Factors Affecting the Lifetime Cost of Myopia and the Impact of Active Myopia Treatments in Europe

LING LEE, LAURA DE ANGELIS, ERICA BARCLAY, NINA TAHHAN, KATHRYN SAUNDERS, EMMA MCCONNELL, NEEMA GHORBANI-MOJARRAD, ANNEGRET DAHLMANN-NOOR, ANTON JASELSKY, NICOLAS LEVEZIEL, DOMINIQUE BREMOND-GIGNAC, SERGE RESNIKOFF, AND TIMOTHY R. FRICKE

• PURPOSE: There are an increasing number of effective myopia control options available; however, their financial impacts are unclear. We estimated lifetime costs of myopia under 5 scenarios in France and the United Kingdom (UK): traditional myopia management (single vision correction), low-dose atropine, anti-myopia spectacles, anti-myopia soft contact lenses, and orthokeratology.

• DESIGN: Model-based cost estimate.

• METHODS: Each modeled scenario began with an 8-year-old child presenting with −0.75 DS. Natural progression data were used to determine the likelihood of possible refractive outcomes for children predicted to be at risk for faster and slower myopia progression until adulthood followed by an assumed exponential decay to zero progression by age 25 years. Societal care costs (direct and indirect) were collected from published sources, key informants, and informal surveys. Predicted progression rates for those at risk for slower and faster progression, costs, protocols, and risks were used to estimate and compare lifetime cost of myopia and its associated complications under each scenario. All future costs were discounted by 3% per year for sensitivity analysis. The main outcome measures were the lifetime cost of myopia, and cost ratio (myopia control cost divided by traditional care cost).

• RESULTS: Estimated lifetime cost of myopia using a traditional approach was US$32,492/US$22,606 for those predicted to experience faster/slower myopia progression in France, and US$48,170/US$29,664 in the UK. For those at risk for faster progression in France and the UK, cost ratios for the myopia control options ranged from 0.60 to 0.81, and 0.50 to 0.69, respectively. For those at risk for slower progression in France and the UK, the cost ratios ranged from 0.81 to 1.10, and 0.73 to 1.00, respectively. Female individuals incurred higher lifetime costs due to higher contact lens wear rates, prevalence of vision impairment, and longer life expectancy.

• CONCLUSIONS: Investment in myopia control during childhood in Europe likely reduces the total lifetime cost of myopia compared to traditional care via reduced refractive progression, need for complex lenses, and risk of pathology and vision loss. Children predicted to experience faster myopia progression derive the greatest economic advantage from myopia control. **(Am J Ophthalmol 2025;278: 212–221.**

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National Vision Research Institute (L.L., L.D.A., E.B., T.R.F.), Australian College of Optometry, Melbourne, Australia; School of Optometry and Vision Science (L.L., N.T., S.R., T.R.F.), University of New South Wales, Sydney, Australia; Department of Optometry and Vision Sciences (E.B., T.R.F.), University of Melbourne, Melbourne, Australia; Brien Holden Vision Institute (N.T., S.R.), Sydney, Australia; Centre for Optometry and Vision Science (K.S., E.M.C.), Ulster University, Northern Ireland, UK; School of Optometry and Vision Science (N.G.-M.), University of Bradford, Bradford, UK; Wolfson Centre for Applied Health Research (N.G.-M.), Bradford Royal Infirmary, Bradford, UK; Institute of Ophthalmology (A.D.-N.), University College London, London, UK; Moorfields Eye Hospital NHS Foundation Trust (A.D.-N., A.J.), London, UK; Service d'ophtalmologie (N.L.), Centre Hospitalier Universitaire (CHU) Poitiers, Poitiers, France; CNRS I3M (N.L.), Poitiers, France; Institut National de la Santé et de la Recherche Médicale (INSERM 1084) (N.L.), Poitiers, France; Ophthalmology Department (D.B.-G.), University Hospital Necker-Enfants Malades, AP-HP, Paris, France; INSERM UMRS 1138 (D.B.-G.), T17, Research Centre des Cordeliers, Paris Cité University, France

Inquiries to Ling Lee, National Vision Research Institute, Australian College of Optometry, Carlton, VIC, Australia; e-mail: llee@aco.org.au

Myopia is increasingly recognized as a global public health problem.[1] While the considerable increase in prevalence and the evidence for slowing myopia have been widely documented in East Asian countries, myopia in Europe is also a growing concern.[2-5] With myopia and its associated pathological complications predicted to increase in prevalence, there are significant implications for individual and societal costs.[6]

The most common traditional myopia management (TMM) is providing single-vision optical correction or refractive surgery to treat the visual symptoms of myopia, without aiming to prevent myopia progression. Higher myopia is associated with greater risk of sight-threatening pathological complications such as primary open-angle glaucoma, retinal detachment, and myopic maculopathy.[7]

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There is now considerable evidence that some active myopia management (AMM) options control myopia progression. While AMM options may provide approximately 50% effective reduction in myopic progression,[8] it is less clear whether the initial AMM implementation costs enable savings later in life by decreasing the frequency and costs associated with myopia-related complications and burden of vision impairment. Families of children with myopia, their health practitioners, health care systems, and funders face an early choice between TMM or AMM. Efficacy evidence is available; however, the costs and overall value of these management options are less well known. Such information is required for comprehensive decision making and service planning.

From an industry perspective, it is also important for companies invested in myopia management product development to know at what price point AMM is cost-competitive against TMM or other AMM counterparts. Understanding the investment in childhood interventions and its potential impact on financial costs associated with tertiary healthcare could also better inform decision making for public and private health insurers.

A methodology was recently developed to estimate the direct and indirect costs of myopia across the lifetime following childhood onset, with examples from Australia and China.[9] The developed model enables adjustments to be applied for different environments where epidemiology, risk profiles, healthcare systems, and available AMM products differ. Based on similar patterns of practitioners, availability of AMM options, and clinical care protocols, we aimed to inform decisions on AMM in France and the United Kingdom (UK) by modeling the estimated lifetime TMM costs with comparisons across 4 AMM options.

METHODS

This model-based cost estimate study was based on published methodology, adapted for myopia control options in the UK and France.[9] For the UK, case scenarios were developed for each of the devolved nations (England, Northern Ireland, Scotland, Wales) with their varying healthcare systems' costs, and then combined and weighted according to their respective population proportions. Our reference case was TMM, and the AMM options included were low-dose atropine (0.01%-0.05%; AMM1), anti-myopia spectacles (AMM2), anti-myopia soft contact lenses (AMM3), and orthokeratology (AMM4). Scenarios included currently validated single-therapy myopia management available in each country.[8,10] Combination therapies and emerging technologies that might improve myopia management were excluded if there were insufficient long-term safety and/or efficacy data.

For each country, and as per the previous study,[9] the starting scenarios were one 8-year-old male individual and one 8-year-old female individual, each presenting for an eye examination with blurred distance vision and found through cycloplegic refraction to have −0.75DS in each eye and no other morbidities. We then followed each child through 5 potential lifetime pathways (Figure 1). As it is clinically reasonable, we assumed that they began TMM or each of the AMM options from their first symptomatic myopia presentation, and ceased AMM by adulthood. Additionally, the potential consequences across the lifetime were tracked following the Consolidated Health Economic Evaluation Reporting Standards (Supplementary Material 1).

• **COST ESTIMATES:** Our cost approach took on a societal perspective that incorporated all myopia-related costs regardless of who covered these expenses. We gathered direct costs for ophthalmic examinations, ophthalmic treatment, myopia-related clinical care, and optical appliance (spectacle frames, lenses, low vision aids) costs. Data were initially gathered from key informants with experience in either ophthalmology and/or optometry/optician sectors and informal practice surveys from the UK and France. Costs were then triangulated with available published sources such as government data and private-practice online information, and reconfirmed with key informants (Supplementary Material 2).

Additional indirect costs associated with receiving ophthalmic care, such as transportation and productivity loss, were also included. Transportation costs include attending examinations, collecting optical appliances (traditional and active myopia management options), and attending examinations or treatment for myopia-related complications. Productivity costs monetized time spent traveling and receiving eye care for the individual and adults who needed to attend with dependents. We also factored in disability weights to estimate the potential productivity impact associated with the level of vision impairment, average travel distances, average adult income, labor force participation rates, and employment rates.[11]

All costs were current in 2024, initially collected in local currency (Great British Pounds or Euros) and then converted to US dollars at the rate provided by the US Federal Reserve for April 2024.[12] We have not predicted inflation or potential price changes to appliances or technologies as they age or become mainstream. Initial outcomes are presented with no discounting. To adjust future costs to the present value (2024 in this publication), we discounted all costs by 3% for sensitivity analysis.[13,14]

• **LIKELIHOOD OF REFRACTIVE OUTCOMES:** For each country and sex, we developed probability profiles for those considered to be at risk for faster or slower progression. Ideally, local natural progression data would be available for use. However, the average and variance in myopia progression data of those at risk for faster progression were modeled on an urban Han Chinese child's natural progression of refractive error where they represent both having fa-

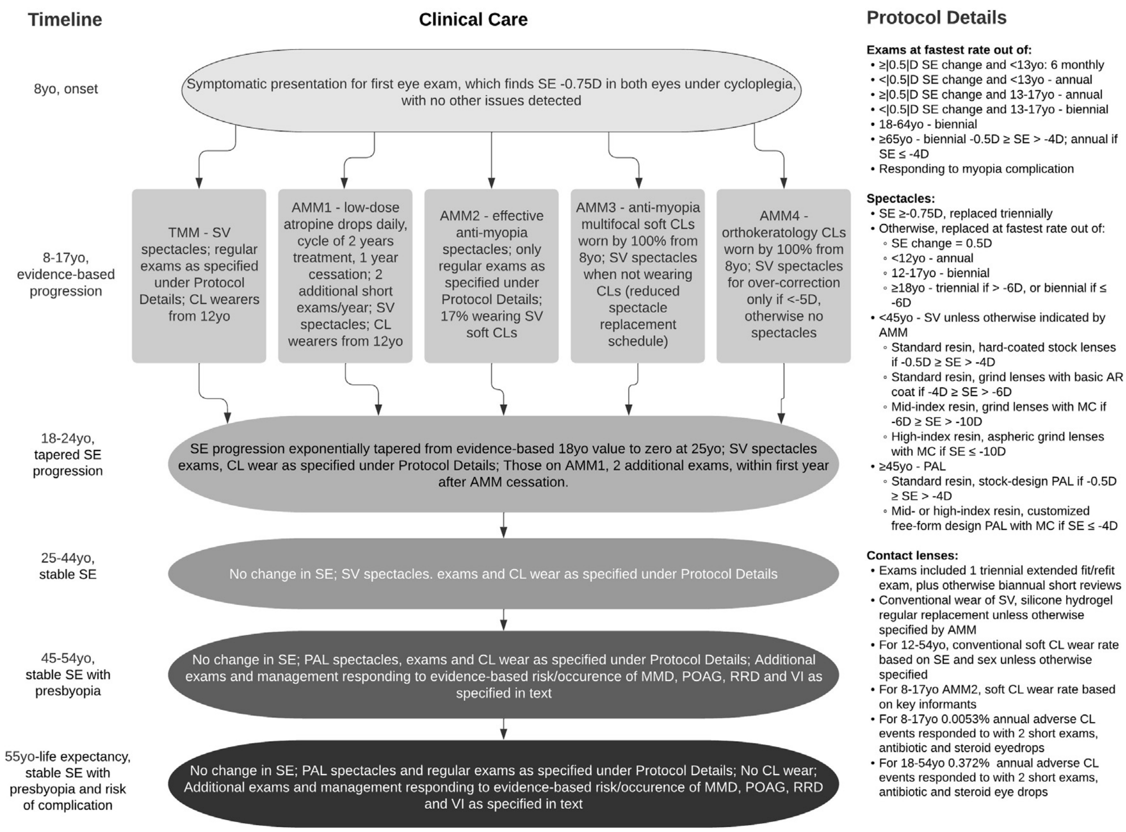

FIGURE 1. Clinical care flow diagram. AMM = active myopia management; AMM1 = low-dose atropine; AMM2 = antimyopia spectacles; AMM3 = antimyopia soft contact lenses; AMM4 = orthokeratology; AR = antireflection; CL = contact lens; D = diopter; MC = multicoat; MMD = myopic macular degeneration; PAL = progressive addition lens; POAG = primary open-angle glaucoma; RRD = rhegmatogenous retinal detachment; SE = spherical equivalent; SV = single vision; TMM = traditional myopia management; VI = vision impairment; yo = years old.

milial and lifestyle reasons to be at risk for faster progression. The White European child's natural progression of refractive error under TMM were used to model individuals at risk for slower progression.[15] We then determined the probability of the 8-year-old child reaching each level of spherical equivalent (in 1-diopter [D] steps) by 25 years of age, as myopia progression can occur in adulthood.[16,17] The spherical equivalent progression to 18 years of age was based on natural progression data; however, for early adulthood, an exponential decay towards zero progression by 25 years of age was assumed.[9] Factors that might impact refractive outcomes such as outdoor time, education, or near work outcomes were not applied differently to any of the scenarios.

For the available products in each country, the efficacy of each AMM were the reported weighted average rates of effectiveness based on spherical equivalent, except orthokeratology that report axial length data, derived from studies around the globe.[8,9,18,19]

- *AMM1* Low-dose atropine and *AMM4* Orthokeratology: 46% reduction in spherical equivalent progression compared with TMM.
- *AMM2* Anti-myopia spectacles: 53.5% reduction based on highly aspherical lenslets and defocus incorporated multiple segment designs.
- *AMM3* Anti-myopia soft contact lenses: 51.5% reduction based on center-distance, dual focus, and extended depth-of-focus designs.

• **CLINICAL CARE PROTOCOLS:** Refractive and ocular health decisions (Figure 1) were adjusted based on available local clinical guidelines that respond to the speed of progression, level of myopia, and prevalence of myopia-related pathology and vision impairment.[20,21] For all age groups, we included frequency and management type (TMM or AMM) of ophthalmic examinations, refractive correction required (spectacle and/or contact lens type and replacement schedule, including, where relevant, wear rates, and care for contact lens complications; as part of and/or in addition to AMM), risk and care of myopia-related complications, and risk and care of vision impairment.

• **DETERMINING TOTAL COSTS AND COST RATIOS:** For each possible spherical equivalent level that a child might reach with TMM or with each AMM, direct and indirect costs were added across the life expectancy. Life expectancy at the age of 65 and 60 years were obtained from the French and UK national statistical datasets, respectively.[22,23] To determine the overall cost, the added costs at each spherical equivalent level were weighted according to the refractive error outcome probability scenario and then summed.

Examination and intervention costs were derived from different healthcare pricing systems in each country and have not been adjusted for price power parity. Rather than making direct comparisons of the overall costs in France and the UK, we observed cost differences within each country and then compared similarity of patterns.

Upper and lower limits of cost estimates were determined with the 95% confidence interval of spherical equivalent outcomes for each TMM and AMM, lowest and highest likely costs for each ophthalmic care item, and hourly rates of minimum gross salary/low pay and maximum net/high pay were used for adult income.[24,25]

Cost ratios were calculated for each AMM divided by TMM. Values below 1 indicated cost savings across the lifetime with the AMM, where the lower the value, the more cost saving, and vice versa for values above 1.

Total costs were compared between sexes across 3 life stages: childhood, where AMM treatment would be applied; younger adulthood (ages 18-54 years), where myopia-related complications are less likely to occur; and older adulthood (ages 55+ years). For this study, we use the terms female and male to represent sex, the biological attributes that characterize physical and physiological human traits, as our source modeling data are categorized by sex.

• **THRESHOLD ANALYSES:** Threshold analyses were conducted in each country on any AMM identified as more costly than TMM over the lifetime. The price point of price-adjustable items within the AMM option to be equivalent to the lifetime cost of TMM was determined. The analyses were completed under 0% and 3% annual discounting.[14]

RESULTS

Estimated lifetime societal costs of myopia across the age groups, including upper and lower limits costs, are presented in Table 1 (France) and Table 2 (UK). The cumulative costs with and without discounting are shown in Figure 2 (France) and Figure 3 (UK).

• **FRANCE:** Without discounting in France, the lifetime costs (for those at risk for faster/slower progression) for each scenario are: TMM, US$32,492/US$22,606; AMM1, US$24,907/US$23,354; AMM2, US$19,421/US$18,249; AMM3, US$26,295/US$24,762; AMM4, US$21,909/US$20,501. Those individuals at risk for faster progression incur higher costs compared to those at risk for slower progression, and the difference in costs appear to be greatest with TMM. Those at risk for faster progression who undertake any AMM option would experience lifetime financial savings ranging from US$6,197 to US$13,071. Those at risk for slower progression achieved financial savings only with anti-myopia spectacles (US$4,357) and orthokeratology (US$2,105), as single therapy.

Without discounting, the AMM/TMM lifetime cost ratios for those individuals at risk for faster progression were AMM1, 0.77; AMM2, 0.60; AMM3, 0.81; and AMM4, 0.67. For those at risk for slower progression, the same cost ratios were 1.03, 0.81, 1.10, and 0.91, respectively. With 3% annual discounting, all AMMs except AMM3 (anti-myopia soft contact lenses) are less expensive than TMM across a lifetime for those at risk for faster progression. Reducing the cost of a 12-month supply of anti-myopia soft contact lenses from the current price of US$658.50 to US$546.76 (threshold price) would equalize the lifetime cost of AMM3 and TMM.

For those individuals at risk for slower progression, only AMM2 (anti-myopia spectacles) remains less expensive than TMM. The critical price-points of adjustable AMM or eye care items to equalize the lifetime costs of TMM for those at risk for slower progression are as follows:

- AMM1 critical item: 12-month supply of low-dose atropine; current price US$644.28.
  - 0% Discounting: threshold price US$531.48
  - 3% Discounting: threshold price US$186.84
- AMM3 critical item: 12-month supply of anti-myopia soft contact lenses; current price US$658.50.
  - 0% Discounting: threshold price US$439.95.
  - 3% Discounting: threshold price US$207.23
- AMM4 critical item: 2-year period of subsequent orthokeratology care (current price US$171.79) and lenses (current price US$438.46).
  - 3% Discounting: threshold prices for subsequent care US$158.05, and lenses US$403.38.

• **UNITED KINGDOM:** Without discounting the lifetime costs (for those individuals at risk for faster/slower progression) in the UK are as follows: TMM, US$48,170/US$29,664; AMM1, US$33,015/US$29,605; AMM2, US$24,167/US$21,639; AMM3, US$27,185/US$23,834; and AMM4, US$26,662 /US$23,437. Those at risk for faster progression accumulate higher costs compared to those at risk for slower progression, and the difference in costs is greatest with TMM. Compared to TMM, individuals showed financial savings from US$59 to US$24,003 if they underwent any of the AMM options during childhood. The AMM/TMM lifetime cost ratios for those at risk for faster progression were: AMM1, 0.69; AMM2, 0.50; AMM3, 0.56; and AMM4, 0.55. For those at risk for slower progression, the cost ratios for the same AMM were 1.00, 0.73, 0.80, and 0.79, respectively. For

TABLE 1. Weighted Average, Upper Limit, and Lower Limit Lifetime Costs for a French Population At Risk for Faster and Slower Myopia Progression, Disaggregated by Age.

Age Group	TMM (Single Vision Optical Correction)		AMM1 (Low-Dose Atropine)		AMM2 (AM Specs)		AMM3 (AM sCLs)		AMM4 (OrthoK)	
	Faster	Slower	Faster	Slower	Faster	Slower	Faster	Slower	Faster	Slower
8-17 y	$4,040	$3,509	$8,072	$8,270	$3,527	$3,797	$9,421	$9,678	$5,152	$5,495
18-54 y	$15,861	$11,042	$9,570	$8,178	$8,840	$7,653	$9,580	$8,164	$9,493	$8,101
55+ y	$12,592	$8,055	$7,265	$6,906	$7,054	$6,798	$7,295	$6,920	$7,265	$6,906
Lifetime	$32,492	$22,606	$24,907	$23,354	$19,421	$18,249	$26,295	$24,762	$21,909	$20,501
Lower Limit Cost (US$)										
8-17 y	$1,274	$1,408	$3,852	$4,132	$2,125	$2,440	$5,153	$5,465	$2,920	$3,232
18-54 y	$6,316	$5,771	$3,969	$3,723	$3,689	$3,504	$3,933	$3,683	$3,905	$3,659
55+ y	$5,697	$5,645	$5,038	$5,265	$5,314	$5,265	$5,314	$5,265	$5,314	$5,265
Lifetime	$13,287	$12,824	$12,859	$13,120	$11,128	$11,209	$14,399	$14,413	$12,138	$12,155
Upper Limit Cost (US$)										
8-17 y	$14,030	$11,362	$18,633	$18,584	$7,387	$8,532	$20,025	$20,540	$8,790	$9,981
18-54 y	$45,716	$25,070	$24,886	$23,114	$24,133	$22,392	$24,679	$22,918	$24,618	$22,847
55+ y	$25,784	$17,089	$13,600	$15,119	$13,209	$15,119	$15,178	$15,119	$13,209	$15,119
Lifetime	$85,530	$53,521	$57,118	$56,818	$44,730	$46,043	$59,883	$58,577	$46,618	$47,947

AMM = active myopia management; AMM1 = low-dose atropine (0.01%-0.05%); AMM2 = anti-myopia spectacles; AMM3 = anti-myopia soft contact lenses; AMM4 = orthokeratology; TMM = traditional myopia management.

TABLE 2. Weighted Average, Upper Limit and Lower Limit Lifetime Costs for a UK Population at Risk for Faster and Slower Myopia Progression, Disaggregated by Age.

Age Group	TMM (Single Vision Optical Correction)		AMM1 (Low-Dose Atropine)		AMM2 (AM Specs)		AMM3 (AM sCLs)		AMM4 (OrthoK)	
	Faster	Slower	Faster	Slower	Faster	Slower	Faster	Slower	Faster	Slower
8-17 y	$4,272	$4,181	$12,085	$12,706	$5,193	$5,972	$6,128	$6,913	$5,820	$6,668
18-54 y	$24,456	$16,122	$13,530	$10,769	$12,148	$9,802	$13,570	$10,753	$13,401	$10,638
55+ y	$19,442	$9,360	$7,401	$6,131	$6,825	$5,864	$7,486	$6,169	$7,401	$6,131
Lifetime	$48,170	$29,664	$33,015	$29,605	$24,167	$21,639	$27,185	$23,834	$26,622	$23,437
Lower Limit Cost (US$)										
8-24 y	$1,624	$1,760	$5,186	$5,507	$3,276	$3,672	$3,921	$4,313	$4,023	$4,415
25-54 y	$8,400	$7,119	$4,085	$3,619	$3,599	$3,234	$4,056	$3,584	$4,003	$3,537
55+ y	$4,576	$3,145	$2,282	$1,905	$2,858	$1,905	$2,858	$1,905	$2,858	$1,905
Lifetime	$14,601	$12,024	$11,553	$11,031	$9,733	$8,811	$10,834	$9,801	$10,883	$9,858
Upper Limit Cost (US$)										
8-24 y	$8,366	$7,379	$21,328	$21,868	$7,532	$8,775	$9,143	$10,194	$15,403	$16,704
25-54 y	$47,894	$26,148	$25,792	$22,578	$25,330	$22,035	$25,661	$21,691	$25,574	$22,361
55+ y	$40,366	$21,050	$13,802	$12,935	$13,057	$12,935	$20,199	$12,935	$13,057	$12,935
Lifetime	$96,626	$54,578	$60,922	$57,381	$45,919	$43,744	$55,003	$44,820	$54,034	$52,000

AMM = active myopia management; AMM1 = low-dose atropine (0.01%-0.05%); AMM2 = anti-myopia spectacles; AMM3 = anti-myopia soft contact lenses; AMM4 = orthokeratology; TMM = traditional myopia management; UK = United Kingdom.

those under TMM, all cost types (ophthalmic examinations, optical correction, other direct costs, and indirect costs) are greater than each of the corresponding types within each AMM option.

With 3% annual discounting, all AMMs continue to be less expensive than TMM across a lifetime for those individuals at risk for faster progression. For those at risk for slower progression, the lifetime costs incurred by children undergoing AMM1 becomes greater than for TMM. Reducing the cost of a 1-month supply of low-dose atropine from the current price of US$84.23 to US$14.67 (threshold price) would equalize the lifetime cost of AMM1 and TMM.

• **SEX DIFFERENCES:** In the UK and France, the lifetime costs for either TMM or any of the AMMs with female indi-

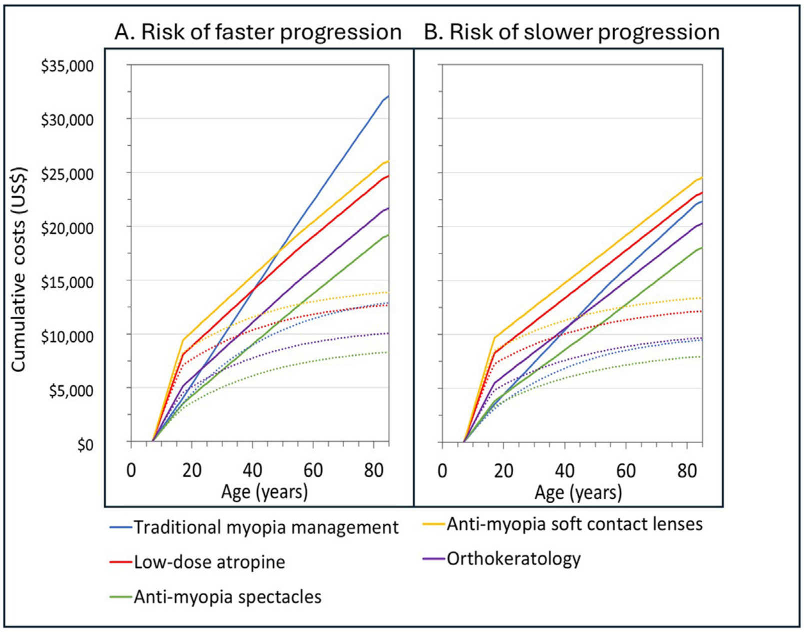

FIGURE 2. France lifetime costs of myopia with traditional myopia management (TMM) and active myopia management (AMM) options based on faster (A) and slower (B) risk of progression profiles without discounting (solid lines) and 3% discounting (dotted lines).

viduals are higher than for male individuals (Table 3) across all age groups (childhood 8-17 years, younger adulthood 18-54 years, and older adulthood 55+ years). The high costs for female individuals from childhood to around middle-age is likely related to contact lens wear rate, given that female individuals wear contact lenses more than male individuals.[26,27] For later adulthood, female individuals accumulating higher costs are related to higher prevalence rates of vision impairment due to myopia complications and longer life expectancy.

DISCUSSION

Our results inform whether AMM is worth investing in from a lifetime cost perspective. In France, any of the AMM options considered in the present study are likely to generate a cost saving for those individuals at risk for faster progression, and anti-myopia spectacles or orthokeratology show cost savings for those at risk for slower progression, when compared to TMM. The overlap of cost ratios for faster and slower progression groups in France suggests that the difference in costs between myopia control options is greater than the difference in costs between our faster and slower progression groups. In the UK, the additional costs incurred with any of the AMM options during childhood reduces overall lifetime costs for all myopic individuals regardless of speed of progression. Across both countries, anti-myopia spectacles were demonstrated to have the greatest cost savings compared to the other AMM options. Conversely, the most expensive AMM options were anti-myopia soft contact lenses and low-dose atropine in France and the UK, respectively.

While we have attempted to collect societal costs, subtle differences in hidden subsidizations and inclusions mean that caution should be taken in any direct comparisons between countries, and that broader applicability to other countries is limited. Notably, there are some striking variations in pricing of critical AMM items between countries. For example, a 1-month supply of low-dose atropine costs US$1.50 in China,[9] US$21.52 in Australia,[9] US$53.69 in France, and US$84.23 in the UK, highlighting different supply and procurement environments. These environments can, and are likely to, change over time and will impact cumulative costs.

Societal costs combine some or all of governmental subsidy, other health insurance coverage, and individual out-of-pocket costs. Hence, the out-of-pocket costs incurred by individuals and their families might differ across the AMM options. For example, despite anti-myopia spectacles giving the greatest cost savings and being the most readily available, both the French national health insurance and UK National Health Service currently partially subsidize the total cost of frame and lenses. Hence, families often pay out-of-pocket, which may alter what to offer as a first-line intervention. Furthermore, affordability reduces accessibility particularly for those from lower socioeconomic backgrounds. Such inequalities in access to myopia control options would create subsequently disparities in the risk of my-

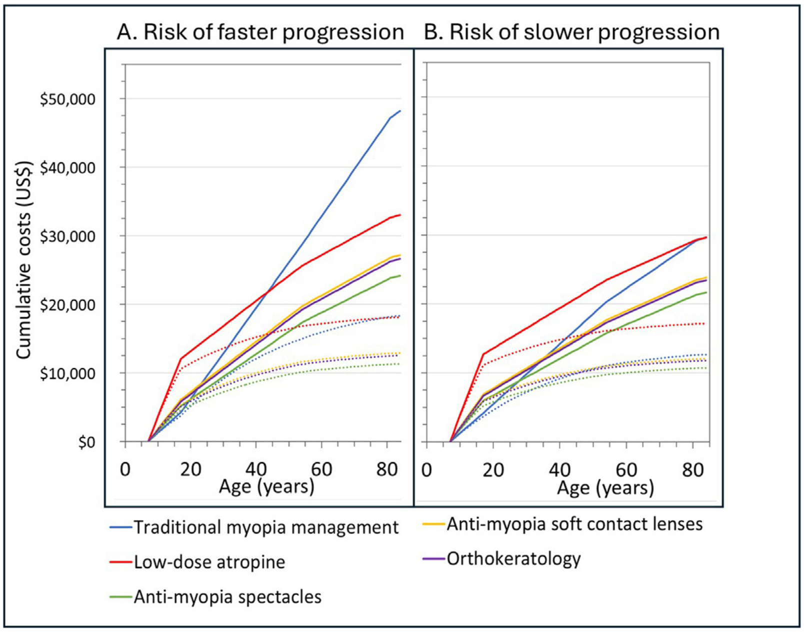

FIGURE 3. United Kingdom lifetime costs of myopia with traditional myopia management (TMM) and active myopia management (AMM) options based on faster (A) and slower (B) risk of progression profiles without discounting (solid lines) and 3% discounting (dotted lines).

opia complications and vision loss, with the greatest burden borne by those in the most deprived areas.[28] By contrast, low-dose atropine is entirely subsidized in France, whereas there is no subsidy at all for patients in the UK. It is useful to note that UK healthcare policy considers only direct healthcare costs (actual cost-effectiveness, not indirect/societal costs) when determining whether to fund or subsidize treatments.

Despite the distinct differences in subsidization for low-dose atropine, there are similarities between the 2 countries. Currently, low-dose atropine is formulated through compounding pharmacists, and only ophthalmologists are able to prescribe. With a predicted increase in prescribing and uptake of AMM,[29] these tertiary services may be overburdened.[30] Furthermore, although it has yet to be rigorously tested in Europe, compounded low-dose atropine formulations in the United States were found to be variable, with the measured concentration ranging from 70.4% to 104.1% of the prescribed concentration.[31] Providing lower than the minimum required concentrations of low-dose atropine to children could result in ineffective treatment. Having commercial preparations available and subjected to rigorous testing would not only improve quality assurance, it also has potential to increase distribution, to lower cost due to production scale, and to broaden the pool of healthcare professions capable of issuing prescriptions.[32] It is worth noting that in the UK, some ophthalmologists believe myopia management to be outside their scope of practice.[30] It has been demonstrated in Australia, the United States, and New Zealand that optometrists can manage myopia with low-dose atropine.[33-35] However eye health systems vary dramatically across settings, and careful considerations need to be taken for each context to determine appropriate cadres in prescribing and managing myopia with atropine, as well as population needs.

Myopia management contact lens options (soft lens anti-myopia designs or orthokeratology) have the advantage of correcting vision without spectacle wear in addition to slowing myopia progression. However, they require additional commitment compared to spectacles or eye drops: costs and frequency of examinations, product replacement costs, lens care, and the associated risk of complications may be higher. In France, where anti-myopia soft contact lenses were the most expensive AMM option, this might be due to the majority of ophthalmologists providing contact lens care where ophthalmic examination costs are greater than with orthoptists or opticians.[36] Therefore, unless affordability barriers are addressed, those individuals most likely to undertake contact lens myopia management options are those already interested in contact lens wear. However, making these options more affordable to patients should not be at the cost of depreciating the value of contact lens practitioners' remuneration. Considerable effort is involved in obtaining the skills to test for and manage myopia appropriately, as well as effectively educating and communicating with parents and children.

TABLE 3. Lifetime Costs of Traditional and Active Myopia Management in France and the United Kingdom, by Gender and Age Groups.

	France										United Kingdom									
	TMM (Single Vision Optical Correction)		AMM1 (Low-Dose Atropine)		AMM2 (AM Specs)		AMM3 (AM sCLs)		AMM4 (OrthoK)		TMM (Single Vision Optical Correction)		AMM1 (Low-Dose Atropine)		AMM2 (AM Specs)		AMM3 (AM sCLs)		AMM4 (OrthoK)	
	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M
8-17 y	$3,614	$3,403	$8,347	$8,186	$3,824	$3,765	$9,679	$9,673	$5,495	$5,491	$4,383	$3,973	$12,854	$12,541	$5,966	$5,967	$6,908	$6,906	$6,664	$6,660
18-54 y	$11,880	$10,203	$8,768	$7,563	$8,178	$7,105	$8,760	$7,543	$8,691	$7,486	$17,541	$14,775	$11,817	$9,720	$10,788	$8,812	$11,811	$9,695	$11,688	$9,587
55+ y	$8,515	$7,617	$7,340	$6,446	$7,223	$6,347	$7,354	$6,459	$7,340	$6,446	$9,865	$8,991	$6,456	$5,811	$6,178	$5,553	$6,496	$5,848	$6,456	$5,811
Lifetime	$24,009	$21,223	$24,456	$22,195	$19,226	$17,217	$25,794	$23,676	$21,526	$19,422	$31,789	$27,738	$31,128	$28,072	$22,932	$20,331	$25,216	$22,449	$24,808	$22,059

AMM = active myopia management; AMM1 = low-dose atropine (0.01%-0.05%); AMM2 = anti-myopia spectacles; AMM3 = anti-myopia soft contact lenses; AMM4 = orthokeratology; F = female; M = male; TMM = traditional myopia management.

The choice of whether or not to wear contact lenses for vision correction—not myopia control—is the major contributor to the greater costs incurred by female compared to male individuals.[26,27] Increasing magnitudes of myopia are associated with an increasing rate of contact lens wear, and the contact lens wear rate at each spherical equivalent refraction is greater in female than male patients.[27] This suggests that, rather than biological reasons, cultural and gender factors might be at play. Compared to male patients, female patients have reported that wearing spectacles affected their self-perceptions and more commonly reduced their self-perceptions of attractiveness.[37] Adolescent self-esteem has also been explored, in which girls were found to rate themselves with lower physical appearance scores compared to boys. The societal emphasis on women's appearance has been suggested to be the cause of lower scores.[38]

Despite the higher costs incurred with some AMM compared to TMM (ie, without discounting, low-dose atropine and anti-myopia soft contact lenses in France), reducing the level of myopia that individuals reach could be perceived as more valuable than a cost saving. Individuals who have high levels of myopia (less than −10 D) have reported reduced vision-related quality of life compared to those with moderate or low myopia. Aspects associated with a worse vision-related quality of life included psychological, cosmetic, and practical factors.[39] However, further research on the personal perceived value of AMM and cost-effectiveness with the latest interventions is needed.

Some limitations exist within the present study. First, by taking a starting point of a child presenting with −0.75 DS myopia, this study does not consider the benefits of preventing or delaying myopia onset or cost differences that occur with patients presenting with higher baseline myopia or at a different age. Prevention or delayed onset may be even more beneficial than slowing progression. However, the challenges with itemizing the underlying costs of these interventions are more challenging than with myopia control products that are provided in existing healthcare systems. While it could appear free of charge for children to spend time outdoors, quantifying the cost of the time, promoting behavior modification, and provision of adequate, safe, and attractive outdoor space is not trivial. Models enabling dynamic adjustments of presenting age, baseline myopia, and different rates of duration of progression in adulthood would also be needed to capture the full spectrum of possibilities and cost estimates. Second, the efficacy rates of low-dose atropine at concentrations of 0.01% and 0.05% differ, yet were averaged as costs identified as the same for each concentration. Hence, our results might suggest overestimated lifetime costs if 0.01% were prescribed, and underestimated costs if 0.05% were prescribed. Third, the efficacy rate of each AMM was maintained throughout 10 years of each AMM. Evidence for each intervention varies, but it is rare for efficacy studies to extend beyond 3 years. Taking the average of the intervention time available might have overestimated the 10-year impact on refractive error progression.[40] Fourth, repeated low-level red light (RLRL) therapy has not been included in this study as an AMM option. To our knowledge, it is currently not widely used in France or the UK, and data are lacking on how long RLRL therapy should be or can be applied safely throughout childhood.[41] Furthermore, combination therapies were not included in this study, but could be explored in the future.

Financial investment in active myopia management during childhood is likely to reduce the total lifetime cost of myopia compared to traditional myopia management in Europe, even for some of those individuals at risk for slower progression. Reducing refractive progression can drive the need for only simpler lenses in adulthood, reduce the risk of pathology and vision loss, and subsequently improve quality of life. Choosing to treat and/or which myopia management modality to use should not only be dependent on cost differences, but each individual's preferences and vision need to be considered. It is not surprising, though, that the greatest economic advantage is derived by applying AMM to children who are predicted to be at higher risk for faster myopia progression, with savings up to US$13,071 in France and US$24,003 in the UK. While average myopia progression is slower in Europe than in East Asia, faster myopia progressors and high myopes do exist. Identifying those individuals at highest risk for faster myopia progress enables practitioners to predict those who will gain the most from AMM—a crucial step toward reducing the burden of myopia.

CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

Ling Lee: Writing – review & editing, Writing – original draft, Visualization, Validation, Project administration, Methodology, Formal analysis, Data curation. **Laura De Angelis:** Writing – review & editing, Methodology, Investigation, Data curation. **Erica Barclay:** Writing – review & editing, Visualization, Methodology, Investigation, Data curation. **Nina Tahhan:** Writing – review & editing, Project administration, Methodology, Funding acquisition, Conceptualization. **Kathryn Saunders:** Writing – review & editing, Resources, Investigation, Data curation. **Emma McConnell:** Writing – review & editing, Resources, Methodology, Investigation. **Neema Ghorbani-Mojarrad:** Writing – review & editing, Resources, Investigation, Data curation. **Annegret Dahlmann-Noor:** Writing – review & editing, Resources, Investigation, Data curation. **Anton Jaselsky:** Writing – review & editing, Investigation, Data curation. **Nicolas Leveziel:** Writing – review & editing, Resources, Investigation, Data curation. **Dominique Bremond-Gignac:** Writing – review & editing, Resources, Investigation, Data curation. **Serge Resnikoff:** Writing – review & editing, Supervision, Methodology, Funding acquisition, Conceptualization. **Timothy R. Fricke:** Writing – review & editing, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization.

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