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Key strategies to reduce the global burden of myopia: consensus from the international myopia summit

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ABSTRACT

In this paper, we describe key strategies to guide global collaborative efforts to further reduce the burden of myopia and myopia-related visual impairment. A modified Delphi method was applied as an iterative multistage process to collect expert and stakeholders' opinions and extract consensus strategies regarding myopia diagnosis, prevention and control. Anonymous pre-meeting preparation rounds, structured discussions for prioritisation and the development of key consensus areas were performed. Consensus was reached on three key areas to collaborate and complement existing frameworks: (1) Myopia defined not only as a refractive error but also as a disease with phenotypic features allowing for risk stratification of significant visual impairment. (2) In addition to preventive strategies, a focus is needed on preventing progression to high myopia (HM). (3) A focus on preventing and treating pathologic myopia (PM), that is, end-stage of myopia disease with irreversible visual impairment. In conclusion, the workgroup suggests a global, collaborative strategy that is needed across public health, healthcare and advocacy sectors to support efforts in reducing visual impairment from myopia. Complementary to existing preventive public health efforts, additional focus on defining myopia as a disease with risk stratification for visual impairment and an emphasis on reducing visual impairment associated with HM and PM should be considered.

INTRODUCTION

Myopia and its associated complications are recognised as a global public health problem.[1] A lack of data on costs to health systems and robust studies of its socioeconomic impact on individuals and caregivers has led to the underestimation of its importance, which is why myopia has a low disability weight.[2] Prevalence rates of up to 80% for myopia and 30% for high myopia (HM) have been observed among high school students in certain East Asian regions, eg, Taiwan, Singapore and Japan, as early as 30 years ago.[3–7] These individuals are now middle-aged adults at risk of developing pathologic myopia (PM) and other myopia-related complications with the potential for irreversible visual impairment. Reduced outdoor time is a risk factor for myopia development, and behavioural changes along with increased screen time indoors from a young age may contribute to rising myopia prevalence, not only in Asia but also globally.[8–13]

While myopia prevalence continues to increase around the world, some of these projections assume that myopia continues to increase without action or policies to address these concerns. However, the WHO, together with the International Agency for the Prevention of Blindness (IAPB), have attempted to lay important groundwork to stem the public health burden of myopia. The 'Global Scientific Meeting on Myopia' in 2015 agreed on definitions of myopia, HM, PM including the term 'myopic macular degeneration' (MMD).[14] Subsequently, two WHO/IAPB-sponsored workshops in 2018 and 2019 provided further agreement on future research directions[15 16]: key findings from the 2018 workshop included the recognition of the need for more prevalence data and school-based screening programmes and to address widespread public misconceptions about myopia and myopia control. Recommendations to focus on public education and raising awareness about increased outdoor time to reduce the onset of myopia in young children were published.[15] The 2019 workshop defined goals for future directions in clinical research for myopia. Particularly, the need for more long-term studies to identify risk factors for the progression to PM was emphasised.[16]

Despite recent advances in the field of myopia and myopia control interventions,[17–22] concerns remain about their effectiveness in achieving the overarching goal of reducing myopia-related visual impairment and blindness. Thus, during the third workshop in 2024, we used a modified Delphi method to reach a consensus on strategic areas for supplementary future efforts to reduce the global burden of myopia.

METHODS

Study design

A modified Delphi method was applied as an iterative multistage process to collect stakeholders' opinions and extract group consensus (figure 1). This approach was deliberately selected to explore potential strategies for future action, rather than to reach consensus on a pre-existing therapy or intervention.[23] Accordingly, we did not establish an a priori consensus threshold, facilitating a more flexible exploration of diverse expert opinions.[24] In alignment with established protocols for Delphi

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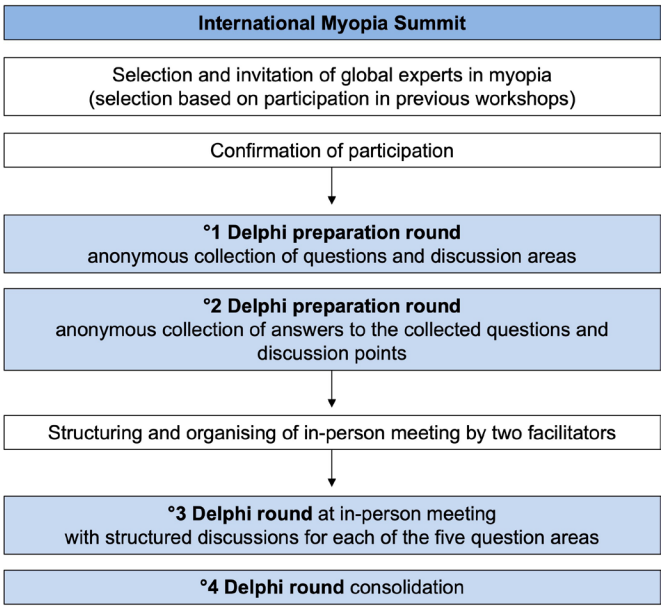

Figure 1 Flow chart of the modified Delphi method applied for the 2024 International Myopia Summit.

studies in healthcare and to ensure a broad representation of viewpoints while maintaining methodological rigor in terms of iteration, anonymity, controlled feedback and convergence of opinions, we recruited a panel of 40 experts.[25]

Panel composition

The selection of panellists was developed over several years from previous WHO and IAPB workshop committees from 2018 and 2019.[15 16] The panellists were chosen based on their expertise, contributions to myopia research and involvement in related public health initiatives and were willing to contribute and participate in this modified Delphi exercise. The selected international panel included individuals from all regions represented by IAPB and WHO, predominantly from the Western Pacific and Asian regions.[12 26] We also included panellists from other geographical areas, including North America and Europe, to provide a broader perspective. To address the multifaceted nature of myopia-related challenges, the panellists represented various sectors, including non-governmental organisations, public health agencies, clinical practice, academic research and industry.

Pre-meeting: Delphi rounds °1 and °2

Panellists were engaged 6 months before the in-person meeting through two rounds of anonymous, iterative pre-meeting activities, designed to elicit and refine the range of issues and potential strategies to be discussed. In the first round, panellists were requested to submit questions and discussion points relevant to their specific areas. These submissions were anonymised and compiled by two facilitators, who then redistributed them to the entire panel. In the second round, panellists provided anonymous feedback to the compiled questions. These responses were categorised into thematic areas to structure and facilitate focused discussions during the International Myopia Summit (IMS), held in Singapore from 19 to 21 January 2024.

In-person meeting: Delphi rounds °3 and °4

During the IMS workshop, structured discussions across the thematic sessions constituted the third Delphi round. Sessions were moderated by two to four chairpersons, typically workgroup leaders, and involved a minimum of four panellists to ensure diverse input. The chairpersons of the sessions received the anonymous answers from the second Delphi round beforehand and were asked to prioritise and engage all panellists equally: the discussions focused on developing and identifying actionable strategies to reduce the burden of myopia and myopia-related visual impairment. Additionally, challenges of implementing public health interventions and the role of different stakeholders, including industry and government entities, were addressed. On the final day, during the fourth Delphi round, the collective opinions on the identified strategies were consolidated and subjected to comprehensive deliberation and vote. Subsequently, the workgroup leaders reviewed, agreed,and summarised in this report the primary consensus strategies.

RESULTS

Consensus strategy (1): myopia should be defined not only as a refractive error but as a disease with specific phenotypic features and stages, that is, myopia with significant visual impairment

The current definition of 'myopia' is included under code 9D00.0 of the International Classification of Diseases 11th Revision (ICD-11) for Mortality and Morbidity Statistics: "myopia is a refractive error in which rays of light entering the eye parallel to the optic axis are brought to a focus in front of the retina when ocular accommodation is relaxed. This usually results from the eyeball being too long from front to back, but can be caused by an overly curved cornea, a lens with increased optical power, or both. It is also called nearsightedness".[20 27] Although the current definition notes that there are different underlying causes for a myopic refractive error, this definition does not adequately describe the impact of myopia as a disease. Myopia encompasses a variety of clinical phenotypes with different risks for complications that may eventually lead to vision impairment or blindness.

The Delphi participants concluded that neither this definition nor the definition of 'degenerative high myopia' (code 9B76)[28] sufficiently reflects the burden related to myopia. For instance, the risk of retinal detachment in a moderate to HM (with a spherical equivalent refractive error between −3.0 to −5.0 dioptres (D)) is 10 times higher than compared with that of a non-myope.[29 30] Cataract occurs earlier in patients with myopia and also the risk of open-angle glaucoma is elevated in patients with higher degrees of axial myopia.[14 16 20 30–33] While not all myopia stages are associated with complications, criteria beyond refractive errors need to guide myopia's definition as a disease.

Hence, participants of the Delphi meeting agreed that there is a need for a novel definition of myopia, one that is cohesive in its reflection of myopia's actual burden of disease. Analogously to hypertension for the cardiovascular system, myopia is both a risk factor and a disease that requires acknowledging and differentiation of specific stages with varying risk levels for complications.[30 34]

Experts from the public health sector and clinicians need to collaborate and elaborate on such a new definition of myopia. Similarly to the guidelines for hypertension, which have evolved substantially in the past decades,[35–38] new guidelines and myopia staging are essential. A myopia definition that encompasses axial myopia that is associated with specific phenotypic features,

eg, myopia-related ocular changes, lattice degenerations, cataracts, etc, and disease stages[20] will aid in risk stratification and identifying individuals at risk of severe visual impairment or blindness.[39] This definition should acknowledge that not only refractive error but also other clinical signs are necessary to comprehensively describe myopia as a disease. In summary, the panellists envisage a definition of myopia as a disease with different degrees of severity. Such a definition should include characteristics associated with complications, for example, peripheral retinal changes, increased axial length and the presence of peripapillary atrophy. Recognising these stages of disease and their associated complications should lead to a better understanding of the impact of myopia on visual health and more effective management strategies.

Consensus strategy (2): focus on prevention of HM as a stage of high-risk disease with a relevant risk of sight-threatening complications (in addition to prevention of myopia)

Preventing and slowing myopia in childhood continues to be the backbone of reducing the future burden of myopia.[22 40 41] However, all participants concluded that a comprehensive approach to reduce myopia, together with an aim of preventing progression to HM, is needed. Although global awareness of myopia and its complications has increased in the last decades, continuous efforts to raise awareness are also needed. Education and advocacy are pivotal to promoting early detection and reducing future burdens.[1 42 43] Panellists underscored the importance of integrating myopia prevention and management into broader public health initiatives, as well as the necessity of including other sectors such as the educational sector in this process.[22] Accordingly, outdoor time has been recognised as a protective factor against the onset of myopia, leading to various approaches aimed at increasing children's outdoor activities. In Singapore, a focus has been on educating parents to take responsibility for their children's eye health, including recommendations for more time outdoors, while in Taiwan, proactive interventions through the school system have been introduced, with evidence suggesting that Taiwan's approach has been more effective.[44] A promising school-based study to include 120 min of outdoors time every day was shown to improve visual acuity, with extrapolations to myopia onset, but it requires further study on implementation and effectiveness in other countries' education systems.[44]

Despite the recognised importance of vision screening,[45–49] many countries have not yet implemented national screening programmes and, if they have, the uptake of referral services after screening is often low, especially in rural areas. Vision screening reduces uncorrected refractive error as new spectacles may be prescribed after screening. But it can only slow myopia progression if the children at risk or with myopia are referred to a myopia treatment clinic in addition to spectacle services. In the People's Republic of China, measures have been initiated to address the myopia epidemic, including systematic screening and referral programmes.[50] But with the exception of the People's Republic of China, where the government supports annual child eye health screening and resources for myopia research, most meeting participants confirmed a persistent and general lack of community and governmental understanding of myopia, as well as limited funding to support research and public awareness campaigns or interventions.

We continue to acknowledge the need for efforts on low-risk, mild to moderate myopia as a refractive error, especially as an uncorrected visual impairment. However, we do suggest additional attention towards HM. First, individuals with HM are at a higher risk of developing complications. Second, this advocates resources towards preventing irreversible visual impairment. Research has shown that the risk of MMD is in the range of 20–40 times for HMs compared with non-myopes,[32 49 51–53] and with each millimetre increase in axial length, the risk of MMD increases by ninefold.[54] One in three adults with HM has staphyloma,[55] a hallmark of PM.[56] Lastly, compared with other retinal diseases, PM is associated with the lowest quality of life,[57] affecting more and more individuals in their working age.[58] A focus on HM is also important because of the disproportionate increase in the prevalence of HM as the prevalence of overall myopia increases, leading to a long-term impact of myopia in the wider population, especially in regions with a high prevalence of myopia and low spectacle coverage.[59]

Almost all experts agreed that while all children should be engaged with regard to myopia prevention, myopia control strategies should focus on children (pre-myopic or myopic) at increased risk of progression.[60–62] Globally, most myopia control interventions and associated costs are borne by patients, leading to potential inequality in terms of accessibility around the world. Based on the consensus strategy (1) definition of myopia as a disease with various (risk) stages, children at risk of progressing to HM and eventually PM will be more easily identifiable, allowing for targeted treatment approaches. From a public health perspective, it is more cost-effective to prevent myopia progression than to treat PM, and the proposed approach specifically aimed at preventing the progression to HM appears even more advantageous. The potential productivity loss associated with the burden of uncorrected myopia in 2015 was estimated at US$244 billion (95% CI, US$49–697 billion) globally.[63] Furthermore, as the prevalence of HM and PM continues to rise, it presents an increasing burden on healthcare systems worldwide. Notably, MMD is responsible for blindness in 3.3 million people globally.[64] However, the workgroup also agreed that more studies are required to examine whole government cost analyses in various countries.

Depending on perspectives and regional differences, different opinions were expressed regarding specific questions about myopia control in children, for example, combination therapy, treatment tapering and cessation. Increasing outdoor time is well-established for overall prevention, but the implementation hurdles in the real world are significant. Newer approaches, such as outdoor scene classrooms, may have the potential to be employed on a wide scale but require further confirmation of their effectiveness.[65] Moreover, the effectiveness of interventions relies heavily on the accessibility and affordability of eye care services, especially for high-risk populations. Panellists agreed that the barriers related to access and costs for clinical myopia control are omnipresent. Also, additional research on the long-term and real-world effects of all interventions is necessary.[18 58 65–67] To address the challenges, public health experts, scientists and clinicians need to continue working together. This should include the promotion of healthy lifestyle habits, as well as ensuring equitable access to timely and appropriate interventions, particularly for those at risk of developing HM. Panellists agreed to unanimously stress the importance of reducing the incidence and prevalence of HM and advocated to drive policy change and gain government support.

Consensus strategy (3): a combined focus on prevention and treatment of PM—a disease stage with irreversible visual impairment

Delphi meeting participants agreed that the knowledge about the factors leading to progression from an event-free myopia, ie, from HM without complications, to the state of PM is still limited. Although it has been established that in HM, the risk of developing PM and myopia-related complications is significantly increased[1 14 16 32 56 68 69] and that there is an increased risk of PM with age, there is a general lack of knowledge on other underlying factors that contribute to this process. Changes occurring in various parts of the eye with higher degrees of myopia should be better understood[16 70]: the anatomical differences in HM compared with non-myopic eyes regarding various ocular structures, eg, the sclera and its biomechanics need to be examined. Changes in both retinal and optic nerve tissues need to be differentiated, eg, glaucomatous optic nerve damage and myopia-related non-glaucomatous optic neuropathy. Most of all, actual treatment options for myopia complications and PM must be developed and improved in their effectiveness and invasiveness.[71]

The number of highly myopic patients with particularly complex situations is constantly increasing[32 72]: patients in need of cataract surgery in their forties who are already at increased risk for post-cataract retinal detachment due to significant peripheral retinal degeneration or patients with PM, including posterior staphyloma, MMD with myopic choroidal neovascularisation, myopic traction maculopathy or HM-associated optic neuropathy, in need of continuous and costly care by health professionals who themselves have persistent questions about prognosis and treatment recommendations for their patients. In conclusion, both diagnostic tools and the treatment of PM or myopia-related complications must be investigated.[16]

Meeting participants agreed on three realms of action which need to move simultaneously to prevent and treat PM: (A) in the public health space, more health economic studies on the long-term impact of HM and especially PM need to be conducted to engage governments and public health authorities for future allocation of resources. (B) Within the realm of clinical research, longitudinal studies need to examine the course of progression from HM to PM, allowing for the identification of risk factors and biomarkers to stratify individuals at risk of progression and the development of novel diagnostic and therapeutic targets. (C) Investment in basic research and development in both academia and industry are needed to create innovations for treating patients with PM and myopia-related complications. These innovations could include treatments aimed at reversing axial elongation or improving scleral health.

DISCUSSION AND CONCLUSION

The prevalence of myopia and HM continues to rise globally, with studies suggesting that the COVID-19 pandemic accelerated this progression.[8 73–78] We are falling behind, and we need to rethink our current approach. By consensus and as a community, we recognise the wide range of time-tested and evidence-based practices, from raising awareness and preventive measures, for example, increasing time spent outdoors, to early detection and screening, to interventions for myopia control. From a public health perspective, all these efforts need to continue. However, we would like to introduce additional strategies on top of these established efforts to counteract the global burden of myopia. Our consensus meeting of international representatives across all sectors agreed that a cohesive strategy is essential to reduce the burden of myopia-related visual impairment. The consensus strategies centred on a unified approach to the advocacy of a

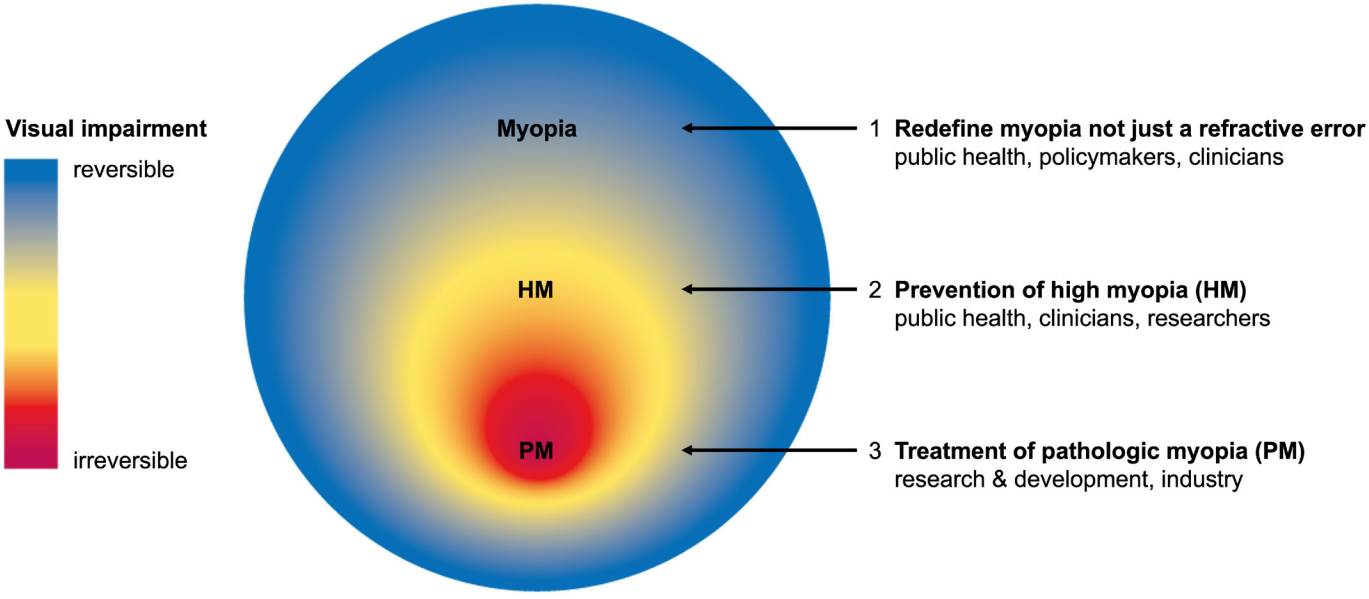

Figure 2 Three consensus strategies to tackle myopia and prevent myopia-related visual impairment and blindness. Necessary action level and resource allocation according to proposed disease stages of myopia. In the public health space, more health economic studies on the long-term impact of high myopia (HM) and especially pathologic myopia (PM) and myopia-related complications need to be conducted to engage governments and public health authorities for future allocation of resources. Future clinical research needs to involve longitudinal studies to examine the course of progression from HM to PM, allowing for the identification of risk factors and biomarkers to stratify individuals at risk of progression, as well as for the development of novel diagnostic and therapeutic targets. The new knowledge could further provide a basis for introducing screening for future PM in adults aged 30–40 years. Investment is needed in the basic research and development in both the academic and industry realms to develop innovations to treat patients with PM and myopia-related complications.

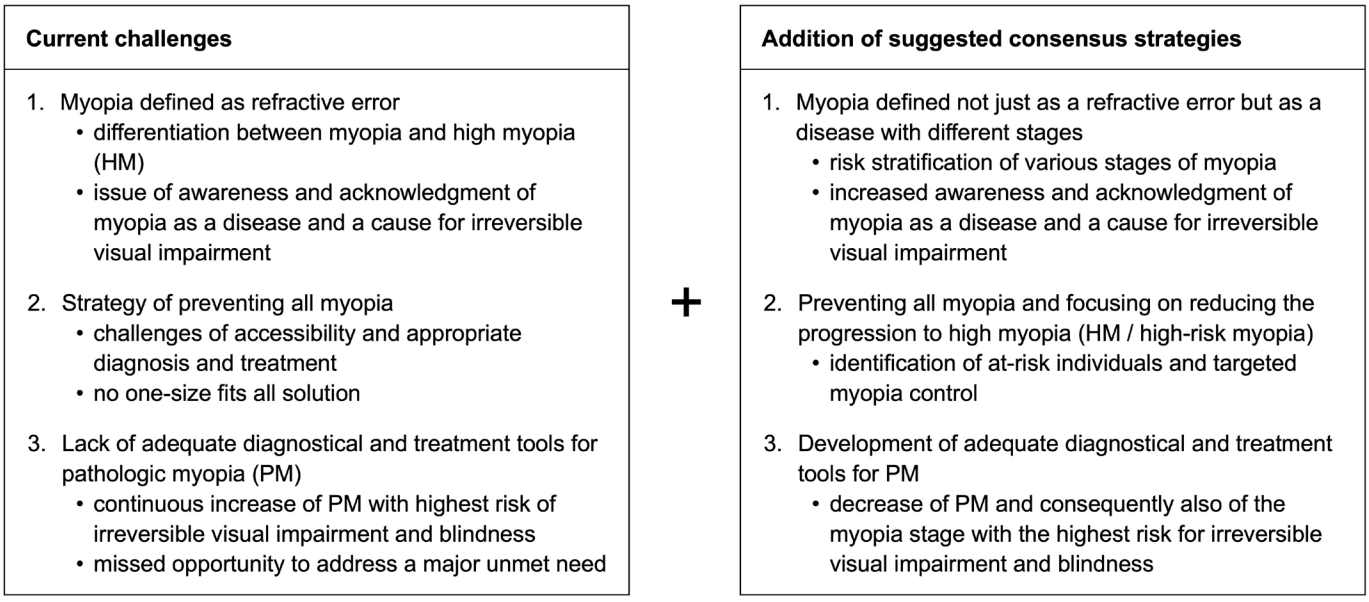

Figure 3 Overview of the current challenges and the workgroup consensus on the proposed adjunctive strategies, as outlined in this paper.

supplement in three key areas (figure 2): (1) redefining myopia as a visually significant disease with several stages; (2) focusing prevention efforts on high-risk individuals, hence reducing progression to HM; and (3) addressing the vision-threatening complications of HM and PM by prioritising the development of diagnostics and treatments for PM.

The consensus builds on and extends previous statements from the International Myopia Institute[79] and the World Society of Paediatric Ophthalmology and Strabismus.[80] While so far, the importance of prevention and management of myopia in its entirety was central, our consensus adds to the conversation by specifically redefining myopia as a disease with distinct stages and focusing on interventions targeting high-risk individuals. Participants unitedly underscored the necessity of tailoring interventions to different stages of myopia. Figure 3 summarises the main advantages of adding the elaborated three consensus strategies to the current approaches. Our consensus aims at suggesting an integrated approach to prevention, treatment and policy advocacy as a unified, global framework. Although we are proposing an additional focus, it should be made clear that our consensus strategies, which focus more on an adjunctive approach for high-risk individuals—and these are not intended to replace existing public health approaches—on the contrary, all aspects are needed (figure 3). Similarly, as public health experts have argued and highlighted in the past, there should be no conflict between the two approaches, ie, myopia prevention from a public health perspective and addressing myopia as a whole, plus targeting specifically 'high-risk' individuals, ie, children at risk of progression to HM, and individuals at risk of visual impairment from HM and PM.[81]

However, potential challenges to global implementation need to be addressed, including differences in healthcare infrastructure, accessibility of resources and cultural attitudes towards myopia management. Policymakers should consider these factors when developing strategies to ensure equitable access to myopia treatment for different populations. Specific strategies for implementation were discussed and agreed on to achieve the outlined goals and ultimately reduce the burden of myopia: the Delphi participants affirmed the need to recognise myopia as a lifetime disease, necessitating intensified research to support and inform advocacy efforts for policy and regulation. Integration into primary care services and co-management of services is required to effectively manage myopia at all disease stages. Furthermore, clear and consistent support and guidance for practitioners were considered crucial. Also, it was agreed that a unified voice is essential to steer governments towards developing and implementing preventative strategies. Robust evidence is needed to underpin an increase in the low disability weight assigned to myopia, specifically evidence on cost data on the health system impact, as well as on the social and economic impact of myopia, and specifically HM and PM. Additionally, integrating advocacy for preventative measures with other public health priorities, such as mental health, obesity and diabetes, was identified as a beneficial approach.

Our key strategies are in line with the recently published detailed report by American National Academies of Science.[82] The authors of which are equally emphasising the need to recognise myopia as a disease and of understanding underlying mechanisms of myopia development and progression. Similarly, they indicate the need for identification of individuals with myopia at risk of developing complications, as well as the necessity to reach out beyond the field of eye health to include, for instance, collaborations with departments of education.[82]

In addition, collaborative efforts to take advantage of technological advances will be critical to the management of myopia as a significant disease. Continued innovation and research will drive the next wave of myopia prevention and care. Participants expressed their views on integrating digital technology in managing the burden of myopia. Especially when it comes to tackling different stages of myopia, technological advances provide excellent opportunities to connect the various stakeholders and jointly develop a cohesive strategy. Digital platforms, artificial intelligence (AI)-driven diagnostics and advanced imaging techniques offer opportunities to enhance early detection, personalised treatment and efficient monitoring of disease progression. The necessity for longitudinal studies to identify risk factors for the progression from HM to PM was already identified over half a decade ago[16]; nevertheless, little progress has been made in this area so far. AI holds significant promise in redefining diagnosis and risk assessment identifying risk factors for progression from HM to PM and developing new treatment modalities.[83 84] Deep learning systems

show potential in detecting peripheral lesions and MMD based on fundus photos, offering early intervention opportunities.[84 85] Still, technology acts as a double-edged sword for myopia, potentially providing previously mentioned benefits, as well as numerous challenges. Issues of concrete implementation in clinical settings, infrastructure requirements, cybersecurity, new dependencies and loss of practical skills must be addressed. Finally, it should be considered that the myopia pandemic itself is being driven by advances in technology and its associated behavioural changes such as excessive screen time.

The applied method of a modified Delphi has several limitations. Most importantly, the selection of participants was based on the list of attendees of previous workshops, which consequently could have led to possible conflicts of interest and bias regarding geographical perspectives. Although we attempted to ensure that the Delphi panel and participants were as diverse as possible, we cannot realistically guarantee that all invitations were comprehensive, and we recognise the possible under-representation of certain views that could have further enriched the discussion. However, we developed the committee of participants through multiple workshops over several years[15 16] and sought to be inclusive across sectors as sanctioned by WHO. Moreover, an independent committee of experts from a different region and background developed similar conclusions and recommendations,[82] further reinforcing our discussion. While our current workshop was unable to cover every aspect of the vast number of discussion points that can arise, we seek to highlight the importance of these consensus points that may be used for further elaboration in the next meeting.

In summary, tackling the multifaceted challenges of myopia necessitates a unified, yet personalised approach. Alignment among experts is crucial; generating robust evidence, particularly regarding cost implications, is essential to garner government and policymaker support. By starting with an agreed, collaborative global approach including defining myopia as a disease with visually significant stages, efforts to focus on preventing progression to HM, in addition to preventing myopia as a whole, and finding novel and effective treatments for PM, we can drive meaningful changes to alleviate the global burden of myopia and promote visual health for all.

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