

TITLE: Using big data to understand interest in myopia

OPTOMETRY AND VISION SCIENCE

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1 INTRODUCTION

2 Myopia management, or myopia control, is an area of increasing professional interest and has
3 established itself as a mainstay topic of optometric conference programmes, professional
4 publications, and continuing professional development for eye care practitioners worldwide.
5 Despite the apparent professional interest, reported prescribing rates, at least for contact
6 lenses, remain lower than expected.^{1,2} Whilst several studies have investigated practitioner
7 and patient insights into the field of myopia management through surveys and focus groups,
8 the use of public online data remains limited.^{3,4} One commonly used approach, through which
9 patients and practitioners may obtain information, is via the internet. With more than two
10 million searches undertaken every minute, the search engine Google (Alphabet, Mountain
11 View, CA, USA) represents the largest global market share for an online search platform.⁵

12 Google Trends is a freely available web-based tool which allows users to quantify the
13 popularity of specific Google search terms. Since its introduction, in 2004, Google Trends has
14 been used in multiple research studies to offer insights into the field of healthcare. Several
15 investigations have demonstrated the usefulness of Google Trends at predicting cases of
16 disease outbreaks, monitoring change in health conditions by season, and at tracking various
17 health related trends over time and geographical region.⁶⁻⁸ The validity of using Google Trends
18 to monitor the spread of disease has been established through comparisons to official disease
19 figures, with some reports suggesting internet searches for symptoms can precede officially
20 recorded figures by several months.⁶

21 Thus far, the use of Google Trends within ophthalmics has been limited. However, big data
22 insights to ascertain interest in myopia may have several applications, e.g., it may prove useful
23 for eye care practitioners wishing to pursue myopia management; for industry representatives
24 in understanding potential markets; and for professional bodies wanting to improve public
25 health messaging. The specific objective of this study was to characterise Google search data

26 about myopia management and associated interventions over time and, where possible,
27 explore differences by geographical region.

28 **METHODS**

29 There was no direct data collection from patients, meaning no ethical application was required.
30 All data used is open access and free of use.

31 **Google Trends**

32 Google Trends offers anonymised search volume data for the period 2004 up until 72 hours
33 prior to data extraction.⁹ To enable faster processing, Google Trends samples data from its
34 larger search volume dataset. The data is normalised by time and location, for example, data
35 points are divided by the total searches in a specific location and by time period. The output
36 is provided in a graph format and a downloadable data file. The numbers on the graph, and
37 data file, do not represent absolute search volume. The data is presented on a scale from 0-
38 100 representing the relative search interest, hence a value of zero does not denote zero
39 searches but rather a lower search volume. Up to five different terms/topics can be searched
40 simultaneously, allowing relative comparisons to be made among them.

41 Google Trends can be searched using pre-set searches referred to as *topics*. These allow
42 searches to be undertaken automatically in different languages, account for alternative terms,
43 and any misspellings. Alternatively, any other search *term* can be used and, if desired, results
44 can be filtered using punctuation (these act as limited Boolean operators e.g., OR, NOT), but
45 unlike search *topics*, use of search *terms* does not return results for searches made in other
46 languages or other similar words.

47 **Data extraction**

48 Google Trends data were extracted during Aug 2023 for searches relating to *myopia control*;
49 *myopia management*; and, in the context of myopia control, searches for orthokeratology,
50 contact lenses, atropine, and glasses were also performed. Data were extracted from January

51 2004 (the earliest records available) to Aug 2023, expressed by month. Where appropriate,
52 variations in search trends were considered worldwide, by country, over time.

53 **Search terms**

54 **Searches relating to myopia only (*terms*)**

55 To evaluate use of alternative (English) terminology for myopia, common variants search as
56 *shortsighted, short-sighted, nearsighted, and near-sighted* were also searched and compared
57 to the search term *myopia*.

58 **Searches relating to myopia management and myopia control**

59 (Unavailable as *topics* thus entered as *terms*)

- 60 • *myopia control* compared to *myopia management*
- 61 • *myopia control* OR *myopia management* combined
- 62 • Comparisons between *myopia control, myopia management*

63 **Searches relating to different myopia control approaches**

64 (Unavailable as *topics* thus entered as *terms*)

- 65 • *Atropine myopia control*
- 66 • *Orthokeratology myopia control*
- 67 • *Contact lenses myopia control*
- 68 • *Glasses myopia control*

69 **Searches relating to other refractive conditions (*topics*)**

70 For context, search volumes for myopia were extracted alongside hyperopia and astigmatism.
71 These specific searches fell under pre-set Google Trends *topics*, thus allowing non-English
72 language searches and spelling variations and alternative terminology to be included in
73 searches.

74 **Statistical analysis**

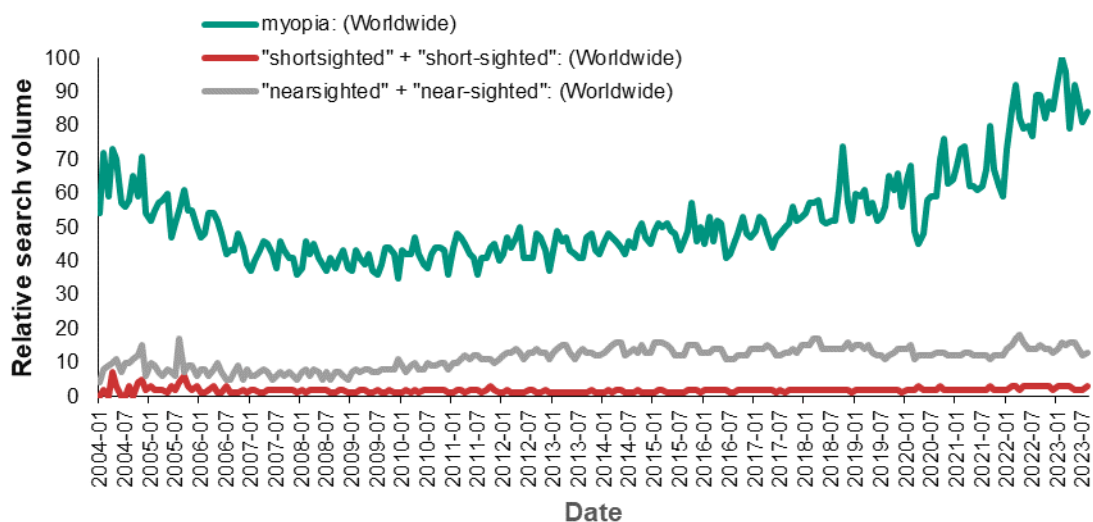
75 The Kruskal-Wallis test was used to compare one or more independent search terms and
76 Wilcoxon signed-rank test to draw comparisons between searches for the same *term/topic* but
77 over two different time periods.

78 **RESULTS**

79 **Searches relating to myopia only (*terms*)**

80 Different variant terms for myopia were investigated to determine their relative popularity as
81 search *terms*. Hyphenated and non-hyphenated styles of the word were combined to
82 investigate the overall popularity of nearsighted and shortsighted.

83 The dominant term describing myopia was *myopia* itself and not any of its variants (see Figure
84 1), accounting for approximately 80% of the monthly relative search volume since 2004. It is
85 possible that because a *term* was employed rather than a *topic* to conduct this search, less
86 relevant results may have been included (i.e., myopia in a business marketing context), but
87 the application of a filter to limit results to those which were *vision care* related only also
88 showed similar outcomes.



90 **Figure 1 Relative popularity of variant terms for *myopia* over the year 2004 to Aug**
91 **2023, (non-English searches will not have been captured)**

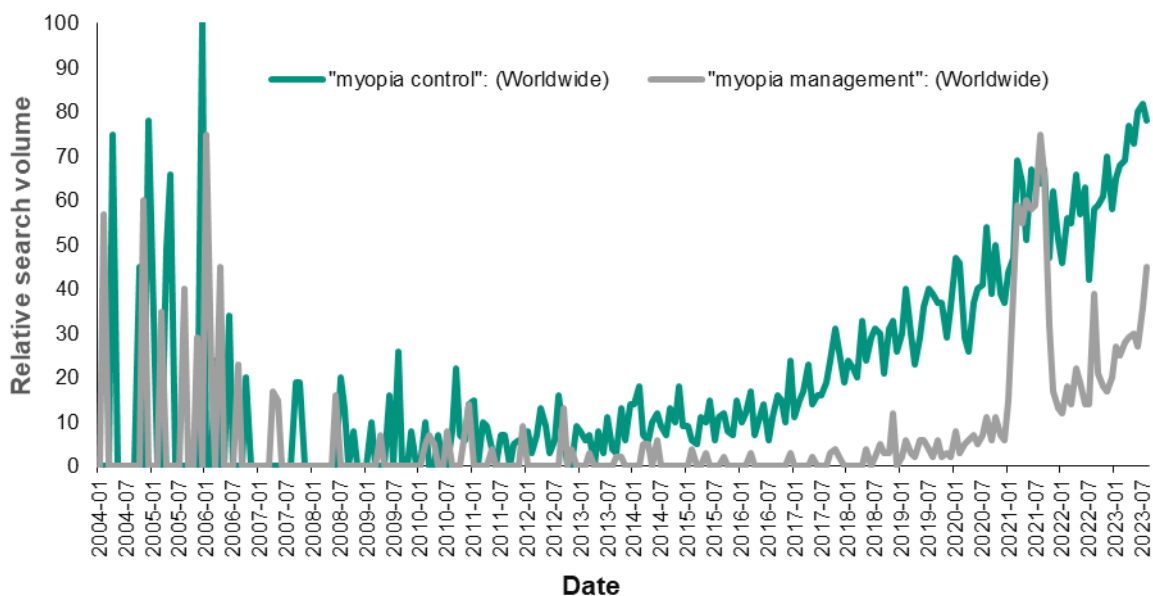
92

93 **Searches relating to myopia management and myopia control**

94 **Worldwide**

95 A significant difference was found between relative search volumes for the terms *myopia*
96 *management* and *myopia control* over the period of January 2004 to Aug 2023 ($H(1) = 66.85$,
97 $P < 0.001$).

98 Inspection of the data plot revealed a peak in search interest for *myopia management* from
99 early to mid-2021 (see Figure 2), but *myopia control* remained the dominant phrase over time
100 and thus the phrase adopted by this study when conducting searches relating to different
101 myopia control/management solutions (see below).



102

103 **Figure 2 Relative search volumes for terms *myopia control* and *myopia management***
104 **over the years of 2004- Aug 2023, (non-English searches will not have been captured)**

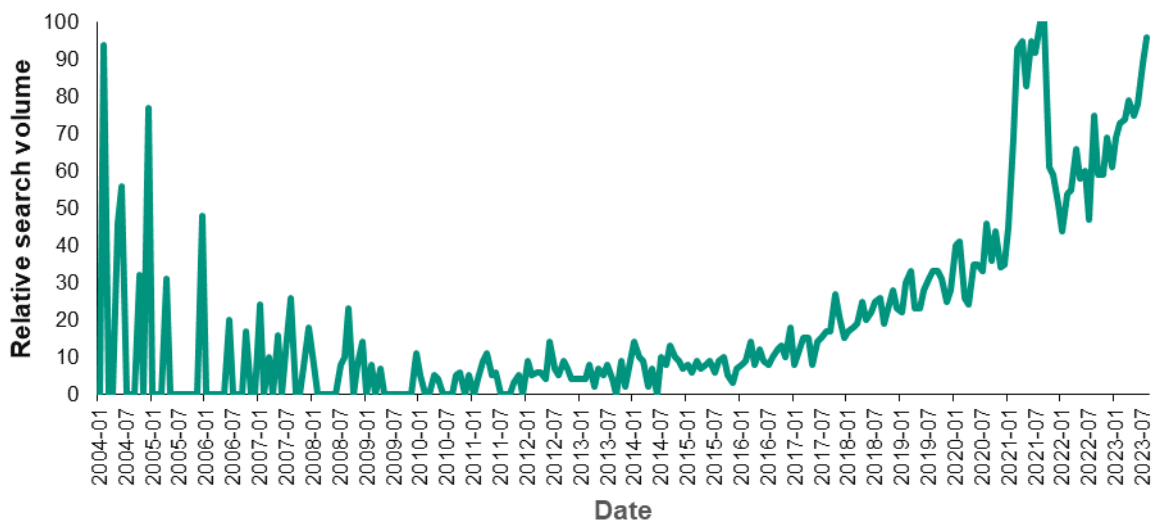
105 **By country**

106 The increase in relative search interest in the phrase *myopia management* compared to
107 *myopia control* stemmed mainly from the US (35% *myopia management*, 65% *myopia control*),
108 UK (26% *myopia management*, 74% *myopia control*), South Korea (23% *myopia*
109 *management*, 77% *myopia control*), and Canada (20% *myopia management*, 80% *myopia*
110 *control*) but this will partly be due to these particular searches being limited to the English
111 language.

112

113 **Searches relating to either myopia management or control**

114 A Wilcoxon 2-tailed test comparing the past 5 years (Sept 2018-Aug 2023 inclusive) to
115 previous equivalent period (Sept 2012-Aug 2018 inclusive) showed a significant increase in
116 search volumes ($z -6.74$, $P < 0.001$), see Figure 3.



117

118 **Figure 3 Relative search volumes for either *myopia control* or *myopia management***
119 **over the years 2004- Aug 2023 (non-English searches will not have been captured)**

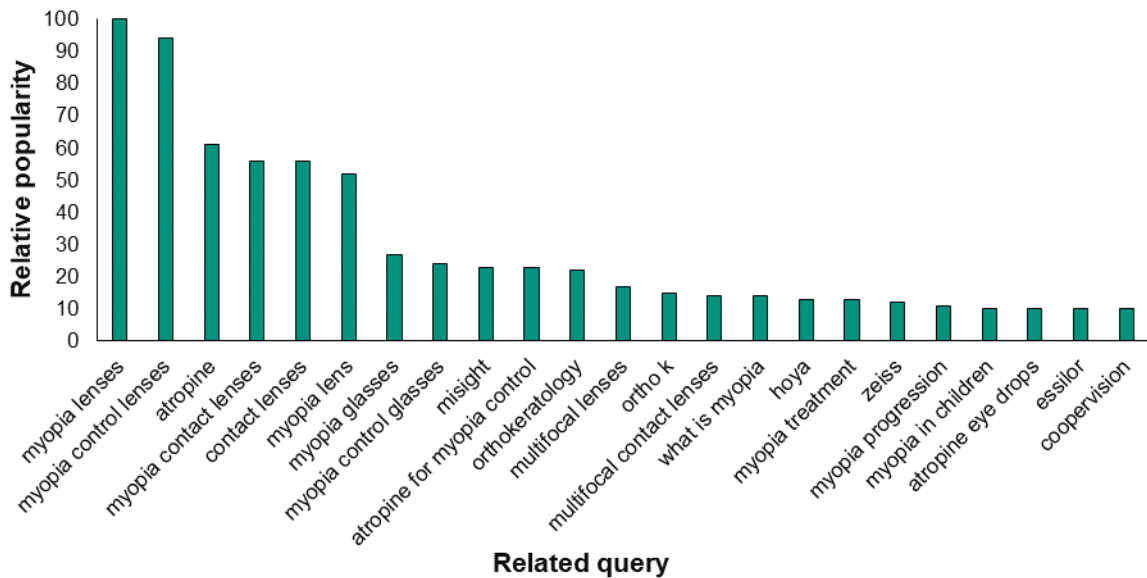
120 Relative search volumes for the terms either *myopia management* or *myopia control* were
121 greatest in Singapore (100% relative popularity), followed by Malaysia (31%), Australia (30%),

122 Canada (26%), UK (17%), USA (16%), South Korea (8%), India (6%) and Russia (2%); these
123 values relate to English language searches only.

124 **Most common related queries**

125 Google Trends also provides insights into the most commonly related queries to the main
126 search term. Figure 4 shows that myopia control/myopia management related searches often
127 corresponded to specific myopia control solutions rather than, for example, concerns about
128 cost, risks, or myopic complications.

129



130

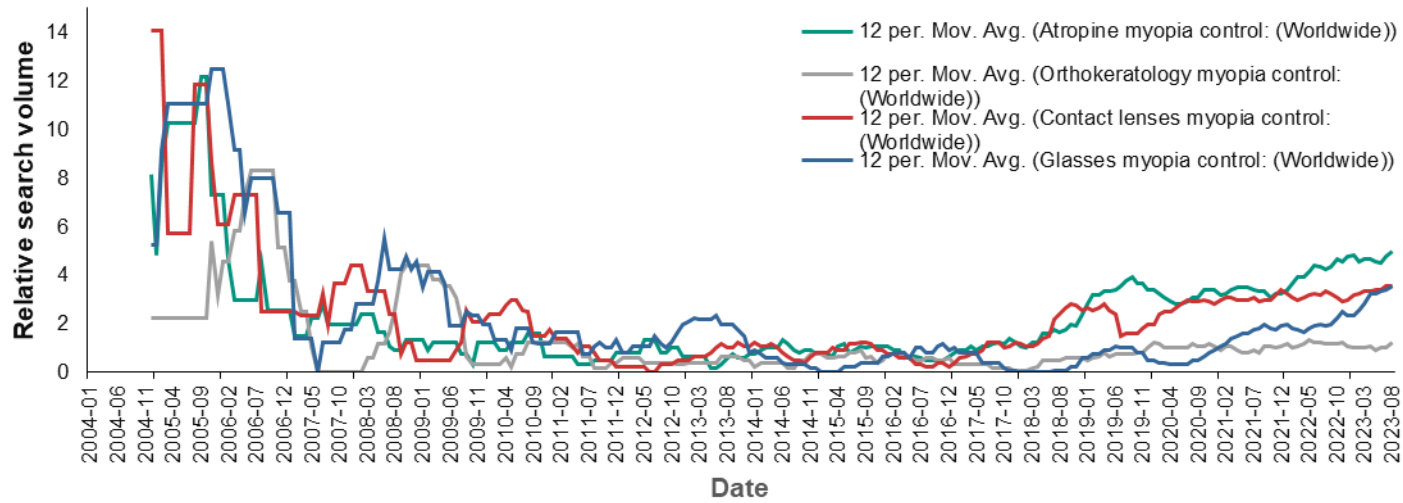
131 **Figure 4 Queries related to *myopia control* and *myopia management* searches over**
132 **the years 2004-Aug 2023**

133 The relative search volumes for variants of shortsightedness and nearsightedness control
134 were all zero for the period 2004 to present when compared to the terms *myopia management*
135 and *myopia control* indicating low search volume.

136 **Searches relating to different myopia control approaches**

137 **Worldwide trends**

138 Statistically significant differences were noted among relative search volumes for myopia
139 solutions atropine, orthokeratology, contact lenses, and glasses in the context of myopia
140 control for the period 2004 - Aug 2023 ($H(3) = 27.00$, $P < 0.001$). To better understand the
141 data and reduce noise, a moving average was fitted for every 12 months (see Figure 5). The
142 presence of relatively high levels of searches up until circa 2007/2008 were unexplained, but
143 a clearer picture emerged based on more recent data where searches for myopia control
144 solutions were found to be increasing (see Figure 5); relative searches for atropine were the
145 highest, but with the gap between contact and glasses now reducing.



148 **Figure 5 Relative global search volumes for different myopia control interventions over the period 2004 to Aug 2023 with moving**
 149 **averages fitted for every ~12 months**

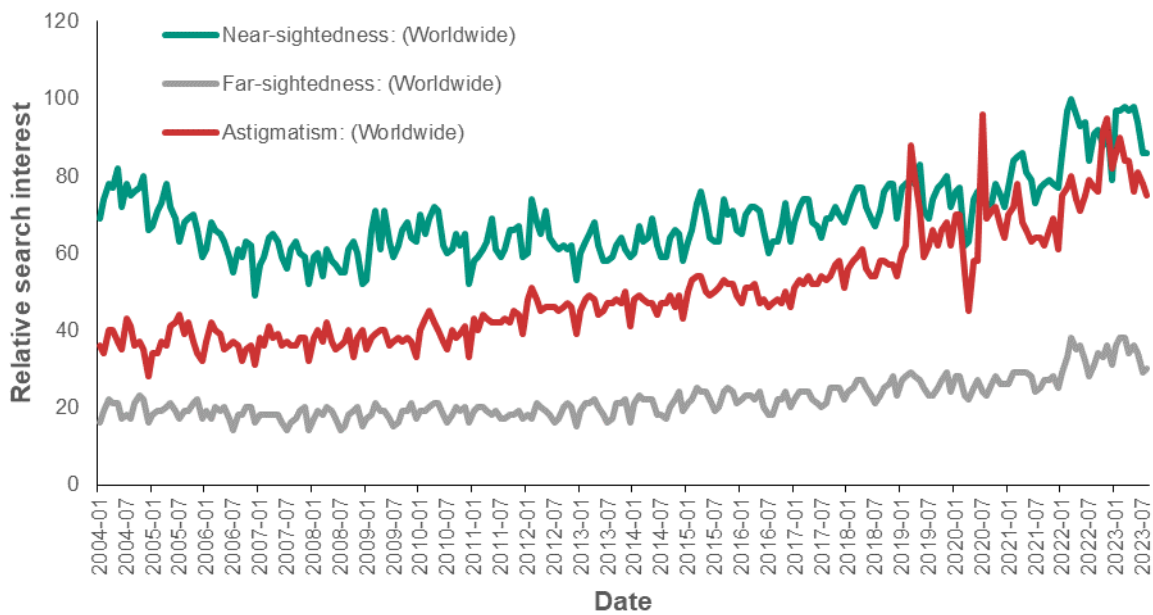
151 **Searches by country**

152 Due to low search volumes, country-level analysis was not available, other than for the USA.
153 Thus, data for the USA were extracted and a moving average fitted every 12 months.
154 Orthokeratology data showed as zero, which did not denote zero searches but rather that
155 relative to the other search terms the search volumes were lower. The most recent searches
156 showed atropine to be the most popular (with respect to myopia control), followed by contact
157 lenses, and then glasses.

158

159 **Searches relating to other refractive conditions (*topics*)**

160 A statistically significant difference was noted among relative search volumes of different
161 refractive conditions ($H(2) = 547.54, P < 0.001$).



162

163 **Figure 6 Relative search volumes for common refractive conditions, over the years**
164 **2004 to Aug 2023, searched as *topics* thus non-English searches, misspellings**
165 **alternative spellings etc, will be included.**

166 On a country-level, the greatest proportion of searches for *myopia* (referred to as the topic
167 *near-sightedness* in figure 6) compared to other refractive conditions were from China for the
168 period 2004 to Aug 2023; for *astigmatism*, the greatest proportion were from Poland; and for
169 hyperopia from South Korea. During the same periods, on a country level, the average
170 proportion of searches for *myopia* accounted for 48% compared to 16% for *far-sightedness*,
171 and 36% for *astigmatism*. Since these data are Google Trends *topics* they will account for
172 differences in spelling and searches in other languages. Data were also extracted for more
173 recent search volumes only, Jan 2022-Aug 2023, see appendix figures A1 and A2.

174 **DISCUSSION**

175 In this study, the relative popularity of search terms related to myopia was investigated,
176 including myopia control interventions, and other common refractive errors. The largest global
177 search engine was used to estimate the interest in these subjects on a worldwide scale, and
178 where possible, by country. Regarding the terminology used, the results identified that most
179 searches were performed using the term *myopia control*, rather than *myopia management*.

180 Scientific lexicon is a continually evolving entity; for example, ophthalmic research papers of
181 the past frequently refer to studies in 'man' to differentiate from studies in animal species, yet
182 in 2023 use of such terminology may be considered peculiar and outdated. More recently, in
183 some scientific circles, language has evolved to refer to study cohorts as *participants* rather
184 than as *subjects* (reflecting an individual's willingness to participate in research);¹⁰ and
185 discussions continue about whether it is reductive to refer to individuals *with myopic eyes* as
186 *myopes*, or those *with diabetes* as *diabetics*.¹¹ In a similar vein, the present study describes
187 the change in popularity of terms used to collectively describe myopia intervention therapies
188 since the early 2000s. From the widespread use of the term *myopia management* by
189 optometric bodies, it may appear as though the term *myopia control* is being gradually
190 supplanted; the data show this is not the case.¹²⁻¹⁴ Globally, despite a temporary rise in

191 popularity in the term *myopia management* during 2020/2021, *myopia control* remains the
192 dominant term searched for within Google.

193 Discussions around nomenclature may seem inconsequential, but the potential future
194 inclusion of myopia control therapies on health insurance policies or by health care providers,
195 and its associated medical coding, raise the importance of reaching a consensus across the
196 profession. Parity across the wider industry could also support a more consistent approach to
197 public messaging for myopia interventions, and aid in communication with patients in
198 consulting rooms.

199 The overall interest in *myopia control* appears to have steadily increased over time (aside from
200 the possibly noisy data in the early 2000s). Whilst the term *myopia management* did show a
201 sharp increase in popularity between December 2020 and July 2021, such transient peaks
202 may be attributed to media coverage around this time.¹⁵⁻¹⁷ Many of the articles suggested that
203 lockdowns could induce myopia, or myopia progression, due to the increased screen time and
204 reduced time spent outdoors, we speculate this could have led to concerned parents
205 investigating therapeutic options.

206 The high levels of relative search interest in the early 2000s remain unexplained, but we
207 speculate this may relate to differences in how Google was used at the time i.e., fewer Google
208 users; fewer handheld digital devices such as tablets and smartphones; lower uptake and
209 availability of internet access.

210 With respect to potential myopia control therapies, the relative search volume for atropine was
211 dominant; the gap between searches for contact lenses and glasses appeared to be closing.
212 The reason for increased search volumes from 2015/2016 onwards cannot be confirmed with
213 absolute certainty, however growing awareness may have been triggered by several seminal
214 publications at the time.^{18,19} Whilst peer reviewed publications are unlikely to have directly
215 reached the wider public, dissemination through mainstream news articles and the promotive

216 efforts of commercial entities, who subsequently launched licenced myopia management
217 products thus increasing accessibility, may have helped accelerate and sustain interest.

218 Data on searches related to myopia showed searches were being undertaken for specific
219 brand names and products (Figure 4), this is perhaps indicative of a high level of engagement
220 and interest from the public and professionals. A previous study reported affordability of
221 myopia control solutions is important to parents in the UK²⁰; our data showed, when evaluating
222 global searches related to myopia control (Figure 4), cost did not feature within the top 20
223 related searches.

224 Of additional interest was the relative unpopularity of terms such as short- and near- sighted
225 when compared to the term *myopia*. We cannot be sure at which point patients undertook
226 searches, whether *after* learning they were myopic and becoming aware of the term or prior
227 to their eye examination, but patient leaflets often tend to contain lay terminology and eye care
228 practitioners may rely on lay terms when communicating with parents, yet it appears the term
229 *myopia* may suffice.

230 A breakdown of results by country showed differences in the popularity of searches for different
231 refractive conditions; for example, in the UK, search volumes for *myopia* are approximately
232 equivalent to searches in *astigmatism*. In Poland, search volumes for astigmatism noticeably
233 exceed those for myopia. That *far-sightedness* was the most searched for refractive term in
234 South Korea, a country known to have high levels of myopia, suggests possible limitations
235 with the terminology used by Google Trends, or may be indicative of confusion between terms
236 such as far- and near-sightedness.

237 There are limitations to the approach taken for this study. Globally, Google is the most popular
238 desktop search engine. By July 2023, Google accounted for nearly 84% of searches
239 conducted, with Bing accounting for~ 9%, and Yahoo! for less than 3%.⁵ Nevertheless, despite
240 its large market share, in some regions alternative search engines are more popular, e.g.,

241 Baidu in China, and thus there is always a risk of sampling bias when using Google Trends
242 data.

243 A further potential limitation could be that individuals undertaking searches are cognisant of
244 the subtle difference between myopia control vs. management i.e., one relates to treatment,
245 but the other also relates to aspects such as managing risk factors or complications.

246 Whilst terms such as atropine, orthokeratology, contact lenses, and glasses were all available
247 as Google *topics*, the need to view these only in the context of myopia control required
248 combining phrases and employing search *terms* not *topics*. Hence, multiple language or
249 alternative terminology results were not returnable for searches relating to myopia therapies,
250 many of the results of this study are therefore more applicable to English language searches.
251 Additional limitations related to a lack of clarity on the way data are sampled, how relative
252 comparisons are made, or specifics relating to data normalisation. There also appeared to be
253 limited information when using *topics* on the languages included by Google, misspellings, and
254 alternative terms. Despite some researchers reporting on the limitations of Google Trends
255 there are multiple reports demonstrating its usefulness within other fields of healthcare
256 research.^{21,22}

257 It is also important to note that while it is impossible to differentiate between searches
258 conducted by patients, practitioners, or researchers, given the volume of searches, the recent
259 data is likely to represent a mix of general public and professionals. Notably, the Google
260 Trends tool is understood to exclude duplicate searches by the same individual, over short
261 periods of time.⁹

262 **Conclusion**

263 The data from Google searches indicates increasing global interest in myopia and its
264 management. Of note is the resounding popularity of *myopia control* in comparison to *myopia*
265 *management*. As tools such as Google continue to refine their algorithms and offer

266 researchers greater access and detail to mass collated data, additional and more relevant
267 insights may be achieved.

268 **APPENDIX**

269 **Appendix Figure A1**

270 **Relative search volumes for common refractive condition topics by country 2004 to**
271 **Aug 2023**

272

273 **Appendix Figure A2**

274 **Relative search volumes for common refractive condition topics by country from Aug**
275 **2022-Aug 2023.**

276

277 **Please note it was possible to search as ‘topics’ rather than ‘search terms’, meaning**
278 **the terms were predefined by Google trends but did capture alternative terms**
279 **including in different languages**

280

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FIGURE LEGENDS:

281 **Figure 1 Relative popularity of variant terms for *myopia* over the year 2004 to Aug**
282 **2023, (non-English searches will not have been captured)**

283

284 **Figure 2 Relative search volumes for terms *myopia control* and *myopia management***
285 **over the years of 2004- Aug 2023, (non-English searches will not have been captured)**

286

287 **Figure 3 Relative search volumes for either *myopia control* or *myopia management***
288 **over the years 2004- Aug 2023 (non-English searches will not have been captured)**

289

290 **Figure 4 Queries related to *myopia control* and *myopia management* searches over**
291 **the years 2004-Aug 2023**

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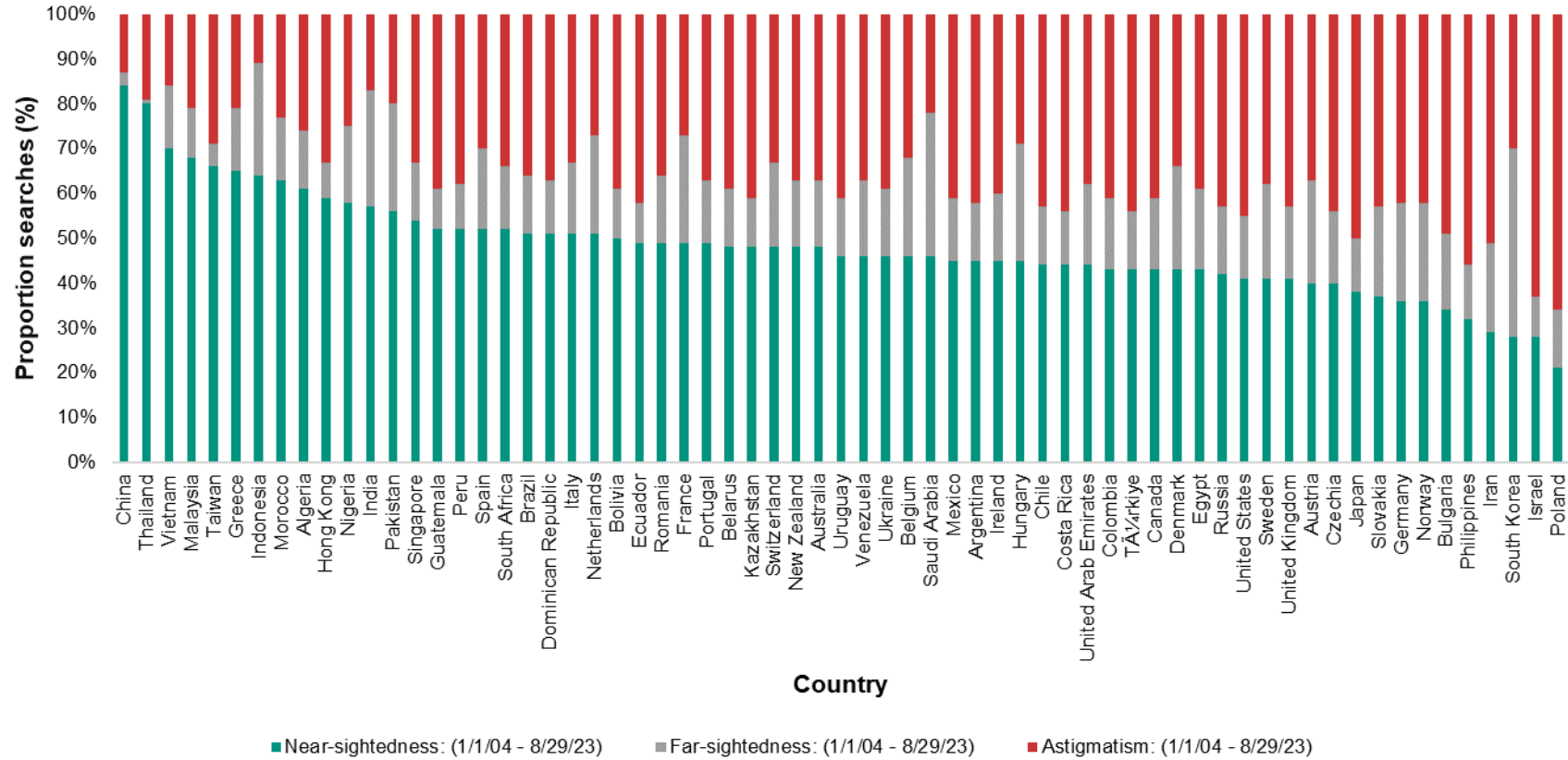
293 **Figure 5 Relative global search volumes for different myopia control interventions**
294 **over the period 2004 to Aug 2023 with moving averages fitted for every ~12 months**

295

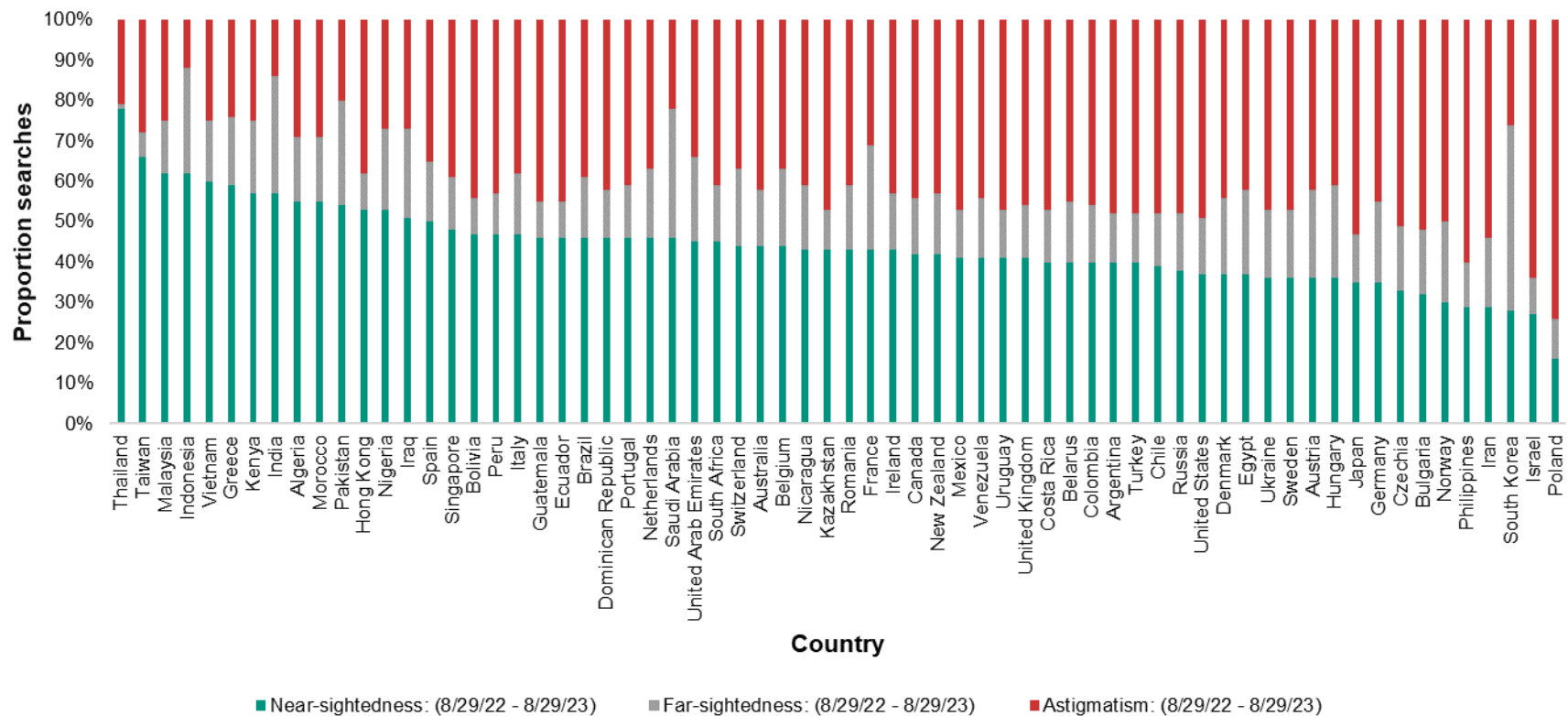
296 **Figure 6 Relative search volumes for common refractive conditions, over the years**
297 **2004 to Aug 2023, searched as *topics* thus non-English searches, misspellings**
298 **alternative spellings etc, will be included.**

Using big data to understand interest in myopia

A1



A2



Supplementary material figures: (A1) Relative search volumes for common refractive condition topics by country 2004 to Aug 2023 (A2) from Aug 2022-Aug 2023. Please note it was possible to search as ‘topics’ rather than ‘search terms’, meaning the terms were predefined by Google trends but did capture alternative terms including in different languages

