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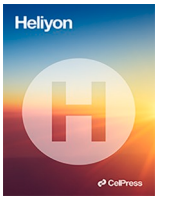

Review article

Evolution and trends of childhood cataract research in the past 10 years: A scientometric analysis

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ABSTRACT

Purpose: To present a panoramic review of childhood cataract knowledge networks, hotspots and trends.

Methods: The Web of Science Core Collection was used to retrieve the global literature on childhood cataract published between 2012 and 2021. Scientometric data were analyzed and visualized using VOSviewer and CiteSpace for metrics including publication count, citation count, country, journal, author, cited reference, subject category and their temporal trends.

Results: A total of 3395 analyzed publications showed an inconsistent annual increasing trend. The USA (n = 939) was the leading contributor among countries. The Journal of American Association for Pediatric Ophthalmology and Strabismus (n = 113) had the highest number of publications among journals. Eight clusters of author collaboration network including 183 authors were identified. Gene mutation, cataract surgery management, intraocular lens implantation complications, prevalence, and glaucoma were identified as the research hotspots. Pediatric cataract surgery, new mutations, artificial intelligence, and cerebrotendinous xanthomatosis were identified as frontier research topics. "Biochemistry and molecular biology", "neurosciences", and "radiology, nuclear medicine and medical imaging" had the highest betweenness centrality values (0.38, 0.32, and 0.22). Multidisciplinary (burst years: 2020 to 2021; strength = 4.32) had the greatest strength as of 2021.

Conclusions: Childhood cataract research intensely focuses on revealing the genetic background and pheno-spectrum of the diseases, innovating and/or optimizing surgical techniques, and preventing and treating postoperative complications. Artificial intelligence has shed light on the diagnosis and treatment of childhood cataracts. The advance in the research on molecular mechanisms of childhood cataracts depends on multidisciplinary cooperation.

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1. Introduction

Childhood cataract is the leading cause of avoidable childhood blindness, with an estimated worldwide incidence of 1 in 3000 [1]. Despite the high success rate of childhood cataract surgery, the prolonged visual deprivation and postoperative complications, such as glaucoma-related adverse events, may lead to lifelong visual impairment or even blindness [2,3]. More importantly, the causal aetiology of childhood cataracts complicated with ocular and/or systemic anomalies is difficult to diagnose. Delayed diagnosis of multisystem diseases that require early interventions, such as cerebrotendinous xanthomatosis, results in increased diagnostic costs and poor prognosis [4,5].

In recent years, great efforts have been made to improve disease management and elucidate the causal aetiology of childhood cataract, contributing to the formation of complex knowledge networks in the scientific area [6,7]. It is essential for researchers and decision-makers to make more efficient use of frontier knowledge in this field. However, a panoramic view of childhood cataract knowledge networks, research hotspots and frontiers has not yet been put forward.

Scientometric methods can be utilized to quantitatively analyze academic publications as well as the changes in research activity over time in a given field, shedding light on scientific decision-making [8,9]. Here, we analyze the 10-year evolution of the field with the aim of identifying the panoramic review of childhood cataract knowledge networks and hotspots and trends using scientometric approaches.

2. Method

2.1. Search strategy and selection

To select recent studies related to childhood cataract, articles published between 2012 and 2021 were considered in the literature search. A comprehensive literature search was conducted in the Web of Science Core Collection (Clarivate Analytics, Philadelphia, PA,

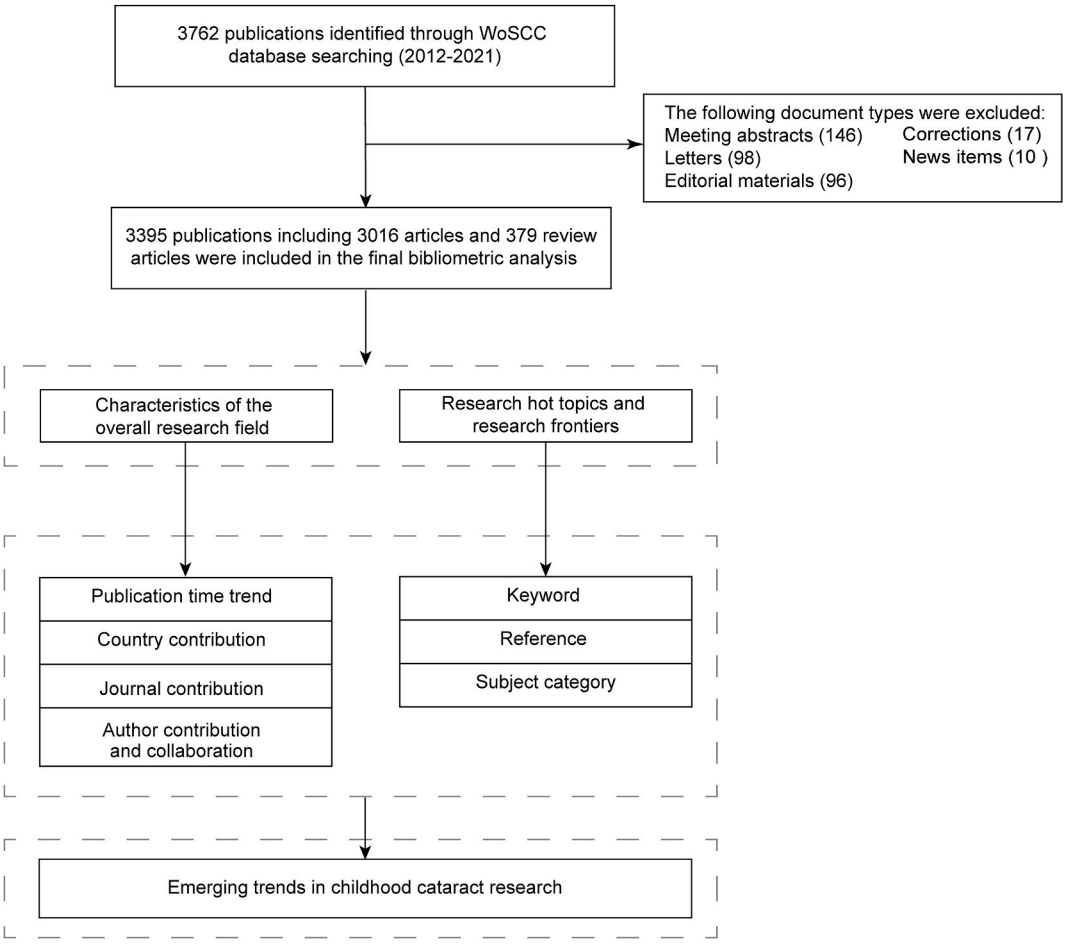

Fig. 1. Flow chart of the study selection process for childhood cataract research publications, as well as the analytic process. Abbreviation: WoSCC, Web of Science Core Collection.

USA) using the following search formula: (TS=(cataract) OR (TS=(opaci*) AND TS=(lens*)) OR TS = pseudoaphakia) AND (TS = infan* OR TS = child* OR TS = adolescen* OR TS = p$ediatric OR TS = teenage* OR TS = congenital OR TS = young people OR TS = juvenile*). Only original research articles and review articles were included in order to analyze childhood cataract research publications that included original study materials or data that had been synthesized by experts. The search was conducted on 21 July 2022, and updated on September 29, 2022. The detailed data acquisition and analysis methods are shown in Fig. 1.

2.2. Data collection

Data were downloaded from Web of Science Core Collection (Clarivate Analytics, Philadelphia, PA, USA) and pre-processed by importing into Microsoft Excel 2019 (Microsoft, Redmond, USA). The publication year, citation count, country, journal, author, keywords, references and subject category of each publication were extracted to perform the scientometric analysis.

2.3. Data analysis and visualization

Annual publications, annual citations and annual growth rates were used to examine the trends of publication volume in childhood cataract research. To determine the annual growth rate, the number of publications in a given year minus the number of publications in the previous year, and then divide the number of publications in the previous year. A value of 0 was assigned to a negative growth rate, which was regarded as the absence of growth. The contribution of countries, journals, and authors were evaluated by the publication counts. The analysis and visualization were performed by using Microsoft Excel 2019 (Microsoft Corporation, Redmond, WA, USA) and GraphPad Prism version 8.4.2 (GraphPad Software, La Jolla, CA, USA). A remarkable year for publication activity was defined as a year with $\geq$100 publications and an annual growth rate of $\geq$10%.

To obtain author collaboration network and research hotspots, data analysis and visualization were carried out using VOSviewer version 1.6.18 (Leiden University Centre for Science and Technology Studies, Leiden, Netherlands). The co-authorship analysis was used to identify author collaboration networks, with collaboration strength being weighted by the total link strength (TLS); the keyword co-occurrence analysis was used to determine research hotspots, with the importance of keywords being weighted by the occurrences. The terms “cataract”, “cataracts”, “child”, “childhood”, “childhood cataract”, “children”, “congenital”, “congenital cataract”, “congenital cataracts”, “infant”, “infantile cataract”, “infants”, “pediatric”, “pediatric cataract” as the search terms were screened to be removed in the keyword analysis and thereby revealed the real keyword associations. Lines between authors or between keywords reflected associations, with thicker lines meaning stronger associations. The full counting method was used in all analyses of associations.

With the aim of identifying research topic trends and research subject category trends, analyses were performed using CiteSpace V version 6.1.3 (Drexel University, Philadelphia, PA, USA). The research topic frontiers were identified using the reference analysis, with clusters that possessed the most recent mean formation year or the most recently recruited members indicating topic frontiers. The silhouette score was applied to assess the homogeneity of the clusters, with higher silhouette scores denoting stronger homogeneity where 1 was the maximum value. The silhouette score was calculated by taking into consideration the average distance between each member of the cluster and all other members within the same cluster, as well as the average distance between each member of the cluster and all members of the nearest neighboring cluster.

To obtain the main and bridge subject categories, the co-occurrence analyses of the subject categories were carried out using CiteSpace V version 6.1.3 (Drexel University, Philadelphia, PA, USA). Subject category bursts, which referred to a sudden increase in the frequency of the subject categories and a high strength signifying a high degree of burst, were obtained to identify the trends in the subject categories. The importance of a discipline (subject category) or reference was evaluated by its occurrence. The bridging roles of

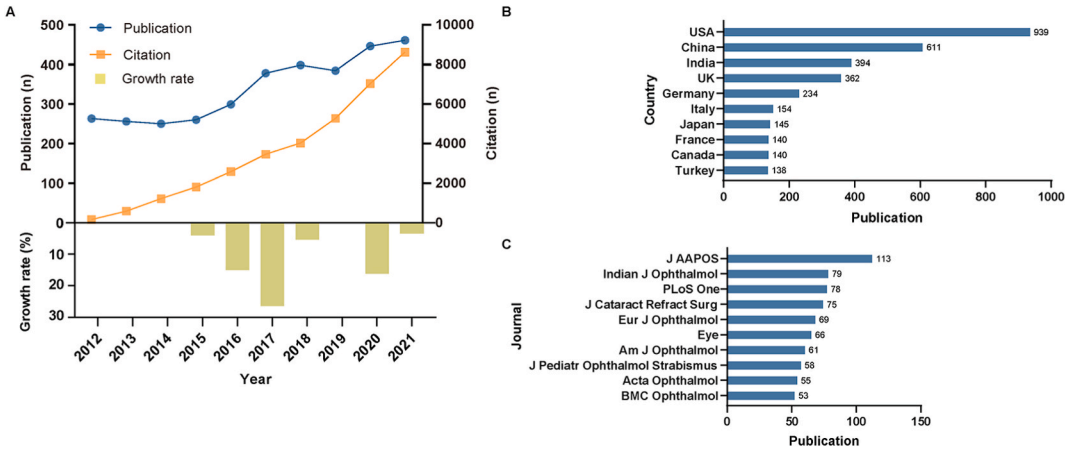

Fig. 2. Profile of research on childhood cataract published in the past 10 years. A. Top graph: worldwide patterns in annual citations and annual publications. Bottom graph: growth rates for publications. B. Top 10 countries. C. Top 10 journals.

subject categories or references were evaluated by their betweenness centrality, with greater than 0.1 being significant. Subject categories with high betweenness centrality act as connectors between various groups through their bridging role. They are essential in facilitating the exchange of information and communication between various groups. Betweenness centrality scores, which were provided in CiteSpace, served as a valuable indicator of the connectivity between different groups. Nodes with high betweenness centrality scores typically bridge two or more large groups of nodes, with the node itself situated in between.

3. Results

3.1. Characteristics of the overall research field

A total of 3395 original research and review articles related to childhood cataract were published during the study period (Fig. 1). The year with the most publications was 2021 (n = 461, 13.58%), while the year with the fewest publications was 2014 (n = 250, 7.36%). A total of 40,808 citations for all publications and an average of 12.02 citations per publication during the study period were identified. Annual citations increased and reached a peak in 2021 (n = 8617) (Fig. 2A top graph). The annual publications during the study period showed a non-continuous increase, with 2016, 2017 and 2020 being the remarkable years for publication activity (annual publication ≥100, growth rate ≥10%) (Fig. 2A bottom graph).

In terms of country contributions, the USA (n = 939), China (n = 611) and India (n = 394) were the top three contributors (Fig. 2B). The Journal of American Association for Pediatric Ophthalmology and Strabismus (J AAPOS; n = 113), Indian Journal of Ophthalmology (Indian J Ophthalmol; n = 79), PloS one (PLoS One; n = 78) were the top three contributors for journals (Fig. 2C). With regard to author contributions, Scott R. Lambert (n = 55), Haotian Lin (n = 49), Zhuoling Lin (n = 39), and Yizhi Liu (n = 39) topped as co-authors (Fig. 3A). Meanwhile, Arif O. Khan (n = 13), Scott R. Lambert (n = 10) and Sudarshan Khokhar (n = 10) had the most publications ranking as first authors (Fig. 3B).

A total of 15,559 authors were involved in the publication of childhood cataract research. Eight clusters of author collaboration network including 183 authors were identified, with a minimum frequency of 5 publications per author. Ranking the author collaboration networks in descending order of the number of collaborated authors in each cluster, the most collaborative authors within the different collaborative networks were as follows. Haotian Lin (TLS = 45.00) in the 41-author collaboration network, Ke Yao (TLS = 32.00) in the 35-author collaboration network, Scott R. Lambert (TLS = 49.00) in the 28-author collaboration network, Rupal H. Trivedi (TLS = 35.00) in the 24-author collaboration network, Arif O. Khan (TLS = 16.00) in the 20-author collaboration network, Anthony T. Moore (TLS = 10.00) in the 13-author collaboration network, Amit Mohan (TLS = 9.00) in the 11-author collaboration network, Yi Lu (TLS = 17.00) in the 11-author collaboration network (Fig. 3C). Scott R. Lamber was among the top three first authors and co-authors, and he was central to the author collaboration network.

3.2. Research hot topics based on keywords

In childhood cataract research, “mutation” (n = 345), “surgery” (n = 269), and “cataract surgery” (n = 229) were the three most

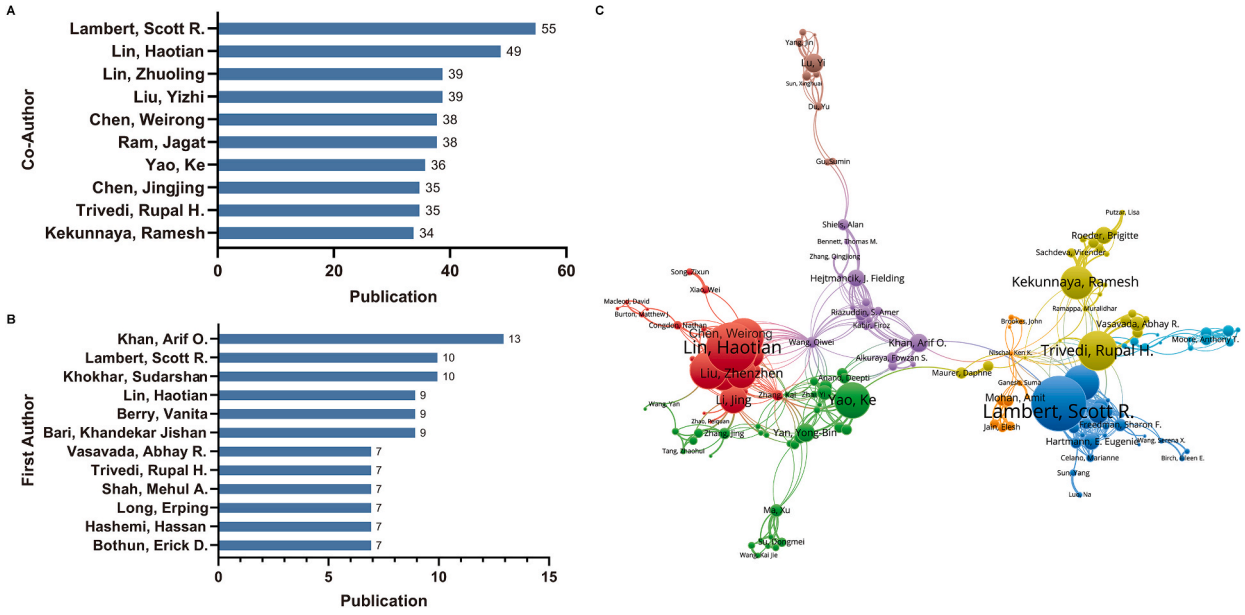

Fig. 3. The most active authors in the field of childhood cataract. A. Top 10 co-authors. B. Top 12 first authors. C. Map of the author collaborations.

frequent keywords. Of the 11,118 keywords obtained, a minimum frequency of keywords to 20 occurrences was set and 178 high-frequency keywords were identified. Five clusters of these keywords were determined (Fig. 4): the "gene mutation" cluster (63 items); the "cataract surgery management" cluster (36 items); the "complications of intraocular lens implantation" cluster (35 items); the "prevalence" cluster (29 items); and the "glaucoma" cluster (15 items).

3.3. Research topic trend based on references

The cited literature formed 8 clusters (Fig. 5, Table 1). The earliest cluster was the "gene expression" cluster (#1; 81 items; silhouette = 0.87; mean formation year = 2012), chronologically followed by the "exome sequencing" cluster (#2; 76 items; silhouette = 0.79; mean formation year = 2015), the "traumatic cataract" cluster (#3; 32 items; silhouette = 0.97; mean formation year = 2015), the "pediatric cataract surgery" cluster (#4; 104 items; silhouette = 0.86; mean formation year = 2017), the "genotype-phenotype correlation" cluster (#5; 17items; silhouette = 0.96; mean formation year = 2017), the "novel mutation" cluster (#6; 73 items; silhouette = 0.85; mean formation year = 2019), the "artificial intelligence" cluster (#7; 16 items; silhouette = 1.00; mean formation year = 2019), and the "cerebrotendinous xanthomatosis" cluster (#8; 13 items; silhouette = 0.99; mean formation year = 2019).

In regards to the cited time duration, the research frontiers were identified as "pediatric cataract surgery" (2012–2021), "novel mutation" (2016–2021), "artificial intelligence" (2017–2021), and "cerebrotendinous xanthomatosis" (2018–2021). The majority of research on childhood cataracts dealt with congenital and developmental cataracts, according to the titles of the top citing articles for the frontiers (11/33, Table 1).

3.4. Research subject category trend

Among the 112 subject categories in childhood cataract research, the top three collaborative subject categories with ophthalmology and pediatrics were "genetics and heredity" (n = 365), "biochemistry and molecular biology" (n = 223), and "internal medicine" (n = 223) (Supplemental Table 1). The "Biochemistry and molecular biology", the "neurosciences", and the "radiology, nuclear medicine and medical imaging" had the highest betweenness centrality values (0.38, 0.32, and 0.22; Fig. 6A, Supplemental Table 2). The burst years continuing into 2021 were identified in the "chemistry, multidisciplinary" (burst years: 2020 to 2021; strength = 4.32; Fig. 6B), which was determined as the subject category involved in the research frontier of childhood cataract.

4. Discussion

Annual publication volume showed a non-continuous increase during the study period. In terms of country, journal and researcher,

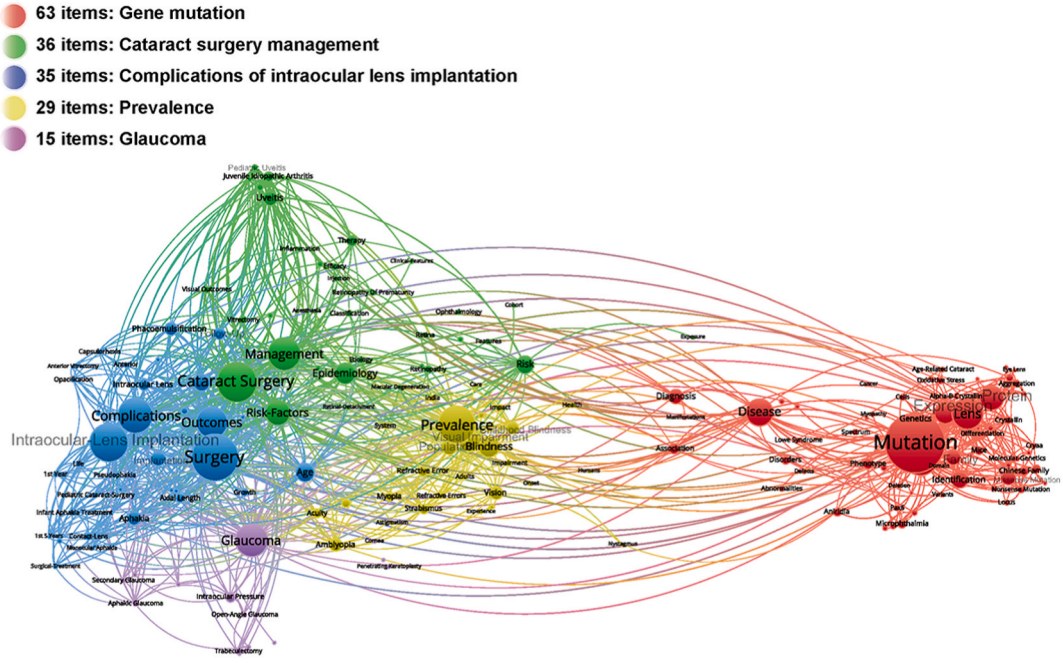

Fig. 4. Keyword-based analysis of research hotspots for childhood cataracts. Every single keyword is represented by a node. The frequency of the keyword increases with node size. The investigation of keywords leads to the formation of clusters. The same colour in a cluster denotes keyword nodes that are closely connected. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

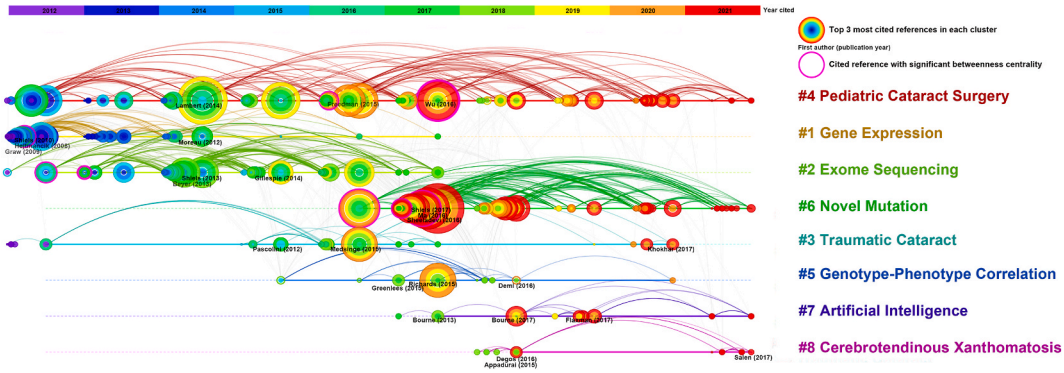

Fig. 5. Reference-baed analysis of research frontiers for childhood cataracts in the past 10 years. The nodes show the cited references for studies on childhood cataract. The frequency of citations increases with node size. Purple outer rings denote nodes with significant betweenness centrality, indicating a pivotal role in changes in research paths. According to the moment of their first citation, each node is positioned in a timeline. The subsequent citation years are represented by the citation tree rings. The knowledge base is seen as the network of co-citations. In order of mean formation year, the co-citation clusters are numbered #1 through #8. The clusters are classified as research topic trends using terms taken from the citing articles. The top 3 articles that receive the most citations are highlighted within each cluster. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

USA, J AAPOS, and Scott R. Lambert were the most active contributors with the largest volume of publications.

Research hot topics were gene mutation, cataract surgery management, complications of intraocular lens implantation, prevalence and glaucoma. The five research hotspots were discussed in descending order of keyword counts in corresponding clusters. In the context of gene mutation, as detected in a majority of cases, genetic factors were associated with the visual and systematic manifestations and prognosis of childhood cataract [10–13]. Clarifying the relationship between disease phenotype and genotype, as well as the underlying molecular mechanism, is of great significance for the diagnosis and treatment of congenital/developmental cataracts. Secondly, the research hotspot on childhood cataract management especially focused on patients with comorbidity. The timing of surgery and the choice of intraocular lens implantation must be taken into consideration when childhood cataracts coincide with other conditions, such as childhood uveitis and diabetes [14–16]. Thirdly, the complications of intraocular lens implantation mainly focus on the incidence and management of visual axis opacification and amblyopia [17,18]. Fourthly, the prevalence of childhood cataracts, the incidence and extent of consequential childhood blindness and visual impairment were crucial information for making the decision in medical policy. Childhood cataracts could cause lifelong visual loss and affect the quality of life of patients and their families, resulting in great social economic costs [19]. Last but not least, glaucoma was determined as a research hotspot in this study. Glaucoma after childhood cataract surgery is difficult to manage and often needs anti-glaucoma surgical treatment, requiring evaluation of surgical outcomes and complications [20]. Moreover, the use of glucocorticoids in children can lead to both intraocular pressure increases and lens opacity, causing the existence of both glaucoma and cataract [21,22].

The research on pediatric cataract surgery, new mutations, artificial intelligence, and research on multisystemic disorders represented by cerebrotendinous xanthomatosis were the research frontiers. Pediatric cataract surgery differs significantly from adult surgery in terms of visual development and complication rates, thus it points to a different set of questions, such as the effort in the planning of intraocular lens implantation and lens regeneration through improved surgical techniques [17,23,24], that deserves continuous attention. The second frontier was the research on new mutation. Ma et al. [25] conducted research on the next generation sequencing application of cataract genes in congenital cataract, which accounts for around 80% of childhood cataract [26]. This research gained sustained attention in recent years as its citations continued to increase. The identification of causative genes and variants using next generation sequencing clarified part of the genetic basis of childhood cataract, and more genes and potential mechanisms remained to be identified [27]. The third research frontier was artificial intelligence in childhood cataract. Artificial intelligence could assist specialists in childhood cataract diagnosis [28]. Besides that, artificial intelligence could also be used for the diagnosis of multiple-system disorders using childhood cataracts as a facial marker [29]. According to our research, cerebrotendinous xanthomatosis was a frontier topic. Cerebrotendinous xanthomatosis was a treatable hereditary multisystemic syndrome, including manifestations of childhood cataracts, characterized by high chances of delayed and missed diagnosis [30,31]. Further elucidation of the genotype-phenotype relationship in childhood cataract patients may benefit from the technological advancements including next generation sequencing and artificial intelligence, so as to improve the diagnostic rate of multisystemic syndrome, such as cerebrotendinous xanthomatosis [32].

Based on the results of this research, it has been observed that congenital and developmental cataracts have been the primary focus of studies on childhood cataracts, in contrast to acquired cataracts brought on in childhood. Possible explanations include the high risk of postoperative complications such as glaucoma and poor prognoses in children with congenital cataracts; the longer duration of blindness due to cataracts diagnosed at a young age; and the significant socioeconomic burden associated with all of the above. All of these warrant further investigation [33]. Moreover, congenital cataracts and developmental cataracts have variable phenotypes and complex mechanisms, underlying genetic and developmental abnormalities. Understanding these mechanisms will help with disease diagnosis, treatment, and comprehension of the patterns of development in children's eye structure and visual function.

Table 1
Co-citation analysis of organization and time trends in childhood cataract research.

Mean formation year	Frontier labels	Top 3 cited references with the highest citation in each cluster		Top 3 citing articles with the highest coverage in each cluster	
		Citations (n)	Author (year), title	Coverage (%)	Author (year), title
2012	#1 Gene Expression (81)	42	Hejtmancik (2008), Congenital cataracts and their molecular genetics	14	Sousounis (2012), Patterns of gene expression in microarrays and expressed sequence tags from normal and cataractous lenses
		38	Shiels (2010), Cat-Map: putting cataract on the map	11	Clark (2012), sHSP in the eye lens: crystallin mutations, cataract and proteostasis
		21	Graw (2009), Genetics of crystallins: cataract and beyond	11	Deng (2014), Molecular genetics of congenital nuclear cataract
		21	Moreau (2012), Protein misfolding and aggregation in cataract disease and prospects for prevention		
2015	#2 Exome Sequencing (76)	41	Shiels (2013), Genetics of human cataract	23	Messina-Baas (2017), Inherited congenital cataract: a guide to suspect the genetic aetiology in the cataract genesis
		37	Gillespie (2014), Personalized diagnosis and management of congenital cataract by next-generation sequencing	11	Gillespie (2014), Personalized diagnosis and management of congenital cataract by next-generation sequencing
		24	Beyer (2013), Connexin mutants and cataracts	10	Patel (2017), Novel phenotypes and loci identified through clinical genomics approaches to pediatric cataract
				10	Gillespie (2014), The use of autozygosity mapping and next-generation sequencing in understanding anterior segment defects caused by an abnormal development of the lens
				10	Zhu (2017), New cataract markers: mechanisms of disease
2015	#3 Traumatic Cataract (32)	36	Medsinge (2015), Pediatric cataract: challenges and future directions	7	Gilbert (2016), Gender inequalities in surgery for bilateral cataract among children in low-income countries a systematic review
		17	Pascolini (2012), Global estimates of visual impairment: 2010	5	Zhang (2016), Visual outcome and related factors in bilateral total congenital cataract patients: a prospective cohort study
		14	Khokhar (2017), Pediatric cataract	5	Jiang (2017), Automatic diagnosis of imbalanced ophthalmic images using a cost-sensitive deep convolutional neural network
2017	#4 Pediatric Cataract Surgery (104)	61	Lambert (2014), Comparison of contact lens and intraocular lens correction of monocular aphakia during infancy	34	Li (2020), Molecular genetics of congenital cataracts
		52	Freedman (2015), Glaucoma-related adverse events in the first 5 years after unilateral cataract removal in the infant aphakia treatment study	15	Chougule (2020), Intraocular lens implantation in infants and toddlers in 2020
		44	Wu (2016), Prevalence and epidemiological characteristics of congenital cataract: a systematic review and meta-analysis	11	Lim (2017), update on congenital cataract surgery management
				11	Lambert (2019), intraocular lens implantation during early childhood a report by the american academy of ophthalmology
				11	Self (2020), cataract management in children: a review of the literature and current practice across 3 large uk centres
				11	Lagreze (2020), treatment of congenital and early childhood cataract

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Table 1 (*continued*)

Mean formation year	Frontier labels	Top 3 cited references with the highest citation in each cluster		Top 3 citing articles with the highest coverage in each cluster	
		Citations (n)	Author (year), title	Coverage (%)	Author (year), title
Mean formation year	Frontier labels	Top 3 cited references with the highest citation in each cluster		Top 3 citing articles with the highest coverage in each cluster	
		Citations (n)	Author (year), title	Coverage (%)	Author (year), title
2017	#5 Genotype-Phenotype Correlation (17)	43	Richards (2015), Standards and guidelines for the interpretation of sequence variants: a joint consensus recommendation of the American College of Medical Genetics and Genomics and the Association for Molecular Pathology	8	Anand (2018), Mutation update of transcription factor genes foxe3, hsf4, maf, and pitx3 causing cataracts and other developmental ocular defects
		8	Greenlees (2015), Mutations in SIPA1L3 cause eye defects through disruption of cell polarity and cytoskeleton organization	8	Plaisancie (2018) Foxe3 mutations: genotype-phenotype correlations
		8	Deml (2016), Novel mutations in PAX6, OTX2 and NDP in anophthalmia, microphthalmia and coloboma	7	Krall (2018), A zebrafish model of foxe3 deficiency demonstrates lens and eye defects with dysregulation of key genes involved in cataract formation in humans
2019	#6 Novel Mutation (73)	71	Sheeladevi (2016), Global prevalence of childhood cataract: a systematic review	31	Li (2020), Molecular genetics of congenital cataracts
		55	Ma (2016), Sporadic and familial congenital cataracts: mutational spectrum and new diagnoses using next-generation sequencing	14	Reis (2019), Genetic landscape of isolated pediatric cataracts: extreme heterogeneity and variable inheritance patterns within genes
		46	Shiels (2017), Mutations and mechanisms in congenital and age-related cataracts	14	Anand (2018), Mutation update of transcription factor genes foxe3, hsf4, maf, and pitx3 causing cataracts and other developmental ocular defects
Mean formation year	Frontier labels	Top 3 cited references with the highest citation in each cluster		Top 3 citing articles with the highest coverage in each cluster	
		Citations (n)	Author (year), title	Coverage (%)	Author (year), title
2019	#7 Artificial Intelligence (16)	15	Bourne (2017), Magnitude, temporal trends, and projections of the global prevalence of blindness and distance and near vision impairment: a systematic review and meta-analysis	5	Ting (2021), Artificial intelligence for anterior segment diseases: emerging applications in ophthalmology
		14	Flaxman (2017), Global causes of blindness and distance vision impairment 1990–2020: a systematic review and meta-analysis	4	Jiang (2021), Automatic classification of heterogeneous slit-illumination images using an ensemble of cost-sensitive convolutional neural networks
		13	Bourne (2013), Causes of vision loss worldwide, 1990–2010: a systematic analysis	4	Slamang (2021), Pediatric non-infectious uveitis in cape town, south africa: a retrospective review of disease characteristics and outcomes on immunomodulating treatment
				4	Jiang (2021), Improving the generalizability of infantile cataracts detection via deep learning-based lens partition strategy and multicenter datasets
				4	Morelle (2019), Chronic and recurrent non-infectious pediatric-onset uveitis: a french cohort
Mean formation year	Frontier labels	Top 3 cited references with the highest citation in each cluster		Top 3 citing articles with the highest coverage in each cluster	
		Citations (n)	Author (year), title	Coverage (%)	Author (year), title
2019	#8 Cerebrotendinous Xanthomatosis (13)	8	Degos (2016), Natural history of cerebrotendinous xanthomatosis: a pediatric disease diagnosed in adulthood	7	Koyama (2021), Cerebrotendinous xanthomatosis: molecular pathogenesis, clinical spectrum, diagnosis, and disease-modifying treatments
		8	Appadurai (2015), Apparent underdiagnosis of Cerebrotendinous Xanthomatosis revealed by analysis of ~60,000 human exomes	6	Atilla (2021), Prevalence of cerebrotendinous xanthomatosis in cases with idiopathic bilateral juvenile cataract in ophthalmology clinics in turkey

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Table 1 (*continued*)

Mean formation year	Frontier labels	Top 3 cited references with the highest citation in each cluster		Top 3 citing articles with the highest coverage in each cluster	
		Citations (n)	Author (year), title	Coverage (%)	Author (year), title
		7	Salen (2017), Epidemiology, diagnosis, and treatment of cerebrotendinous xanthomatosis (CTX)	6	Kisa (2021), Patients with cerebrotendinous xanthomatosis diagnosed with diverse multisystem involvement
				6	Amador (2018), Treatment with chenodeoxycholic acid in cerebrotendinous xanthomatosis: clinical, neurophysiological, and quantitative brain structural outcomes
				6	Debarber (2021), Update on cerebrotendinous xanthomatosis

Abbreviation: Mean year: Average cluster formation year; Coverage: Percentage of cited references of the citing article that belong to the corresponding cluster in the total cited references of the article.

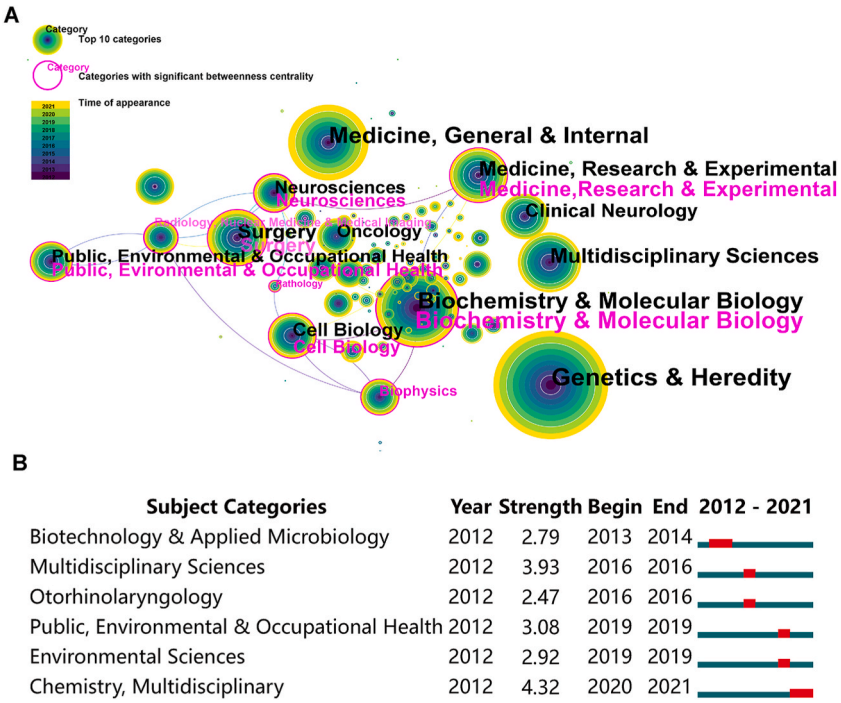

Fig. 6. Key subject categories in childhood cataract research. A. The subject category distribution map. Eleven main collaborative subject categories (occurrence >61) and 9 bridge subject categories (betweenness centrality >0.1) are shown. Bridge subject categories are represented by nodes with purple outside rings. B. Research subject category trend. The period of the citation burst is shown by a red line segment, and a burst signifies a rapid rise in frequency. High strength indicates that the burst is at a high degree. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

The multidisciplinary collaboration contributed to the insightful discovery of molecular mechanisms for childhood cataracts. Pediatric cataract after cancer radiotherapy (35.6% of children with cancer in the high lens radiation dosage group had cataracts five years following radiotherapy) and cerebrotendinous xanthomatosis are two examples of childhood cataract research topics where biochemistry and molecular biology, neurosciences, and radiology have shown significant bridging effects [34]. Interdisciplinary chemistry was the subject category with burst time continuing into 2021, suggesting an increase in scholarly interest in multidisciplinary applications to the molecular mechanisms in childhood cataract research and a boost in disciplinary collaboration.

There are limitations to this study. Firstly, despite detailed search strategies being developed, only the Web of Science Core Collection was used due to the restriction of the CiteSpace and VOSviewer. However, the Web of Science Core Collection, as the authoritative database, already contains comprehensive research information. In addition, CiteSpace and VOSviewer were only able to analyze English content, which induced language bias. In our study, we considered the quantity of publications while the quality of publications was not taken into account. Further improvements to this type of study are necessary to address the assessment of quality.

In conclusion, the research hotspots and frontiers in childhood cataracts focused on revealing the genetic background and pheno-

spectrum of the diseases, innovating and/or optimizing surgical techniques, and preventing and treating postoperative complications. The implementation of artificial intelligence has contributed to advancements in the diagnosis and treatment of childhood cataracts. The progress in the molecular mechanisms of childhood cataracts takes advantage of multidisciplinary cooperation.

Author contribution statement

Yuan Tan, Hui Chen and Shaoyi Gong: Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Yingshi Zou, Yanyu Shen and Lixia Luo: Analyzed and interpreted the data; Wrote the paper.

Guangming Jin and Zhenzhen Liu: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

Additional information

Supplementary content related to this article has been published online at [URL].

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Ethics statement

This study does not involve human participants.

Data availability statement

The data of this study can be obtained by contacting the corresponding author.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2023.e17590.

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