniture and is based on children's physical development. Many studies concentrate on the basic functions of children's furniture, such as sleeping, studying, and storage, and only a few literatures explore the interactive, emotional, and interesting aspects of children's furniture. For example, Zhang Shaolun and Yang Wenwen discuss the interactive nature of children's furniture and argue that the interactive experience of children's furniture can break away from the single usage mode of traditional children's furniture. They suggest that when children can interact with furniture, they can also gain fun from it, and that the interaction modes can be various, not only involving language communication, but also action and behavior communication [27]. He Wei analyzes the interesting aspect of children's furniture from the perspective of its educational significance, pleasure satisfaction, and useful form. He provides a new direction for children's

furniture design, such as situational design, bionic design, humanized design, and interesting design. He aims to enrich the categories of children's furniture products and to enhance the humanization of children's experience in using them [11].

The domestic studies on the color design of children's furniture indicate that the color of children's furniture usually tends to be bright, lively, and light warm colors. The color preferences of children vary by their gender and age. For example, girls tend to prefer soft pink and warm yellow, while boys prefer cool colors that reflect a sense of power. In contrast, adult furniture shows higher richness and diversity in color. Hong Zhigang discusses the color design technology of children's furniture [12]. Yang Keqin explores the preliminary study on the color style design of children's furniture [24]. Guo Nan examines the application of color in furniture design of children's game area [10]. They all express similar views on the characteristics and principles of children's furniture color design.

The domestic studies on the form design of children's furniture cover various aspects and perspectives. Tang Jia discusses the form simulation application in kindergarten children's furniture [19]. Wang Jing analyzes the modeling language application of children's furniture product design [21]. They all agree that good design products should be able to serve the wider population as much as possible without special adjustments and modifications. They also suggest that the form design of children's furniture should highlight the beauty of simplicity, order, and nature, in order to fully display the artistic and aesthetic feeling of liveliness, conciseness, comfort, and naturalness.

The field of affective design of children's furniture has achieved remarkable research results in China. Many scholars, such as Zhao Hongyan, Sun Hui and Tong Li have presented their insights through their papers. Zhao Hongyan explores the emotional design of furniture for school-aged children [28], Sun Huiliang et al. discuss the emotional design of children's furniture based on the concept of cognitive experience [17], Tong Li analyzes the emotional design principles of children's furniture [20]. They all emphasize that while meeting children's use needs, they pay attention to children's psychological and physiological needs and integrate the emotional design concept into the design process, aiming to attract children through the emotional level and provide them with a pleasant emotional experience.

Some scholars have explored the historical and cultural context of children's furniture,

and traced its development and evolution, in order to provide insights and references for the current design. They have found that the origin and change of children's furniture were driven by the needs of life. Some scholars have studied children's furniture from an artistic angle, and incorporated aesthetic elements into its design, thus enhancing its aesthetic value. For example, the research on Western furniture design has revealed the artistic value of traditional furniture design and inspired the modern design of children's furniture [1]. In China, some scholars also explore the manifestations of traditional Chinese culture in furniture based on the historical theory and modern market situation of children's furniture, speculate on the development trend of traditional children's furniture, and propose innovative methods for promoting the development of children's furniture [14]. These are all scholars studying children's furniture design from a historical perspective, which has been widely used as one of the research methods.

In recent years, studies on children's furniture flattening mainly focus on the aspects of modularity, growth, and ductility. In China, Tang Hao et al. analyze the application of modular design method in children's furniture design [18]. Wei Feng explores the concept of growth-based children's furniture design, and propose to adjust the size, structure, and function of the furniture according to the children's growth needs [22]. Yuan Hongzhe examine the growth structure of children's seats and the continuous design of children's furniture use function, and suggest to use foldable, removable, and 32mm system structure to achieve flattening [26]. Zheng Chunzhi and Zhang Xiaofan discuss the design of the ductility of children's furniture and the realization of play in the ductile space, and recommend to use color inflatable materials to achieve flattening [29]. Internationally, Devanny Gumulya's article points out that the children's furniture is efficient as each piece is standardized, the waste materials are used to make children's educational toys, the chair is stackable, and the table can be disassembled for efficient shipping [3]. Besides, she also mentioned Furniture lack of mobility and not suit to early childhood education learning style is raised as the main problem. Because the furniture is so fixed and cannot be stack, this creates space problem in already a very tight space. Therefore, the design explores the idea of modularity and knockdown. So, the furniture can be adaptable to different learning context and space [4]. J. S. Velazquez-Blazquez et al. present the conceptual design of a new line of

preschool furniture that is modular, foldable and stackable. The furniture is intended for indoor use in schools, kindergartens, or homes, and consists of a highchair, a desk and a chair. The design aims to improve the functionality, flexibility and interactivity of the furniture, as well as to meet the ergonomic, health and safety criteria. The article also analyzes the optimal materials and the manufacturing cost of the furniture [7].

## PROBLEM STATEMENT

Children's furniture design has accumulated a wealth of research results, especially in terms of color, shape, modularity and emotionality. Despite the growing body of research on children's furniture design, there is a lack of comprehensive understanding of the field's intellectual structure, major research themes, and emerging trends. This study aims to address this gap by using CiteSpace to conduct a bibliometric analysis of the children's furniture design literature.

## THE RESULTS OF THE RESEARCH AND THEIR DISCUSSION

A comprehensive literature search was conducted using 'children's furniture' as the primary search term in both the CNKI (China National Knowledge Infrastructure) and Web of Science Core Collection (WoSCC) databases, covering the period from January 2000 to June 2024. To enhance the relevance of the sample literature, SPSSAU was employed to analyze and screen the retrieved data, examining topics, keywords, and abstracts. After eliminating samples with implicit associations, the final selection yielded 1,170 Chinese articles and 729 English-language articles. The Chinese literature from CNKI was exported in bulk using the Refworks format, while the literature from WoSCC was exported in plain text format, with the content recorded as 'full record and cited references'.

The literature exported in RefWorks format from CNKI and in plain text format from WoSCC was imported into CiteSpace 6.1.R6 for analysis. In the parameter settings, the time span was set from 2000 to 2024, with each year as a time slice.

Relevant analyses were conducted on the included literature, generating knowledge maps to examine various aspects such as keywords, burst terms, and document co-citation patterns. This systematic review aimed to visualize the current research status, hot topics, and trends in the field of children's furniture.

The analysis focused on identifying key terms and concepts through keyword analysis,

detecting emerging topics and sudden increases in research interest via burst detection, and mapping the intellectual structure of the field through document co-citation analysis.

This comprehensive approach allowed for a systematic examination of the field’s research landscape, highlighting current focal points and evolving trends. The resulting visualization provides a clear, graphical representation of the knowledge structure and development in the domain of children’s furniture research.

Based on these analytical results, we discuss potential future research hotspots and developmental directions in this field, offering insights into promising areas for further investigation and innovation in children’s furniture studies.

This study incorporated a total of 1,899 Chinese and English-language publications. The trend in annual publication volume is illustrated in Fig. 1. Changes in annual publication volume reflect the research weight of children’s furniture-related fields within the overall design domain and the level of theoretical development, serving as a crucial indicator for measuring research activity and popularity.

According to the CNKI database, research related to children’s furniture entered an exponential growth phase from 2000, surging from 7 publications to 108 in 2011. After regressing to a stable growth rate, it began to decline rapidly from 2020, indicating that research in this field has entered a phase of slow development. In contrast, statistics from the WoSCC database show a steady increase from 7 publications in 2000 to 62 in 2023.

Overall, from 2009 to 2021, the annual

growth rate of Chinese literature far exceeded that of English literature. However, from 2021 to 2023, the gap in publication volume between the two gradually narrowed to similar levels. Unlike the steady rise in English-language publications, Chinese literature exhibits greater fluctuations and can be divided into three phases: accelerated development (2000–2012), fluctuation and consolidation (2012–2020), and bottleneck decline (2020–2023).

The causes for these phases are multifaceted, including factors such as technological development, compensatory effects in research levels, and demographic factors. To break through the current bottleneck, two approaches can be considered: prioritizing the continued enhancement of China’s independent research capabilities as the primary breakthrough point, and strengthening international collaboration between research institutions as a supplementary strategy.

A co-occurrence analysis of institutional collaboration networks for children’s furniture-related literature in Chinese and English was conducted using CiteSpace. The K-value for nodes was set to 25, and the label threshold was 5. The visualization maps are shown in Fig. 2 and 3.

In the analysis of publications, a total of 378 and 934 research institutions were identified in the Chinese and English literature, respectively. In the CiteSpace-generated network, larger node areas indicate higher publication volumes, while connecting lines represent collaborative relationships between institutions. In the Chinese literature, Nanjing Forestry University (including its affiliates) had the highest publication

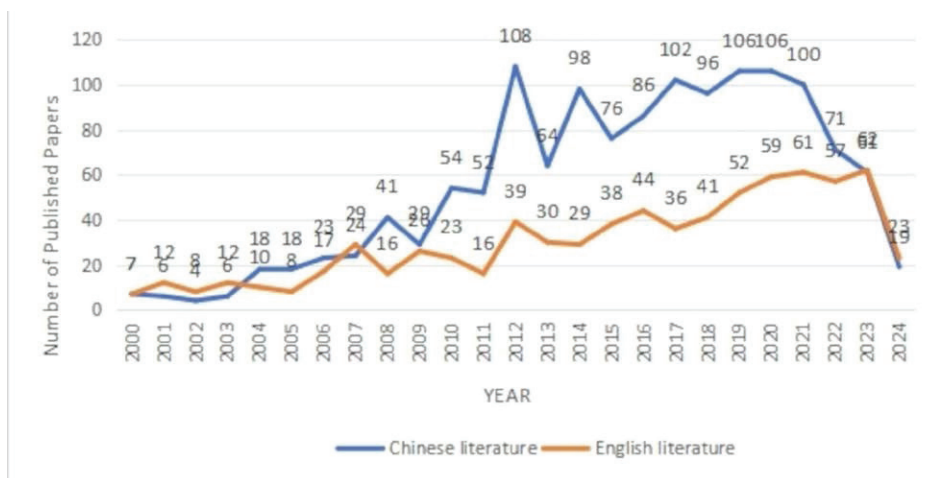


Fig. 1. Comparison of Annual Publication Trends in Children's Furniture Research between Chinese (CNKI) and English-language (WoSCC) Literature (2000–2024)

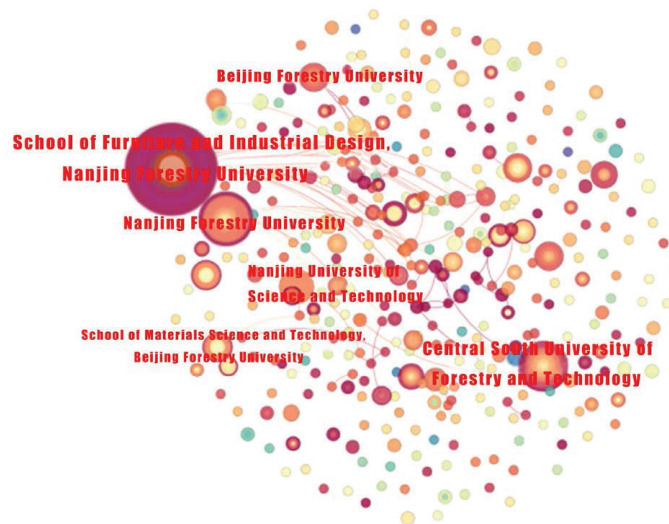


Fig. 2. Institutional Collaboration Network in Chinese Children's Furniture Literature

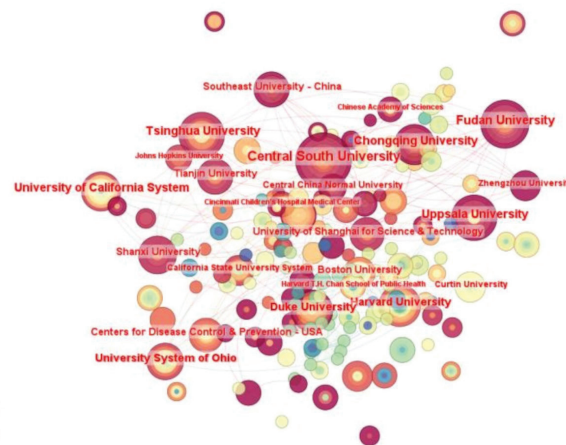


Fig. 3. Institutional Collaboration Network in English-language Children's Furniture Literature

volume with 142 papers, collaborating with 19 institutions. This included 25 papers published in core journals, and the research directions were relatively balanced, covering various aspects such as cultural heritage, emotional factors, marketing strategies, and human-computer interaction. Central South University of Forestry and Technology (including its affiliated colleges) followed with 45 papers, collaborating with 4 institutions. Their focus was primarily on integrated innovation methodologies and emotional factors, with 14 papers published in core journals.

In the English-language literature, Central South University had the highest publication volume with 23 papers, collaborating with 14 institutions. Their research concentrated on material safety indicators and pathogenic

causes. Fudan University followed with 17 papers, collaborating with 18 institutions, with a particularly close partnership with Central South University. The research directions of both universities were largely aligned. The top 10 institutions by publication volume for both Chinese and English-language literature are presented in Tables 1 and 2.

Using CiteSpace, a keyword burst analysis was conducted on the Chinese and English-language literature from the databases for the period 2000–2024 to reveal research trends through historical hotspots and cutting-edge results. Based on the abovementioned settings, the  $\gamma$  value (0–1) was adjusted to 0.5, and the top 15 burst strengths were sorted by start time, as shown in Fig. 4 and 5. Supported by system algorithms, the keyword burst analysis visually

Table 1

**Ranking of Literature Quantity of Chinese Publishing Institutions**

Ranking	Publishing Institution	Number of Publications
1	Nanjing Forestry University	142
2	Central South University of Forestry and Technology	46
3	Northeast Forestry University	25
4	Hubei University of Technology	20
5	Beijing Forestry University	13
6	Guangdong University of Technology	13
7	Taiyuan University of Technology	11
8	Changchun University of Technology	10
9	Kunming University of Science and Technology	10
10	Shanghai Institute of Quality Inspection and Technical Research	10

Table 2

**Ranking of English-language Publishing Institutions' Literature Quantity**

Ranking	Publishing Institution	Number of Publications
1	Central South University	23
2	Fudan University	17
3	Chongqing University	15
4	Tsinghua University	14
5	Uppsala University	14
6	University System of Ohio	14
7	University of California System	13
8	Delft University of Technology	12
9	Duke University	11
10	Harvard University	11

**Top 15 Keywords with the Strongest Citation Bursts**

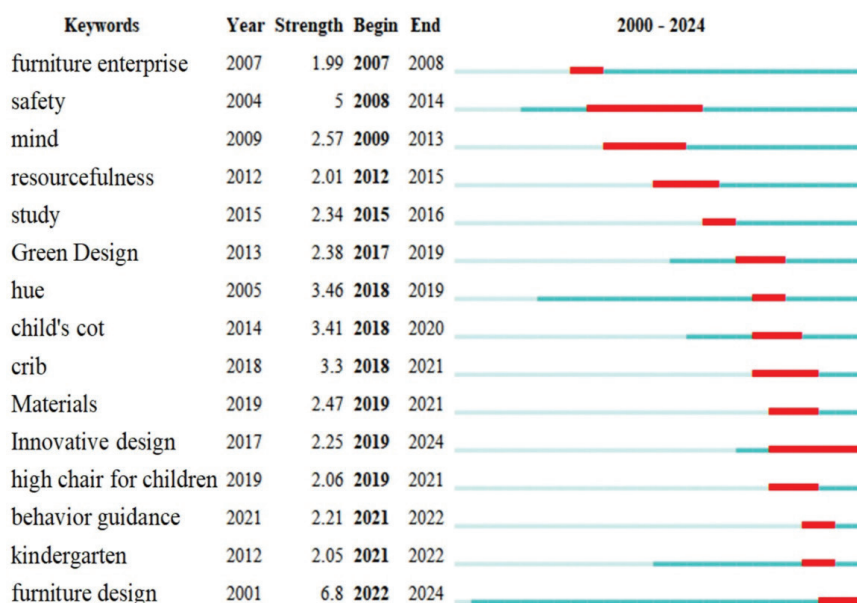


Fig. 4. Keyword Burst Analysis in Chinese Literature on Children's Furniture Research (2000–2024)

### Top 15 Keywords with the Strongest Citation Bursts

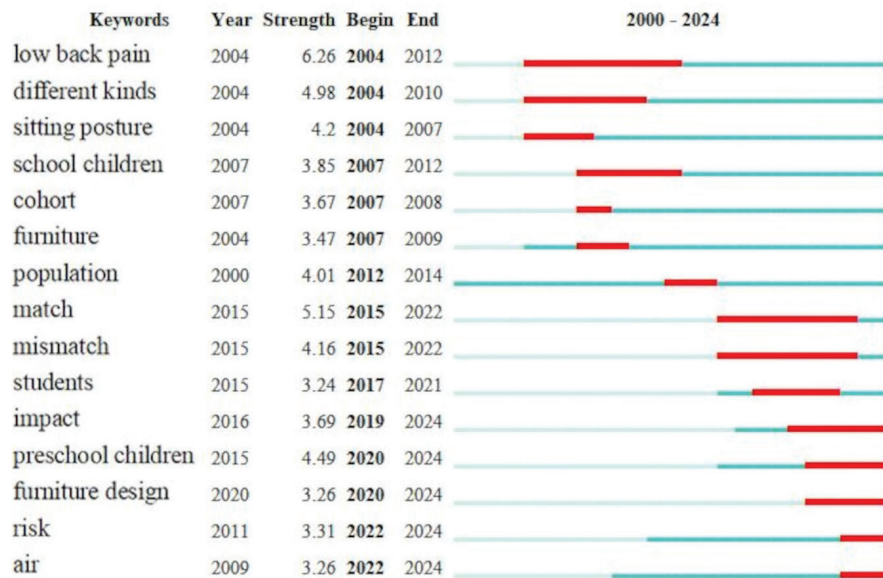


Fig. 5. Keyword Burst Analysis in English-language Literature on Children's Furniture Research (2000–2024)

reflects the evolution of hotspots in children's furniture-related fields along the timeline, enabling research trend derivation.

Results indicate that within this timeframe, early hotspots (2008–2015) in Chinese literature were safety, psychology, and educational value. Research during this period primarily focused on safety performance and emotional factors related to children's health considerations. Mid-term hotspots (2017–2021) included green design, children's beds, materials, and behavioral guidance. This period saw initial explorations of design concepts, with frequent appearances of terms like green, low-carbon, growth adaptability, and modularity, leading to diversified research directions without clear dominant hotspots.

As research in the field deepened, the integrated innovation of methodologies became the current research hotspot, continuing from the mid-term to present with high research vitality and prospects, exemplified by the application of methods such as KANO, TRIZ, and AHP.

For English-language literature, early hotspots (2004–2007) were lower back pain, differentiated children, and school children, focusing on differentiated children's health considerations based on ergonomics. Mid-term hotspots (2015–2022) centered on matching and mismatching (dimensions), further refining the analysis of physiological functions and body dimensions for children of different ages and ethnicities. Current hotspots (2019–2024) include preschool children, risk factors, and air

(impact), shifting research focus from external risk factor assessment of children's physical function measurements to internal risk factor assessment of material analysis and pathogenic causes in children.

The current research hotspots in children's furniture-related fields revolve around two directions: integrated innovation of methodologies and material risk assessment with the establishment of safety indicators.

Recent years have witnessed several significant trends in children's furniture design research, with bionic design and interdisciplinary approaches gaining prominence.

Bionic design, which draws inspiration from natural forms and processes, has emerged as a fertile area of research in children's furniture design. In China, Zeng You has explored the synergy between bionic design and children's furniture, positing that bionic principles can facilitate the creation of furniture more aligned with children's needs, interests, and developmental stages [8].

Internationally, Meng Ji-dong has applied bionic design principles to children's chair furniture, discussing both the theoretical underpinnings and practical applications of this approach, while also speculating on future developmental trajectories [16].

The field has also witnessed an influx of research methodologies from other disciplines, notably the application of TRIZ theory, QFD (Quality Function Deployment), and KANO models. In China, Liu Zongming has investigated

innovative design methods for lightweight children's furniture by integrating the KANO model with TRIZ theory [15]. Cui Longyao's work has focused on applying TRIZ theory to generate innovative solutions in children's furniture design, identifying common principles among TRIZ's 40 inventive principles [9]. Jia Yuyu has proposed a hybrid approach, employing QFD to transform user needs into design elements, followed by TRIZ theory to address conflicts in structural stability, versatility, and material efficiency [13]. Xiao Fei's research has utilized the KANO model to assess user satisfaction and demand for smart functions in intelligent children's desks [23].

On the international front, Yi Xin has proposed an integrated design model incorporating QFD, TRIZ, and Finite Element Method (FEM) to address the multifaceted challenges in children's furniture design and quality assurance [25]. Zhong Guang Ming's study has applied TRIZ theory to design innovative, growth-adaptive wooden chairs for children [30].

Songwut Egwutvongsa's work has demonstrated the practical application of TRIZ in converting user needs into design functions for high-quality residential buildings, with potential implications for children's furniture design [2]. Adila Md Hashim's research has employed the Kano model and QFD method to improve ergonomic design in school workshop workstations, offering valuable insights for children's furniture innovation [5]. M. Jagusiak-Kocik's study utilized the Kano model to analyze customer preferences for children's travel beds, informing the design process based on parental expectations [6].

This diverse body of research underscores the multidisciplinary nature of contemporary children's furniture design, integrating principles from ergonomics, psychology, engineering, and design theory to create innovative, user-centered solutions. These approaches not only address functional and aesthetic considerations but also prioritize children's developmental needs, safety, and emotional well-being.

## CONCLUSIONS

This study presents a comprehensive bibliometric analysis of children's furniture design research, employing CiteSpace to elucidate the field's intellectual structure and evolutionary trajectory. Through sophisticated visualization techniques and rigorous analytical methods, we have successfully mapped the landscape of this dynamic domain, identifying key research clusters, seminal works, and emerging trends

that are shaping its future. Our findings reveal a complex and multifaceted field that, while firmly grounded in fundamental considerations such as ergonomics and safety, is rapidly evolving to embrace innovative technologies, sustainable practices, and increasingly personalized design approaches. This evolution reflects a growing recognition of the intricate interplay between children's physical, cognitive, and emotional development and their immediate environment. The analysis highlights a significant shift towards bionic design principles, drawing inspiration from nature to create furniture that resonates with children's innate curiosity and developmental needs. Concurrently, the integration of advanced problem-solving methodologies such as TRIZ theory, QFD, and KANO models signifies a move towards more systematic, data-driven design processes. These approaches enable designers to more effectively translate user needs into tangible features, addressing complex challenges such as adaptability, sustainability, and ergonomic optimization. Looking forward, the field of children's furniture design appears poised for continued innovation and interdisciplinary integration. As the field continues to evolve, we anticipate the emergence of furniture that transcends traditional roles, becoming responsive, intelligent systems that adapt to individual needs, promote learning, and seamlessly integrate with the digital world that today's children inhabit. This study thus not only provides a comprehensive overview of the current state of children's furniture design research but also serves as a roadmap for future investigations.

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## АНОТАЦІЯ

**Чжан Лінь, Косенко Д. Гарячі точки досліджень та тенденції в дизайні дитячих меблів: огляд літератури з використанням CiteSpace**

**Мета.** Провести бібліометричний аналіз досліджень дизайну дитячих меблів, визначити ключові точки дослідження та нові тенденції, а також надати інформацію для спрямування майбутніх досліджень і розробок у цій галузі.

**Методологія.** У дослідженні використовується CiteSpace, складний інструмент бібліометричної візуалізації, для аналізу академічних публікацій про дизайн дитячих меблів, отриманих як з CNKI (Китайської національної інфраструктури знань), так і з бази даних Web of Science. Аналітичний підхід включає аналіз спільного використання ключових слів, аналіз спільного цитування посилань і виявлення гарячих точок для з'ясування тенденцій, що виникають.

**Результати.** Очікується, що аналіз виявить значні дослідницькі кластери в області дизайну дитячих меблів, виявить ключових впливових авторів і основоположні публікації, а також розкриє нові напрямки досліджень. Будуть створені візуалізації, щоб проілюструвати структуру знань і еволюцію галузі. Згодом, шляхом ретельного аналізу літератури, дослідження буде синтезувати основні тенденції досліджень і гарячі точки в дизайні дитячих меблів, забезпечуючи тим самим стратегічний шлях для майбутніх досліджень у цій галузі.

**Наукова новизна.** У той час як попередні дослідження переважно зосереджувалися на конкретних аспектах дизайну дитячих меблів, це дослідження пропонує вичерпний бібліометричний огляд галузі, представляючи керовану даними точку зору на гарячі точки досліджень і тенденції. Цей цілісний підхід дозволяє більш детально зрозуміти розвиток галузі та поточний стан.

**Практична значущість.** Результати цього дослідження можуть скерувати дослідників, дизайнерів і виробників у визначенні перспективних напрямків досліджень і ринкових можливостей у дизайні дитячих меблів. Крім того, детальний аналіз тенденцій досліджень надасть цінну інформацію для вчених у галузі дитячих меблів, дозволяючи їм проводити більш цілеспрямовані та поглиблені дослідження в цій галузі.

**Ключові слова:** дизайн, дизайн меблів, промисловий дизайн, дитячі меблі, CiteSpace, бібліометричний аналіз, тенденції досліджень, тенденції в дизайні, візуалізація.

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