• Bibliometric Research •

Bibliometric analysis of hotspots and trends of global myopia research

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Abstract

● **AIM:** To gain insights into the global research hotspots and trends of myopia.

● **METHODS:** Articles were downloaded from January 1, 2013 to December 31, 2022 from the Science Core Database website and were mainly statistically analyzed by bibliometrics software.

● **RESULTS:** A total of 444 institutions in 87 countries published 4124 articles. Between 2013 and 2022, China had the highest number of publications (*n*=1865) and the highest H-index (61). Sun Yat-sen University had the highest number of publications (*n*=229) and the highest H-index (33). Ophthalmology is the main category in related journals. Citations from 2020 to 2022 highlight keywords of options and reference, child health (pediatrics), myopic traction mechanism, public health, and machine learning, which represent research frontiers.

● **CONCLUSION:** Myopia has become a hot research field. China and Chinese institutions have the strongest academic influence in the field from 2013 to 2022. The main driver of myopic research is still medical or ophthalmologists. This study highlights the importance of public health in addressing the global rise in myopia, especially its impact on children's health. At present, a unified theoretical system is still needed. Accurate surgical and therapeutic solutions must be proposed for people with different characteristics to manage and intervene refractive errors. In addition, the benefits of artificial intelligence (AI) models are also reflected in disease monitoring and prediction.

● **KEYWORDS:** bibliometric analysis; myopia; global trends

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INTRODUCTION

Myopia is one of the most common refractive diseases, which mostly affects children and young adults, has become a public health issue[1]. Clear vision is obtained because the eye can accurately focus the image in space on the retina. The image of myopia is focused in front of the retina. Myopia is considered as a benign disease due to its correctable property[2]. It can be divided into simple myopia or pathological myopia[3]. The diopter of "simple myopia" or "school myopia" is 0 to -6 degrees, which is low to medium myopia. Myopia with diopter greater than -6 degrees, axial length greater than 26.5 mm, and different degrees of fundus changes, is called high myopia or pathological myopia[4]. Simple myopia lacks pathological changes[3]. Pathological myopia, also known as high myopia or degenerative myopia, is a kind of severe and progressive myopia that is defined by alterations in the fundus brought on by posterior staphyloma and insufficiently corrected vision[5]. However, pathological myopia cannot always result from high myopia.

The research points out that the classification and concept of myopia have not been unified yet, and there is heterogeneity in the intervention and treatment of myopia in children[6-7]. At the same time, the prevalence of myopia is increasing[8-12]. Myopia has a diverse and complicated etiology that is influenced by both hereditary and environmental factors[13]. According to the geographic distribution of the myopic people, East Asia and Southeast Asia are the regions with the highest incidence rates of myopia[14]. In addition, the same trend has been observed in other regions[15]. Myopia can have serious social, psychological, economic, and developmental repercussions if it is not treated[16]. As a result, myopia researchers at this time should focus on the objective frontier and trend of myopia-related research.

At present, there is no article on bibliometric analysis of myopia related research from 2013 to 2022. This study aims to deeply understand the progress and hot issues of myopia related research through the following aspects, so as to better guide the next step of research. We used bibliometric methods to analyze papers on myopia in Web of Science. The data includes countries, regions, institutions, journals, research categories, keywords. At the same time, we combine bibliometric software and manual reading to establish an intuitive and relatively unbiased method to explore the research field. In addition, we discussed the limitations of current research progress, which can guide future research to a certain extent.

MATERIALS AND METHODS

Selection On March 12, 2023, all citation data published between January 1, 2013, and December 31, 2022, was retrieved from the Web of Science Core Collection (WoSCC). It was independently verified by two authors (Wu XY and Yang WH). The search formula was Title= myopi*. Selecting English literature and articles and excluding book chapter and proceedings paper. From each publication, we gathered the following basic data: title, publication year, country or region, institution, journal, references, and keywords. The detailed search and analysis processes are depicted in Figure 1.

Statistical Analysis Utilizing https://bibliometric.com/app and CiteSpace.6.1.3, collaborative networks of nations, organizations, journals, keywords, references, and research fields were examined. The article describes all citation features. The Web of Science analyzer was used to derive the H-index, which is a measure of the importance and overall effect of the research contributions.

RESULTS

Distribution of Articles by Publication Years This study analyzed 4124 papers, which were published between 2013 and 2022 in the research area of myopia. Using the Web of Science analyzer and the duplicate removal function of CiteSpace, we can get the annual number of literature publication. The annual number of literature publications can be obtained using CiteSpace's duplication elimination feature and the Web of Science analyzer. The number of published studies can be seen in the Figure 2. From 2013 to 2018, the number of articles published each year showed a trend of overall steady growth. On average, about 17 more articles are published each year than the previous year. Since 2019, the number of studies on myopia has skyrocketed. In general, more than 100 articles have been added in each year.

Countries or Regions As demonstrated in Figure 3, bibliometric analysis can be used to describe the volume of publications and international collaboration. The amount of documents released by various nations is represented by

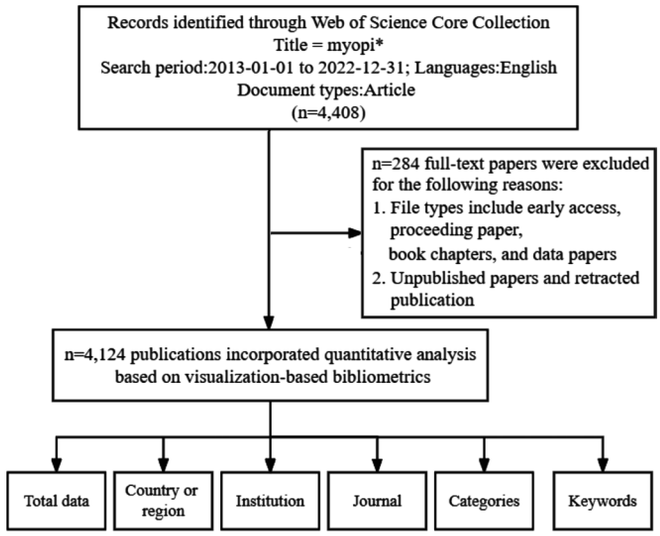

Figure 1 A frame flow diagram The diagram shows the detailed selection criteria and bibliometric analysis steps of myopia researches.

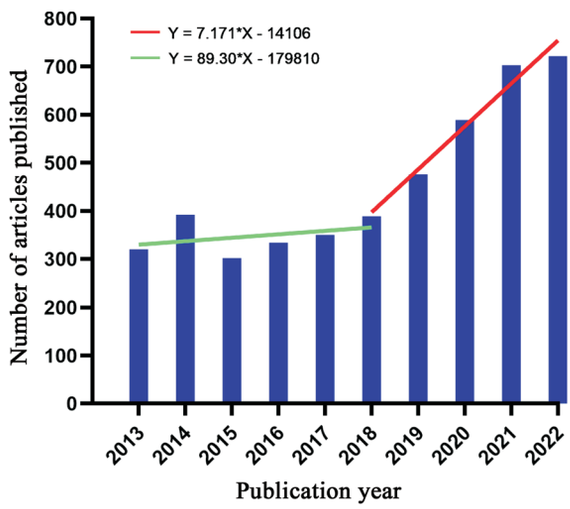

Figure 2 Trends in the number of publications on myopia.

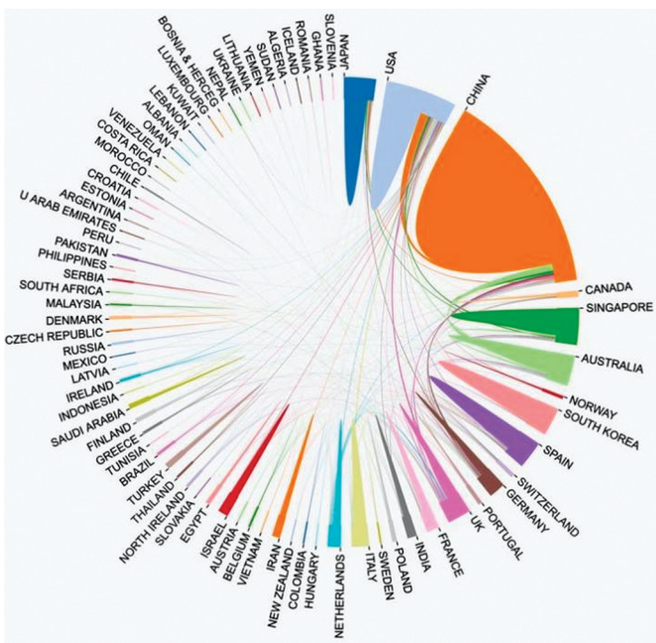

Figure 3 The cooperation of countries or regions that contributed to publications on myopia from 2013 to 2022.

various color blocks, and the connections between these color blocks show international collaboration. Figure 3 demonstrates that China possesses the most documentation, while the USA has considerably greater international collaboration. Citespace software's inter-country collaboration analysis tool reveals that 4124 papers have been published in total by 87 different countries. And it has resulted in 671 instances of international cooperation. In Figure 4 and Table 1, the top ten countries or regions with the most documents are listed. The size of green nodes indicates the quantity of documents that various nations have published. China possesses the most documents of all of them. The strength of intergovernmental collaboration is symbolized by the purple circle, which stands for centrality. Table 1 includes a list of the precise values. According to the data, USA cooperation is at its best level. The Web of Science analyzer computes the H-index and the percentage of documents issued by each nation. The quality of academic accomplishments can be accurately reflected by the H-index. According to Table 1, China, which accounts for 45.7% of all documents, has the most of them. The second-most articles published were those from the USA, which accounted for 18.3% of all analytical citations. China has the greatest H-index, which shows that China-published articles have a greater impact than those from other countries. What's more, we also analyzed the trend of the number of papers published in the top five nations over the past ten years. It is discovered that China has published more publications since 2018 than any other nation, with over 60 (Figure 5).

Institutions Table 2 lists the top 10 institutions with the highest number of documents, there are 5 Chinese organizations. Among them, the top 5 organizations in the number of documents issued all belong to China. National University of Singapore and Singapore National Eye Center has the highest H-index. Citespace software depicts the number of documents issued by the organization and the cooperation relationship. The citations included in the analysis came from 444 research institutions, which formed 976 cooperation. The connecting line between each two labels shows that institutions in the same country cooperate closely. In addition, the area of each node in Figure 6 also shows the number of documents issued by the mechanism.

Journals and Research Category We can visualize the citation relationships between the journals' study topics using a dual map created with CiteSpace software. The knowledge base of the cited journal articles is made up of the documents in the citing journals. Research hotspots in recent years have been in the fields of highly citing journals. The left and right sides of Figure 7 show the research fields of the citing journals and the cited journals respectively. The pink and yellow paths show how frequently articles in the domains of mobile/biology/

Figure 4 The cooperation of countries or regions that contributed to publications on myopia from 2013 to 2022.

Table 1 The top 10 countries or regions with publications on myopia from 2013 to 2022

Rank	Countries or regions	Count	Centrality	% of 4057	H-index
1	China	1865	0.05	45.684	61
2	USA	756	0.31	18.332	59
3	Japan	330	0.04	8.002	44
4	Australia	310	0.12	7.517	54
5	South Korea	265	0.01	6.426	29
6	Germany	254	0.18	6.159	38
7	England	209	0.08	5.068	39
8	Singapore	202	0.05	4.898	42
9	Spain	192	0.04	4.656	26
10	Italy	171	0.03	4.146	28

Table 2 The top 10 institutions with publications on myopia from 2013 to 2022

Rank	Institutions	Country	Count	H-index
1	Sun Yat-Sun University	China	229	33
2	Fudan University	China	222	25
3	Wenzhou Medical University	China	186	29
4	Capital Medical University	China	142	28
5	Shang Hai Jiao Tong University	China	118	20
6	National University of Singapore	Singapore	114	42
7	Tokyo Medical Dental University Tmdu	Japan	107	31
8	Singapore National Eye Center	Singapore	100	40
9	Heidelberg University	Germany	91	31
10	University of Melbourne	Australia	83	24

astronomy and hydrology/ports/optics are cited in the research of mobile/biology/genetics. The blue road illustrates the inclusion of economic, political, psychological, educational, and social fields in myopia research. The ten citing journals with the most publications are listed in Table 3, and the ten cited journals with the most publications are listed in Table 4. Both of them can make statistics that the current research related to myopia is mainly in medicine/opthalmology.

Keywords For keyword research on authors, we make use of CiteSpace software. The minimum duration was set at 1 in order to obtain more sensitive significant keywords that fluctuate over time. In Figure 8, the red square denotes a

Table 3 The top 10 citing journals of publications on myopia from 2013 to 2022

Rank	Citing journals	Research fields	Count
1	*Investigative Ophthalmology & Visual Science*	Medicine/Ophthalmology	263
2	*Journal of Cataract and Refractive Surgery*	Medicine/Ophthalmology	154
3	*BMC Ophthalmology*	Medicine/Ophthalmology	144
4	*Retina-the Journal of Retinal and Vitreous Diseases*	Medicine/Ophthalmology	142
5	*Journal of Refractive Surgery*	Medicine/Ophthalmology	129
6	*British Journal of Ophthalmology*	Medicine/Ophthalmology	124
7	*PLoS One*	Biological/Comprehensive	124
8	*Graefes Archive for Clinical and Experimental Ophthalmology*	Medicine/Ophthalmology	118
9	*International Journal of Ophthalmology*	Medicine/Ophthalmology	113
10	*Journal of Ophthalmology*	Medicine/Ophthalmology	109

Table 4 The top 10 cited journals of publications on myopia from 2013 to 2022

Rank	Cited journals	Research fields	Count
1	*Ophthalmology*	Medicine/Ophthalmology	3039
2	*Investigative Ophthalmology & Visual Science*	Medicine/Ophthalmology	2791
3	*American Journal of Ophthalmology*	Medicine/Ophthalmology	2489
4	*British Journal of Ophthalmology*	Medicine/Ophthalmology	2229
5	*Archives of Ophthalmology*	Medicine/Ophthalmology	1695
6	*Optometry and Vision Science*	Medicine /Ophthalmology	1509
7	*Graefes Archive for Clinical and Experimental Ophthalmology*	Medicine/Ophthalmology	1322
8	*Eye*	Medicine/Ophthalmology	1307
9	*Ophthalmic and Physiological Optics*	Medicine/Ophthalmology	1301
10	*PLoS One*	Biological/Comprehensive	1265

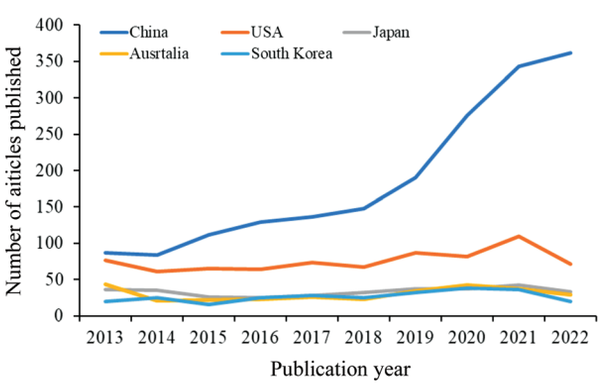

Figure 5 National trends in the number of myopia publications.

Figure 6 The cooperation of institutions that contributed to publications on myopia from 2013 to 2022.

sudden rise in the quantity of keywords on the left during this time. Optics and refraction, child health (pediatrics), myopic traction maculopathy, public health, and machine learning are the surprising keywords from the past two years. These terms describe the hotspots for research through 2022. We further use the recent prominent keywords to search the articles published in 2020 and 2022, and listed the top10 highest citations articles for each keyword in Tables 5-9[17-36] respectively.

DISCUSSION

Principal Results The aforementioned findings show an increase in myopia-related studies, notably since 2019. This demonstrates that myopia has become a hotly debated issue in recent years. At the same time, this may possibly be connected to the development of myopia brought on by people's confinement to their homes since the COVID-19 outbreak[37]. China has the most articles and the most influence, according to our statistical analysis of the quantity and caliber of articles produced by each nation. It demonstrates that China is the primary force in this industry. This may be related to the introduction of a national policy in 2018, which has attracted great attention from the society[38]. Chinese institutions make up the largest percentage of the top 10 institutions in terms of the number of publications they produce. However, all of the institutions with the highest H-index are from Singapore. This demonstrates the necessity for Chinese institutions to pay closer attention to the caliber of publications that are published. The most popular field in terms of the journal's subject matter

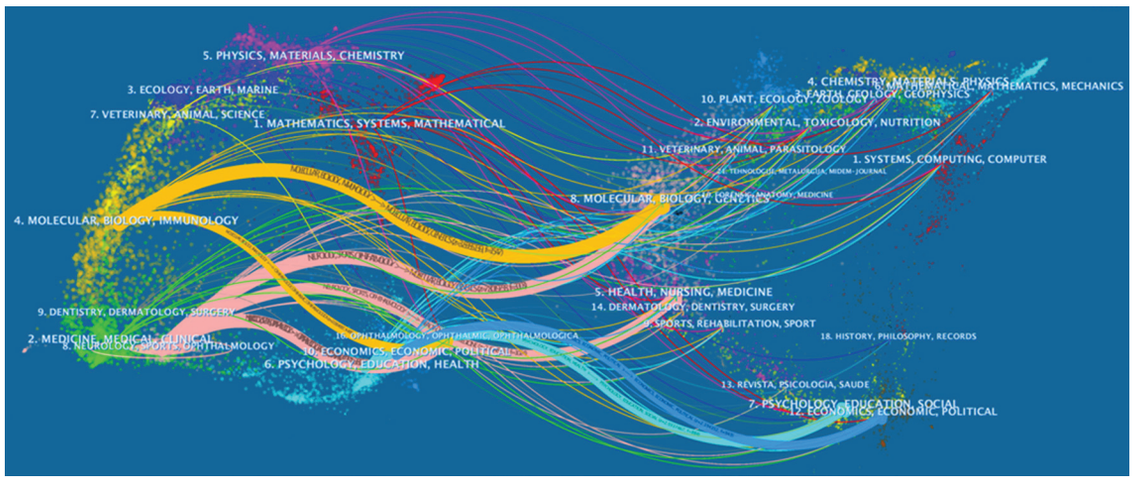

Figure 7 The dual map overlay of journals contributed to publications on myopia from 2013 to 2022.

Table 5 The top 5 publications include the keyword—optics and refraction in myopia research from 2013 to 2022

Rank	Title	Citations	Interpretation of the findings	Research limitations
1	Objectively measured near work, outdoor exposure and myopia in children[17]	42	There was a correlation between near work intensity, light intensity and myopia.	The daily visual behavior of the subjects is difficult to control; The sample size is small.
2	Protective behaviours of near work and time outdoors in myopia prevalence and progression in myopic children: a 2-year prospective population study[18]	34	Among myopic children around 10y, it is generally emphasized to keep an appropriate distance when working in close proximity, which may help to prevent myopia.	This study did not take children's outdoor exercise time as a covariate. Some flaws exist in the study's statistical sample.
3	One-year myopia control efficacy of spectacle lenses with aspherical lenslets[19]	25	To control myopia in early childhood and lower the risk of myopia in late childhood, highly aspherical lenslets may be a beneficial solution.	The subjects included in this study only include Chinese children.
4	Areal summed corneal power shift is an important determinant for axial length elongation in myopic children treated with overnight orthokeratology[20]	20	The areal summed corneal power shift, measured early after keratoplastic surgery, predicts the influence of the lens on axial length extension in myopia.	The subjects included in this study only include Chinese children.
5	Low-dose (0.01%) atropine eye-drops to reduce progression of myopia in children: a multicentre placebo-controlled randomised trial in the UK (CHAMP-UK)-study protocol[21]	18	This 20-year study's objective is to assess the effectiveness, safety, and mechanism of low-dose atropine eye drops in slowing the progression of myopia in UK children.	Not raised

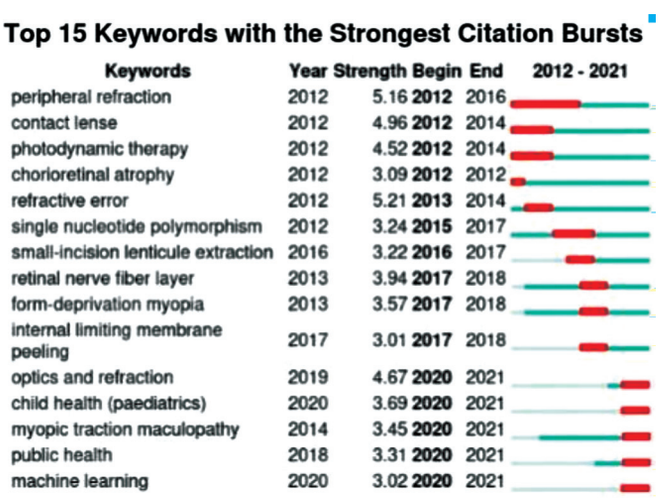

Figure 8 Keywords with the strongest citation bursts for publications on myopia from 2013 to 2022.

is medicine/ophthalmology. This demonstrates that the primary driving force behind myopia-related research is still medicine or ophthalmologists. In addition, the examination of journals reveals that a significant portion of the citations we used in the analysis also includes research in the fields of sociology and pedagogy. It shows that a specific number of people have been impacted by the condition. Summarizing the top 10 articles with prominent keywords from 2020 to 2022, we found that the research on epidemiology, diagnosis, medication and prognosis of myopia constituted the frontier of recent research. Recent studies from the cluster analysis of widely read and frequently referenced literatures that will last through 2023 are interested in the concept, prevention and control, classification, and classification of myopia.

China occupies a central position in the field of myopia research. At present, the most research is still in the field of medical ophthalmology. Recent hot topics have been discussed extensively, covering the promotion of research from theory to clinical status and application as well as social phenomena.

Research Hotspots The ten articles with the greatest citations on the network from 2019 to 2022 can carefully evaluate the hot themes by searching for hot keywords in the citations and further summarizing each phrase in the WoSCC database.

Optics and Reflection As noted in Table 5, the angle of refraction is the principal method used to study myopia. The anatomical features of the eyes have undergone significant changes during human growth, which will have an impact on the optical system[39]. Peripheral refraction is of great significance in the field of vision research[40]. The eccentricity between the relative peripheral refraction error of 20 and 35

Table 6 The top 5 publications include the keyword—child health (pediatrics) and refraction in myopia research from 2013 to 2022

Rank	Title	Citations	Interpretation of the findings	Research limitations
1	The impact of computer use on myopia development in childhood: The Generation R study[22]	46	The increase in computer use is related to the development of myopia.	The use of hand-held digital devices is not taken into account.
2	Myopia prevalence and risk factors in children[23]	45	The prevalence and risk factors for myopia in contemporary American children and found that Asian-American children had the highest rate of myopia and that exercise reduced the risk of myopia.	The follow-up time was different between the two groups.
3	Myopia incidence and lifestyle changes among school children during the COVID-19 pandemic: a population-based prospective study[24]	36	During the COVID-19 pandemic, the rate of myopia among school age children in Hong Kong is likely to increase.	The demographic characteristics of both groups are difficult to meet the ideal requirements.
4	Protective behaviours of near work and time outdoors in myopia prevalence and progression in myopic children: a 2-year prospective population study[18]	29	Among myopic children around 10y, it is generally emphasized to keep an appropriate distance when working in close proximity, which may help to prevent myopia.	This study did not take children's outdoor exercise time as a covariate; Some flaws exist in the study's statistical sample.
5	A cluster randomised controlled trial evaluating an incentive-based outdoor physical activity programme to increase outdoor time and prevent myopia in children[25]	31	A reward-based outdoor physical activity program was designed, in which targeted eye education and eye health habit cultivation were carried out on children, which could effectively reduce the myopia rate of experimental children.	Not mentioned

Table 7 The top 5 publications include the keyword—myopic traction maculopathy in myopia research from 2013 to 2022

Rank	Title	Citations	Interpretation of the findings	Research limitations
1	IMI pathologic myopia[26]	41	Comprehensively introduced and summarized the concept, pathology, genetics, clinical manifestations, diagnosis, treatment, pathological characteristics, disease progress, classification and grading of pathological myopia and related diseases.	Not mentioned
2	Long-term outcome of foveolar internal limiting membrane nonpeeling for myopic traction maculopathy[27]	39	The operation to retain the concave cone without spalling has better anatomical and visual effects than the operation to completely spalling, and can prevent long-term concave retina thinning and successfully avoid the formation of macular holes.	Not mentioned
3	Vitrectomy with or without internal limiting membrane peeling for each stage of myopic traction maculopathy[28]	30	The vitrectomy with internal boundary membrane detachment can improve vision in patients with macular retinal splits or foveal detachment with visual impairment.	The retrospective design of this study did not include randomization; The number of patients in each group was small and unequal.
4	Morphological and clinical characteristics of myopic posterior staphyloma in Caucasians[29]	21	The morphological features of myopic posterior scleral staphyloma in Caucasians, and relationship between posterior scleral staphyloma, myopic macular degeneration, and visual acuity. A significant association was demonstrated between the type of posterior scleral staphyloma and MRI modal images of eye shape, OCT modal images of macular contour, and the location of choroidal retinal atrophy.	More research is needed to support the conclusions of this study, as well as additional information on the natural evolution of posterior scleral staphyloma and its associated complications.
5	Lamellar macular hole in high myopic eyes with posterior staphyloma: morphological and functional characteristics[30]	17	Compared with the conventional LMH associated with ERM, the atypical ERM-associated LMH is a more complex and severe symptom with unstable conditions.	The experimental sample size is small.

OCT: Optical coherence tomography; LMH: Lamellar macular hole; ERM: Epiretinal retinal membrane.

Table 8 The top 10 publications include the keyword—public health in myopia related research from 2013 to 2022

Rank	Title	Citations	Interpretation of the findings	Research limitations
1	Myopia among school students in rural China (Yunnan)[31]	51	The myopia, rather than high myopia, is prevalent among schoolchildren in rural China. No significant racial differences in myopia prevalence were observed. The cohort effect in myopia previously observed in cities is gradually appearing in rural communities in China.	Parents reported important lifestyle predictors such as time spent reading and time spent outdoors, which could lead to information bias; Due to the cross-sectional design of the study, causal relationships could not be established when analysing risk factors; Cycloplegia is less effective in people with darker irises (such as Chinese), and there may be errors in the statistical results of the incidence of myopia in this population.
2	The impact of computer use on myopia development in childhood: the Generation R study[22]	40	The increase in computer use is related to the development of myopia.	The use of hand-held digital devices is not taken into account.
3	Myopia prevalence and risk factors in children[23]	45	The prevalence and risk factors for myopia in contemporary American children and found that Asian-American children had the highest rate of myopia and that exercise reduced the risk of myopia.	The cross-sectional design of the study does not allow for the establishment of causality; Assessment of daily exercise relied on reports from patients or their parents, and the association between hours of exercise or type of exercise and lower rates of myopia remains to be explored.
4	Protective behaviours of near work and time outdoors in myopia prevalence and progression in myopic children: a 2-year prospective population study[18]	34	Among myopic children around 10y, it is generally emphasized to keep an appropriate distance when working in close proximity, which may help to prevent myopia.	This study did not take children's outdoor exercise time as a covariate. Some flaws exist in the study's statistical sample.
5	A cluster randomised controlled trial evaluating an incentive-based outdoor physical activity programme to increase outdoor time and prevent myopia in children[25]	31	In this study, a reward-based outdoor physical activity program was designed, in which targeted eye education and eye health habit cultivation were carried out on children, which could effectively reduce the myopia rate of experimental children.	Not mentioned

Table 9 The top 10 publications include the keyword—machine learning in myopia related research from 2013 to 2022

Rank	Title	Citations	Interpretation of the findings	Research limitations
1	Evaluating the effect of topical atropine use for myopia control on intraocular pressure by using machine learning[32]	12	This study shows that it is promising to use machine learning methods to evaluate the factors that affect intraocular pressure of myopic children treated with local atropine.	Dose and duration of treatment were not included in the analysis.
2	Prediction of myopia in adolescents through machine learning methods[33]	12	Based on machine learning method, this paper proposes a prediction model of adolescent myopia using measurement and behavior data of primary school students.	Not mentioned
3	A machine learning-based algorithm used to estimate the physiological elongation of ocular axial length in myopic children[34]	12	This research constructs a machine learning model. It is found that the physiological elongation of axial length decreases linearly with age.	The sample size is not large; The data of the refractive state of the crowd are not included in the work; Multiple genetic and environmental factors.
4	Accuracy improvement of IOL power prediction for highly myopic eyes with an XGBoost machine learning-based calculator[35]	6	The study developed a machine learning calculator that can improve the accuracy of prediction of intraocular lens degree in high myopia.	Not mentioned
5	Machine learning to determine risk factors for myopia progression in primary school children: the Anyang Childhood Eye Study[36]	6	This study used machine learning model to study the risk factors of vulnerable progress in primary school students and predict the risk factors of myopia development in children. It was pointed out that uncorrected distance visual acuity and spherical equivalent were good predictors of myopia development in children.	Participants' recall bias affects the questionnaire data; The wider applicability of the prediction model needs to be considered; It is difficult to predict the risk factors of disease deterioration in the future.

degrees may be closely related to the refractive development and eye growth of Chinese young people[41]. According to Koomson *et al*'s research, adolescents whose parents are myopic positive have longer myopic eyes and more peripheral hyperopia defocus than adolescents whose parents are myopic negative[42]. For intervention and treatment, the changes in relative peripheral refraction can offer unbiased data support. Children's relative peripheral refraction showed relative myopia defocusing after wearing corrective glasses, and 0.01% atropine eye drops may be involved in myopia control[43-44]. At the same time, the development of these ophthalmology research cannot be separated from accurate and efficient detection methods. Hervella *et al*[45] measured 76 eyes of 38 volunteers, and used the adaptive optical visual simulator to assess whether the subjective diopter was consistent with the gold standard. Tabernero *et al*[46] described the clinical comparison between several types of traditional refraction methods and new adaptive optical refractors, comparing the objective and subjective refraction findings of visual adaptive optics with the subjective refraction results of commercial self-refractors and optometrists.

The aforementioned research study demonstrates that studies are being conducted on various ametropia treatment and intervention strategies in various age groups as well as studies on human refractive status from an epidemiological standpoint. The above research hotspots suggest that the current need to pay attention to the detection of peripheral defocus and the role in the occurrence and development of myopia, as well as the development and promotion of more accurate and more effective optometry innovative instruments.

Child Health (Pediatrics) and Public Health Tables 6 and 8 show that myopia is a global public health problem, focusing on interventions and cohort studies related to myopia. In addition, children's health problems have attracted more researchers' attention in recent years.

Holden *et al*[47] made a prediction that 50% of the world's population will suffer from myopia by 2050, and the proportion of people with high myopia will increase from 5.2% in 2000 to 10%. The 90% of Japanese teenagers around the age of 20 suffer from myopia[48]. In addition, studies have shown that there are great differences in the treatment modes of preventing and treating children's myopia[49]. To some extent, this has increased the burden of disease prevention. The prevalence and causes of eye diseases in school-age children in various regions of the world have been investigated and analyzed[50-52]. During the COVID-19 pandemic, Chinese government has adopted home online classes to solve students' academic problems. This has led to more than 200 million students being locked at home and having to complete the study provided by the Internet[53]. There is already a report pointed that an increasing trend of visual impairment has been observed among students, and the epidemic seems to be related to the rapid onset of visual impairment in young and boy populations[54]. Additionally, some researchers have discovered that the prevalence of myopia in some regions varies by gender[55]. There are also the corresponding study findings[56]. These outcomes could be brought on by some more challenging conditions.

Overall, the global increase in myopia is an important public health consideration. Affected by environmental factors, this phenomenon is gradually significant between children and adolescents. The research on children and the research from the public health point of view is the focus of the research on myopia.

Myopic Traction Maculopathy Table 7 shows that myopic traction maculopathy (MTM) is an important factor affecting vision, and the related research frontier is the mechanism, detection, and surgery of complications of high myopia.

A number of illnesses caused by tractional strain on the retina in high myopic eyes are referred to as MTM. Lamellar hole, epiretinal membrane, and numerous additional disorders pulling on the retina are among them[26]. The most distinctive feature and primary indication of pathological myopia is the appearance of posterior grape balls[57]. However, the definition of pathological myopia has been inconsistent. The optical coherence tomography (OCT) system has greatly improved the visualization of peripheral retinopathy, and is able to evaluate broad staphyloma and ocular curvature[58]. A recent report have stated that the disease progression of high myopia can be detected by optical coherence tomography angiography (OCTA)[59]. These can be used to evaluate the surgical effect. Kumar *et al*[60] used microscope integrated intra OCT guided center sparing internal limiting membrane peeling and gas tamping for pars plana vitrectomy in 9 patients with pathological myopia whose age is less than 18y and myopia degree is less than 6 diopters, which has proven to completely eliminate traction. In 2022, He *et al*[61] used preoperative and postoperative OCT images together with other ophthalmic measurement data to study the efficacy of posterior scleral enhancement therapy for MTM, which is safe and effective. In the same year, Zhu *et al*[62] proved that it is safe and effective to treat MTM at different stages of the posterior spiral contract.

The present research outcomes for treating myopic traction maculopathy are often favorable when theory, technology, and clinical practice are all taken into consideration. However, via the debate and review in this section, we discovered that ophthalmologists and researchers alike still need to explore the pathogenic mechanism, disease classification, and even concept elaboration of MTM.

Machine Learning Table 9 shows that the research in the field of machine learning related to myopia is to explore the progress of disease and the treatment and prediction of related complications.

As one of the key technologies of the fourth industrial revolution, artificial intelligence has been studied and applied in the medical field[63-65]. Machine learning is an important branch of artificial intelligence, which is defined as computers can learn themselves without explicit instructions[66]. Artificial intelligence can be used to predict the prognosis, risk, and prevalence of myopia. For example, the most frequent long-term complication of refractive surgery is myopic regression after surgery, but it is challenging to diagnose without long-term observation. An efficient method for locating myopia degeneration patients at high risk involves machine learning algorithms[67]. Through the use of a machine learning algorithm, Zhang *et al*[68] discovered that high serum vitamin A levels appear to be linked to an increase in the prevalence of high myopia. However, the author pointed that further research is still needed to determine the mechanism underlying this connection. Some researchers established machine learning models to predict the risk of disease by investigating the key factors that affect the occurrence and progress of the disease[36,69]. The effectiveness of the preventive measures still needs to be taken into account for long-term detection.

All in all, there is still a lot of study evidence needed to determine the function and impact of artificial intelligence in the field of myopia. Prior to using a reliable artificial intelligence model for myopia therapy on a broad scale, it is important to go over technical, clinical, and even outside environmental obstacles.

Open Challenges and Future Opportunities Summarizing the limitations of hot topic research can provide guidance and suggestions for future research. We further summarize the limitations of Tables 5 to 9. It can be found that the limitations of current research are as follows: 1) The concept and classification of diseases are lack of accurate and detailed elaboration; 2) The number of samples included in the study is small; 3) The demographic characteristics of the sample are not representative; 4) Inadequate testing level of testing data technology; 5) Environmental factors and the self-factors of the included subjects are difficult to control; 6) Limitations of retrospective design.

Therefore, a more rigorous classification scheme is needed for the crucial things mentioned above. To establish a solid knowledge foundation for next studies, the ideas of sub illnesses are developed one at a time. For instance, further research is needed to understand the mechanisms and causes of disorders connected to myopia, such as MTM[59]. It is necessary to suggest more prospective research and a bigger sample size, like a prospective cross-sectional study by Xu *et al*[70]. The samples that are included can be separated further. Moreover, it is widely acknowledged that the research directions concerning myopia are extensive, and the pathogenesis of myopia is complex and still lacks a definitive conclusion. In our subsequent research, the more prominent research directions in myopia could be subdivided into groups and analyzed in layers. This might offer better guidance for the fundamental research aspects of myopia.

Combining artificial intelligence technologies with multidimensional models of genetic, environmental, and socioeconomic factors will result in the best prediction accuracy in myopia identification.

This study has several limitations. First, our search period is from 2013 to 2022, and some studies may not have been included in the WoSCC database. In order to reduce the confusion of this limitation on the results, we discussed the newly published research in 2023 in the discussion section. Second, due to software limitations, we cannot include articles

in other databases in the same batch of data for analysis. These may subtly distort the findings. However, we can ensure the quality of citations in the database currently in use. Third, in order to understand the author's purpose more accurately, we did not include the vocabulary of "keyword plus" in our analysis of hot keywords. However, we further use the keyword retrieval function to browse articles for two people to prevent this occurrence. Therefore, in addition to software analysis, more accurate conclusions need further manual reading and summary. Finally, even if the three authors search and comment on publications at the same time, we cannot completely rule out the inherent bias of researchers.

In conclusion, myopia has become a hot research field, which has attracted attentions of many researchers. Developing in this field of study is beneficial to the issues with myopia-related worldwide public health. According to our analysis, China holds the leading position in this area. The main driver of myopic research is still medical or ophthalmologists. It is still necessary to develop a theoretical system that is more ideal. It is emphasized that the importance of public health in addressing the global rise in myopia, particularly the effects on children's health. Similar to the previous research finding, accurate surgical and therapeutic solutions for the management and intervention of ametropia for people with diverse characteristics must be propose[71]. Moreover, the benefits of artificial intelligence models are also demonstrated in the monitoring and forecasting of disease.

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