



Myopia Control: A Citation Network Study

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ABSTRACT

Background: According to the World Health Organization, myopia is already one of the major causes of vision impairment and blindness. It is predicted to affect almost a half of the world's population within the next years. A lot of researches around the world have been performed on myopia, there is no clear overview of these researchers. In this manuscript, we analyzed the main connections between the most cited researchers, to build a citation network to evaluate the impact of different authors, journals, and subjects in the field of myopia control.

Methods: A search using the keywords "myopia control" was made through Web of Science. Extracted data was analyzed using CitNetExplorer[®] software obtaining a visual evaluation of the most cited publications. A subnet analysis was made by adding the keywords "myopia control" AND ("orthokeratology" OR "corneal refractive therapy"), "myopia control" AND ("soft contact lens*" OR "multifocal contact lens*"), and "myopia control" AND "atropine". The most important publications of the network and subnetworks were analyzed using the "core" function.

Results: This study showed 228 references that generated 1087 citations across the network. 2013 was the most important year for myopia control, with most publications and citations. Optometry and Vision Science journal has published the most cited papers. Regarding the authors, Walline ranked the first of the most cited articles on myopia control.

Conclusion: This study analyzed the associations between the authors, journals and subjects in myopia control, highlighting the great importance of this area in the recent years. More than 50% of the papers in the network were published after 2013.

KEY WORDS

Myopia Control; Atropine; Atropine Sulphate; Contact Lens; Orthokeratology Citation Network; Historical Control Studies.

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INTRODUCTION

Recently there has been a significant worldwide increase in the number of people having myopia to the extent that it has become an epidemiological problem [1]. The prevalence of myopia increased from 10.4% in 1993 to 34.2% in 2016 [2]. The latest estimates show a rate close to 50% by 2050 [3]. Being able to reduce myopia progression has become a worldwide concern, especially for the parents of myopic children [4]. At the same time, there has been an evolution in methods to control this progression. Research on myopia has been

increased in the recent years [5], driven by the diversity of the methods used in myopia control. A citation network analysis gives more simple and visual information, providing a better understanding of the research conducted in a specific field. However, statistical analysis of the strength of the relationship between articles that are both cited by a third article can help researchers identify the intellectual basics of the discipline. The use of this citation analysis methodology will allow us to identify the most



relevant authors, publications and journals. As far as their citation is concerned, the most important years for their publications, and the different clusters of study within a specific field are elucidated [6].

The aim of this study was to identify the most relevant research and different areas of study on myopia control. Through this kind of analysis, the most cited studies can be quantified.

METHODS

This bibliometric research was defined to clustering publications, based on their citation relations, and analyze the results of the clustering at individual publications' level.

The website used in this first bibliometric step was WEB OF SCIENCE, a Web technology-based platform that includes the references of the main scientific publications of any discipline of knowledge since 1945 [7]. Using remote download techniques, papers published between 1970 and June of 2019 were selected by entering the main descriptor: " myopia control ", limiting the field for the article, keywords and abstract, linked with the OR tab. All original articles, brief articles, reviews, editorials, letters to the editor, etc., were considered and duplicated documents were eliminated.

The file downloaded from Web of Science was analyzed using the CitNetExplorer® software, a software used to visualize and analyze the most important publications in a specific field and showing their relationships [8].

A quantitative analysis was made to show the total number of citations in the network in a given period. The attribute of CitNetExplorer® studied was the "citation score". This is a very useful tool in the citation network analysis. It allows quantifying internal connections between the authors, magazines and subjects through the publications within the network [9].

The subnet analysis could be performed by entering more keywords or using the software's cluster function [10]. Therefore, clusters are created according to the most frequent subtopics studied in the field [11].

In this study, the subnet analysis was made to analyze the different treatments for controlling myopia development. The keywords used in this subnet analysis were "myopia control" AND ("orthokeratology" OR "corneal refractive therapy"), "myopia control" AND ("soft contact lens*" OR "multifocal contact lens*"), and "myopia control" AND "atropine".

The most important publications of the network were also analyzed using the function "core". This function gives the percentage of publications with four or more citations within the network [6].

Finally, the analysis was supported graphically with VOSviewer®, a software tool for constructing and visualizing bibliometric networks. This software analyzes graphically the most cited articles and the clustering results obtained from CitNetExplorer®. VOSviewer® facilitates the analysis of clustering solutions. The same software was used to visualize the core function graph [12].

RESULTS

During the study period, 228 documents were published, generating 1087 citations within the network. Table 1 shows the 20 most cited publications. The most cited paper was written by Walline et al. [13], published in 2009, with a citation score of 68. Figure 1 shows the network of 20 most cited articles about myopia control.

"Core Function" result is shown in Figure 2. One hundred and forty-eight publications had four or more citations, which represented 64.92%. In this figure, each circle corresponds to an important paper represented by the last name of the first author and year of publication. The size of the circles corresponds to the number of times the paper has been cited. Finally, the colors of the map show the different clusters of publications created automatically by the software.

Analyzing the 20 most cited publications about myopia control showed that 8 were about orthokeratology, 6 about multifocal contact lenses, 3 meta-analyses or treatment reviews, one on ophthalmic lenses, one about rigid gas permeable lenses, and one about atropine. According to the abovementioned most cited publications and the knowledge about the most currently used treatments for myopia control that are defined in a review [14] and a meta-analysis, the results of orthokeratology, contact lenses, and atropine were as follows:

In the first case "myopia control" AND ("orthokeratology" OR "corneal refractive therapy"), 100 publications were found since 2004, generating 482 citations across the network. The abovementioned paper of Walline et al [13] published in 2009 was the most cited one. In this paper, the authors confirmed all the previous work on controlling myopia by fitting orthokeratology lenses. This network is shown in Figure 3.



Table 1. Twenty Most Cited Papers From 1970 to 2019 in the Myopia Control Citation Network

Authors	Paper title	Journal	Year	Citation
Walline et al.	Corneal reshaping and myopia progression	Br J Ophthalmol. Sep; 93 (9): 1181-5	2009	68
Walline et al.	Multifocal contact lens myopia control	Optom Vis Sci. Nov; 90 (11): 1207-14	2013	52
Santodomingo-Rubido et al.	Myopia control with orthokeratology contact lenses in Spain: refractive and biometric changes	Invest Ophthalmol Vis Sci. Jul; 53 (8): 5060-5	2012	51
Swarbrick et al.	Myopia control during orthokeratology lens wear in children using a novel study design	Ophthalmology Tue; 122 (3): 620-30	2014	36
Edwards et al.	The Hong Kong progressive lens myopia control study: study design and main findings	Invest Ophthalmol Vis Sci. Sep; 43 (9): 2852-8	2002	35
Kang et al.	Peripheral refraction in myopic children wearing orthokeratology and gas-permeable lenses.	Optom Vis Sci. Apr; 88 (4): 476-82	2011	33
Chen et al.	Myopia control using toric orthokeratology (TO-SEE study)	Invest Ophthalmol Vis Sci. Oct; 54 (10): 6510-7	2013	33
Huang et al.	Efficacy Comparison of 16 Interventions for Myopia Control in Children: A Network Meta-analysis	Ophthalmology Apr; 123 (4): 697-708	2016	32
Charm et al.	High myopia-partial reduction ortho-k: a 2-year randomized study	Optom Vis Sci. Jun; 90 (6): 530-9 2011	2013	31
Walline et al.	Interventions to slow progression of myopia in children	Cochrane Database Syst Rev. Dec 7; (12):CD004916	2011	29
Aller et al.	Myopia Control with Bifocal Contact Lenses: A Randomized Clinical Trial	Optom Vis Sci. Apr; 93 (4): 344-52	2016	29
Walline et al.	A randomized trial of the effects of rigid contact lenses on myopia progression	Arch Ophthalmol. Dec; 122 (12): 1760.6	2004	28
Si et al.	Orthokeratology for myopia control: a meta-analysis	Optom Vis Sci. Tue; 92 (3): 252-7	2015	28
Leung et al.	Progression of myopia in Hong Kong Chinese schoolchildren is slowed by wearing progressive lenses	Optom Vis Sci. Jun; 76 (6): 346-54	1999	25
Chia et al.	Five-Year Clinical Trial on Atropine for the Treatment of Myopia 2: Myopia Control with Atropine 0.01%	Ophthalmology. Feb; 123 (2): 391-9	2016	22
Aller et al.	Bifocal soft contact lenses as a possible myopia control treatment: a case report involving identical twins	Clin Exp Optom. Jul; 91 (4): 394-9	2008	18
Pauné et al.	Myopia Control with a Novel Peripheral Gradient Soft Lens and Orthokeratology: A 2-Year Clinical Trial	Biomed Res Tnt. 2015: 507572	2015	17
Cheng et al.	Soft Contact Lenses with Positive Spherical Aberration for Myopia Control	Optom Vis Sci. Apr; 93 (4): 353-66	2016	16
Holden et al.	Myopia, an underrated global challenge to vision: where the current data takes us on myopia control	Eye (Lond). Feb; 28 (2): 142-6	2014	15
Tarrant et al.	Accommodation in emmetropic and myopic young adults wearing bifocal soft contact lenses	Ophthalmic Physiol Opt. Jan; 28 (1): 62-72	2008	13

The second search "myopia control" AND ("soft contact lens*" OR "multifocal contact lens*") produced 53 publications that generated 230 citations. In this case, the most cited also corresponded to Walline et al. [15], but on this occasion, it is their paper about myopia control with multifocal contact lenses published in 2013. This paper took the second place of 20 in the general "myopia control" network, and its authors concluded that the use of multifocal soft contact lenses reduced myopia progression by 50% and axial length by 29% over two years compared to a historical control group. However, the authors indicated the need for randomized clinical

trials to confirm the data. The graph of this network is shown in Figure 4. Finally, in the third search ("myopia control" AND "atropine"), 42 publications were found that generated 75 citations across the network. In this case, the most cited paper was from Chia et al. [16], published in Ophthalmology in 2016. This paper ranked 15th of the 20 most cited papers in the general "myopia control" network Table 1. Its authors concluded that 0.01% atropine was effective in controlling myopia with fewer side effects on vision than other higher doses of the abovementioned medicine. The graph of this network is shown in Figure 5.

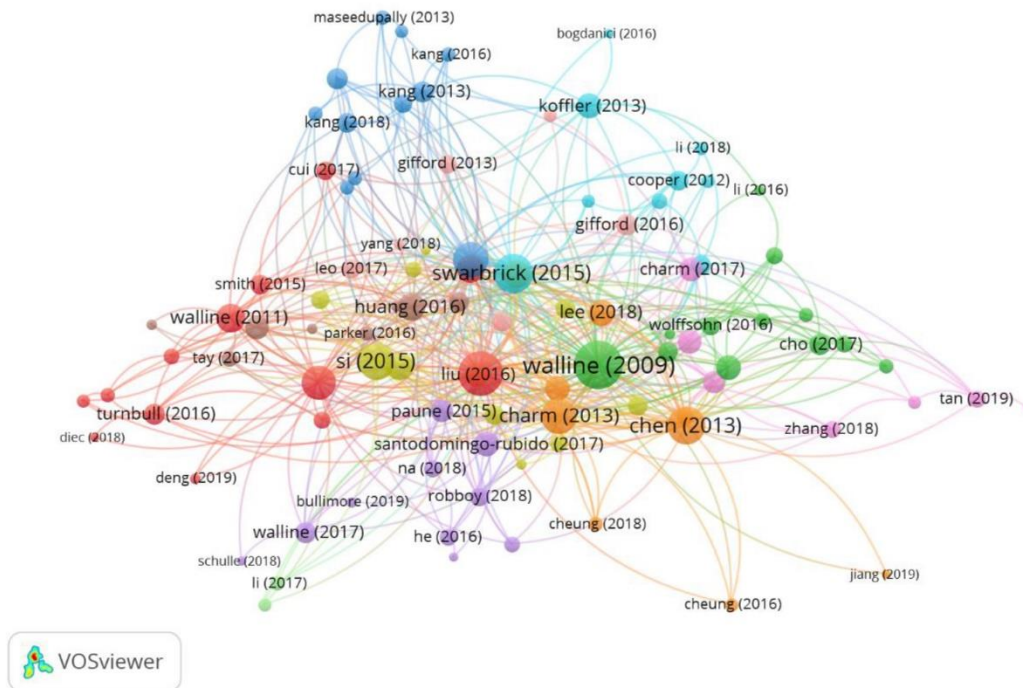


Figure 3. The Citation Network of “Myopia Control” and (“Orthokeratology” or “Corneal Refractive Therapy”).

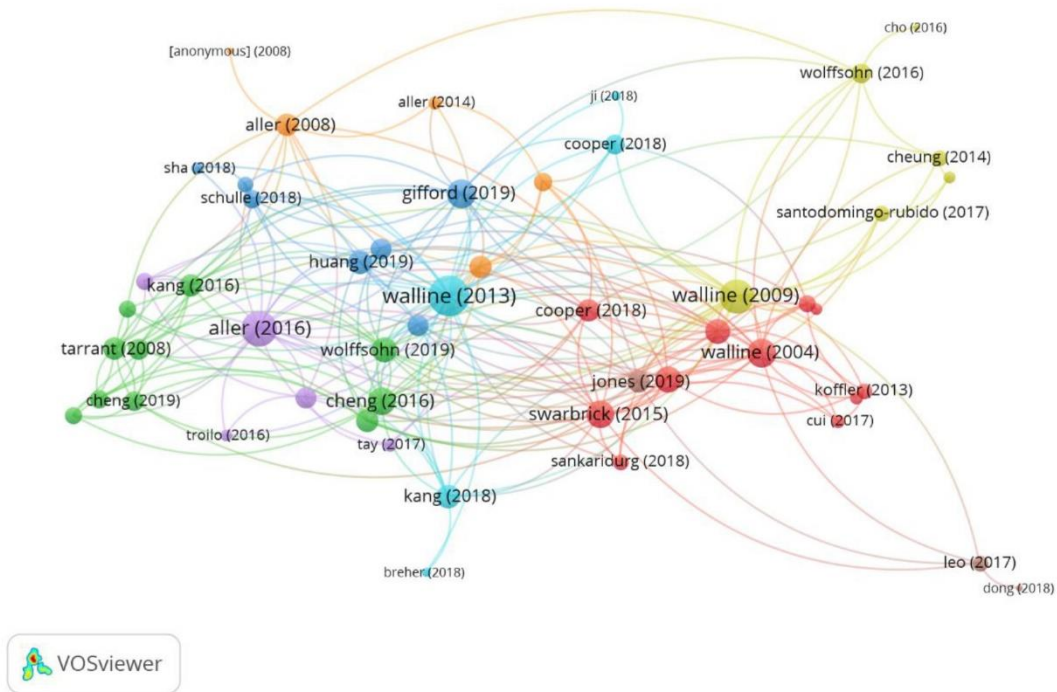


Figure 4. The Citation Network of “Myopia Control” and (“Soft Contact Lens” or “Multifocal Contact Lens”).



the most productive year, with five publications. The number of citations were lower than the rest of clusters, varying between 1 and 12. The authors whose publications had more than 10 citations were Chia [16], Walline [19], and Huang [14].

The journals containing the most cited papers were the OVS, Ophthalmology, and Eye & Contact Lens, with 4, 3, and 2 papers, respectively. The number of MEDLINE publications of these journals with the keywords “myopia control” and “atropine” were 8, 76 and 4, respectively.

CONCLUSION

Myopia control is a very important field for researchers, with a very high number of publications and many connections among articles increasing in the recent years. This citation network analysis shows 2013 as a key year in this field. Besides, orthokeratology and soft contact lenses are the most productive research areas in myopia control. Regarding the authors, Walline ranked the first of the most cited articles on myopia control and the Optometry and Vision Science have published most cited papers.

ETHICAL DECLARATIONS

Ethical Approval: This is a scientometric study based on other published articles. No ethical approval is required.

Conflict of Interest: None.

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REFERENCES

1. Mitchell P, Hourihan F, Sandbach J, Jin Wang J. The relationship between glaucoma and myopia. *Ophthalmology*. 1999;106(10):2010-5. doi: [10.1016/s0161-6420\(99\)90416-5](https://doi.org/10.1016/s0161-6420(99)90416-5)
2. Hashemi H, Fotouhi A, Yekta A, Pakzad R, Ostadimoghaddam H, Khabazkhoob M. Global and regional estimates of prevalence of refractive errors: Systematic review and meta-analysis. *J Curr Ophthalmol*. 2018;30(1):3-22. doi: [10.1016/j.joco.2017.08.009](https://doi.org/10.1016/j.joco.2017.08.009) pmid: [29564404](https://pubmed.ncbi.nlm.nih.gov/29564404/)
3. Holden BA, Fricke TR, Wilson DA, Jong M, Naidoo KS, Sankaridurg P, et al. Global Prevalence of Myopia and High Myopia and Temporal Trends from 2000 through 2050. *Ophthalmology*. 2016;123(5):1036-42. doi: [10.1016/j.ophtha.2016.01.006](https://doi.org/10.1016/j.ophtha.2016.01.006) pmid: [26875007](https://pubmed.ncbi.nlm.nih.gov/26875007/)
4. Walline JJ. Myopia Control: A Review. *Eye Contact Lens*. 2016;42(1):3-8. doi: [10.1097/ICL.0000000000000207](https://doi.org/10.1097/ICL.0000000000000207) pmid: [26513719](https://pubmed.ncbi.nlm.nih.gov/26513719/)
5. Villa-Collar C, Alvarez-Peregrina C, Hidalgo Santa Cruz F, Povedano-Montero FJ. Bibliometric Study of Scientific Research on Overnight Orthokeratology. *Eye Contact Lens*. 2018;44(5):344-9. doi: [10.1097/ICL.0000000000000545](https://doi.org/10.1097/ICL.0000000000000545) pmid: [30148458](https://pubmed.ncbi.nlm.nih.gov/30148458/)
6. Van Eck N, Waltman L. CitNetExplorer: A new software tool for analyzing and visualizing citation networks. *Journal of Informetrics*. 2014;8(4):802-23. doi: <https://doi.org/10.1016/j.joi.2014.07.006>
7. Web of Science [cited 2020 May 20]. Available from: <https://clarivate.com/webofsciencelibrary/>
8. CitNetExplorer. Analyzing citation patterns in scientific literature. [Citation Network Explorer Web Site] 2019 [February 8, 2019]. Available from: <http://www.citnetexplorer.nl>
9. Torres-Salinas D, Delgado López-Cózar E, Jiménez-Contreras E. Redes de citación de las revistas españolas de Ciencias Sociales 1994-2006. *Revista española de Documentación Científica*. 2009;32(2):34-50. doi: [10.3989/redc.2009.2.686](https://doi.org/10.3989/redc.2009.2.686)
10. Sanchez-Tena M, Alvarez-Peregrina CC, Villa-Collar CC. Dry Eye Analysis: A Citation Network Study. *J Ophthalmol*. 2019;2019:3048740. doi: [10.1155/2019/3048740](https://doi.org/10.1155/2019/3048740) pmid: [31485342](https://pubmed.ncbi.nlm.nih.gov/31485342/)
11. González C. Citation and social network analysis for the study of the use of journals in research centers Brasília2009 [updated 29 September 2019; cited 2009]. Available from: <http://www.scielo.br/pdf/ci/v38n2/04.pdf>
12. van Eck NJ, Waltman L. Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics*. 2010;84:523-38. doi: <https://doi.org/10.1007/s11192-009-0146-3>
13. Walline JJ, Jones LA, Sinnott LT. Corneal reshaping and myopia progression. *Br J Ophthalmol*. 2009;93(9):1181-5. doi: [10.1136/bjo.2008.151365](https://doi.org/10.1136/bjo.2008.151365) pmid: [19416935](https://pubmed.ncbi.nlm.nih.gov/19416935/)
14. Huang J, Wen D, Wang Q, McAlinden C, Flitcroft I, Chen H, et al. Efficacy Comparison of 16 Interventions for Myopia Control in Children: A Network Meta-analysis. *Ophthalmology*. 2016;123(4):697-708. doi: [10.1016/j.ophtha.2015.11.010](https://doi.org/10.1016/j.ophtha.2015.11.010) pmid: [26826749](https://pubmed.ncbi.nlm.nih.gov/26826749/)
15. Walline JJ, Greiner KL, McVey ME, Jones-Jordan LA. Multifocal contact lens myopia control. *Optom Vis Sci*. 2013;90(11):1207-14. doi: [10.1097/OPX.0000000000000036](https://doi.org/10.1097/OPX.0000000000000036) pmid: [24061152](https://pubmed.ncbi.nlm.nih.gov/24061152/)
16. Chia A, Lu QS, Tan D. Five-Year Clinical Trial on Atropine for the Treatment of Myopia 2: Myopia Control with Atropine 0.01% Eyedrops. *Ophthalmology*. 2016;123(2):391-9. doi: [10.1016/j.ophtha.2015.07.004](https://doi.org/10.1016/j.ophtha.2015.07.004) pmid: [26271839](https://pubmed.ncbi.nlm.nih.gov/26271839/)
17. Santodomingo-Rubido J, Villa-Collar C, Gilmartin B, Gutierrez-Ortega R. Myopia control with orthokeratology contact lenses in Spain: refractive and biometric changes. *Invest Ophthalmol Vis Sci*. 2012;53(8):5060-5. doi: [10.1167/iovs.11-8005](https://doi.org/10.1167/iovs.11-8005) pmid: [22729437](https://pubmed.ncbi.nlm.nih.gov/22729437/)
18. Aller TA, Liu M, Wildsoet CF. Myopia Control with Bifocal Contact Lenses: A Randomized Clinical Trial. *Optom Vis Sci*. 2016;93(4):344-52. doi: [10.1097/OPX.0000000000000808](https://doi.org/10.1097/OPX.0000000000000808) pmid: [26784710](https://pubmed.ncbi.nlm.nih.gov/26784710/)
19. Walline JJ, Lindsley K, Vedula SS, Cotter SA, Mutti DO, Twelker JD. Interventions to slow progression of myopia in children. *Cochrane Database Syst Rev*. 2011(12):CD004916. doi: [10.1002/14651858.CD004916.pub3](https://doi.org/10.1002/14651858.CD004916.pub3) pmid: [22161388](https://pubmed.ncbi.nlm.nih.gov/22161388/)