Review Article

Report of the National Myopia Prevention and Control Workgroup 2006: A Summary

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Abstract

Introduction: The National Myopia Prevention and Control Workgroup was set up to review current scientific evidence, to review the National Myopia Prevention Programme (NMPP) and to recommend strategies to the Ministry of Health. Methods: A Medline search was conducted to identify relevant articles. Workgroup members met with representatives from Health Promotion Board, Ministry of Education and several world-renowned myopia researchers. Results: Near work contributes to myopia development. Greater time outdoors significantly lowers the risk of myopia. Breastfeeding may be protective. Family history of myopia and higher IQ were associated with development of new myopia (level II evidence). Other risk factors such as PAX 6 genes, higher educational level, prematurity, Chinese race, female gender and socioeconomic status were significantly associated with myopia (level III evidence). There is no evidence to support the use of commercial products for retardation of myopia progression. Topical atropine is effective in slowing myopia progression. The NMPP overpromotes use of vision breaks with little emphasis on outdoor activity. Conclusions: Further research with better quantification of near work is recommended. The role of vision breaks should be de-emphasised. There should be more emphasis on outdoor play and stricter regulation of commercial devices. Atropine is recommended only in cases of rapid myopia progression or high, progressive myopia. The frequency of vision screening can be reduced. Future research efforts should focus on specific risk factors, reassessment of selected programmes and new treatment options. Reading material summarising the workgroup's findings can be distributed.

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Introduction

The prevalence rates of myopia, including high myopia (spherical equivalent at least –6.0 diopters), are rising to epidemic proportions in Asia. Singapore has one of the highest rates of myopia in the world.[1-3] To address this huge public health problem, the national disease control plan for prevention and control of myopia was developed in 2000. Subsequently, the Health Promotion Board (HPB) launched the National Myopia Prevention Programme (NMPP) in 2001. The National Myopia Prevention and Control Workgroup was set up in October 2005 to review current scientific evidence, to review the NMPP and recommend strategies to the Ministry of Health (MOH). The chairman of the workgroup was Dr Yvonne Ling and the members were Dr Quah Boon Long, A/P Wong Tien Yin and Dr Leo Seo Wei. Four resource people were appointed, namely A/P Donald Tan, A/P Saw Seang Mei, Dr Rose Vaithinathan and Dr Chew Ling. Dr Derrick Heng from the Epidemiology and Disease Control Division was the representative from Ministry of Health while Dr Julia Lim provided secretariat support.

Methods

A Medline search using PubMed was conducted to identify relevant articles published in the last 20 years (1987-2006). The proceedings of recent major international

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conferences on myopia research, such as the International Myopia Conference (August 2006) and the Association for Research in Vision and Ophthalmology (ARVO) meeting (May 2006) and Singapore Eye Research Institute and Association for Research in Vision and Ophthalmology (SERI-ARVO) meeting on research in Vision and Ophthalmology (February 2005), were included too. Information on commercial products was also obtained. HPB briefed the workgroup on the programmes and strategies carried out in the NMPP. Workgroup members also met with the HPB and schoolteachers from the Ministry of Education (MOE) to gather feedback. To be updated on the latest in myopia research, the workgroup members attended the 11th International Myopia Conference in August 2006. In addition, a closed-door meeting was arranged by HPB where the workgroup members met internationally renowned myopia researchers, namely Professor Paul Mitchell (Centre for Vision Research Westmead Millennium Institute, University of Sydney, Australia), Professor Josh Wallman (City College of the City University of New York) and Professor Ernst Goldschmidt (Danish Institute of Myopia Research).

Results

Risk Factors

Criteria for levels of evidence and grades of recommendation as used in the current Ministry of Health Clinical Practice Guidelines (Tables 1 and 2) were adopted. Most studies provided level III evidence and grade B recommendations unless stated otherwise.

1) Near work: Clinical experience and most epidemiology studies[3-9] (level III evidence) indicate the contribution of near work to the development of myopia. In the Singapore Cohort Study of the Risk factors in Myopia (SCORM), the initial cross-sectional analysis of data indicated that children aged 7 to 9 years who read more than 2 books per week had 3.05 times higher risk of moderate myopia (at least –3.0D of myopia).[10] However, in the SCORM cohort analysis of children who were not myopic at inception, reading (in books per week) did not predict the development of myopia in the next few years (level II evidence).[6] Other measures of near work, such as number of hours spent reading per day, using the computer, and diopter-hours were not associated with new cases of myopia (incident myopia). These contradictory results may be due to the inherent difficulties of measuring and quantifying near work.

2) Outdoor activities: Increasing time spent outdoors was significantly associated with a lower level of myopia, as shown cross-sectionally in the Sydney Myopia study[11] (level III) and prospectively in the Orinda Longitudinal Study of myopia[7] (level IIa). In the Sydney study, 3% of their 7-year-old Chinese children were myopic compared to 29% of 7-year-old Chinese children in Singapore (oral communication). The outstanding difference between the 2 groups was that the children in Sydney spent more time outdoors (4 times more) compared to our local children. The study also found that a larger proportion of Singapore children had educational coaching (tuition) than Sydney children and that they started education at age 3 years, younger than in Australia.

Table 1. Levels of Evidence

Level of evidence	Criteria
Ia	Evidence obtained from meta-analysis of randomised controlled trials
Ib	Evidence obtained from at least one randomised controlled trial
IIa	Evidence obtained from at least one well-designed controlled study without randomisation
IIb	Evidence obtained from at least one other type of well-designed quasi-experimental study
III	Evidence obtained from well-designed non-experimental descriptive studies, such as comparative studies, correlation studies and case studies
IV	Evidence obtained from expert committee reports or opinions and/or clinical experiences of respected authorities

3) Breastfeeding: SCORM[6] (level III) reported that a history of breastfeeding was independently associated with decreased likelihood of myopia after controlling for other risk factors. However, duration and type of breastfeeding (full-time versus part-time breastfeeding) were not associated.

Myopia was significantly associated with the following non-modifiable factors (most studies provided level III evidence except SCORM which provided level II evidence on some risk factors):

1) *Genetics*: PAX6 may be involved in myopia development in Asians[12]
2) *Parental history of myopia (level II evidence)*: This was significantly associated with myopia[3,4,6,7,13-16]
3) *Ethnicity*: In Singapore, prevalence rates of myopia were higher in Chinese than in non-Chinese[5,13,15,17,18]
4) *IQ (level II evidence)*: Children with higher non-verbal IQ were more likely to be myopic after controlling for confounders[6,19]
5) *Birth parameters*: Babies born prematurely, with low birth weight, or with retinopathy of prematurity were found to have higher risks[20]
6) *Gender*: Female gender is a statistically significant risk factor[6,15,16,17]
7) *Educational level, school performance*: This was again found to be significantly associated with myopia[5,7,13,14,17,21,22]

Table 2. Grades of Recommendation

Grade	Level of evidence	Criteria
A	Ia Ib	Requires at least one randomised controlled trial, as part of the body of literature of overall good quality and consistency, addressing the specific recommendation
B	IIa IIb III	Requires availability of well conducted clinical studies, but no randomised clinical trials on the topic of recommendation
C	IV	Requires evidence obtained from expert committee reports or opinions, and/or clinical experiences of respected authorities. Indicates absence of directly applicable studies of good quality
GPP (good clinical practice points)	–	Recommended best practice based on the clinical experience of the guideline development group

8) *Socio-economic status*: There is a positive association between higher myopia prevalence rates and higher socioeconomic status[4,5]

Although earlier studies showed that children with higher myopia were more likely to be taller than emmetropes,[14,16,23-25] the results of SCORM[20] (level III evidence) proved that although children with longer body lengths at birth had longer axial lengths and deeper vitreous and anterior chambers, there were no differences in refraction at ages 7 to 9 years, possibly because of observed compensatory flattening of the cornea.

Current Interventions

Commercial Products/Techniques

Commercial products for myopia are currently not regulated except for orthokeratology, which has guidelines issued by the Health Sciences Authority (HSA). A market survey using print advertisements and newspaper clippings revealed numerous interventions purported to reduce or prevent myopia, some of which are aggressively touted in schools. However, as detailed in Table 3, there is no scientific evidence to show the efficacy of these products. The anecdotal accounts of 'improvement' or reduction of myopia may be related to pseudomyopia[26,27] which often occurs in children because of their high accommodative facility.

Orthokeratology (also called OK, ortho-k, corneal reshaping, corneal refractive therapy or vision shaping treatment)[28] is a clinical technique that uses specially designed rigid contact lenses to reshape the cornea to

Table 3. Other Commercial Products/Techniques

Name and cost	Description	Indications	Evidence
"Eye Relax" from Energie Eyecare, $500	Microscope-like device. Users peer into the eye-pieces to see a kaleidoscope of brightly coloured lights, which focus and defocus.	Purported to improve vision of emmetropes, myopes and even presbyopes, besides preventing the worsening of myopia.	No published studies.
"EYExercise" from Life Compact Health, $700	Users look into this microscope-like device for 15 minutes per eye, 2 to 3 times a day. Images of plants and animals are presented and change every 20 seconds. Images blur and become clear in turn.	Advertised to improve vision in all age groups, all degrees of myopia as well as those with perfect eyesight to improve vision.	No published studies.
Vision Therapy Eyewear, cost variable	Pinhole spectacles, which are black opaque lenses with multiple small holes.	For myopes of up to 4 diopters while watching television or reading. A 10% to 20% improvement in vision, even elimination of myopia is advertised.	No published studies.
Bates Method, cost variable	"Self-healing" of the eyes. Good habits of natural perfect sight are taught to the child and parents at the workshop.	Advertised benefits include relaxed vision with better eye-mind coordination, improved memory and concentration, improved colour vision and depth perception.	Anecdotal reports. *(Reference: Perfect Sight Without Glasses by William H Bates)*
Eye supplements, cost variable	Tablets containing ingredients such as bilberries and wolfberries sold at health food stores and pharmacies.	Promote healthy eyes.	No published studies.

temporarily reduce or eliminate refractive error. The patient wears reverse geometry lenses overnight and reduction in the myopia (up to –4D) is achieved by central epithelial thinning, midperipheral epithelial and stromal thickening. When the lenses are removed in the day, the patient does not require glasses to see clearly. Clinical trials[29-32] showed temporary effects without permanent reduction of myopia after discontinuation of lens wear. There is currently no evidence for long-term efficacy of reducing myopia progression, despite a lot of anecdotal examples. The Longitudinal Orthokeratology Research In Children (LORIC) in Hong Kong, a pilot study on refractive changes and myopia control, suffered from scientific flaws.[33] The safety of orthokeratology is questionable with numerous reports of severe microbial keratitis.[34-36] Orthokeratology lenses are fitted by optometrists and are priced around $1000 to $2500 as a 1-year package. These practitioners should have undergone a designated course. Practice guidelines for orthokeratology have been issued by HSA but the practice is not further regulated.

Neurovision® technology is a programme where the user looks at special patterns on the computer screen. This is a patient specific, neural adaptation programme based on visual stimulation and facilitation of neural connections at cortical level. The user is required to make choices on which of 2 images presented at a time is clearer. Thirty sessions cost about $1000. Small studies have shown improved unaided visual acuity and contrast sensitivity in adults with low myopia (–1.5D and below)[37] and improved vision in adult amblyopes. The SERI is currently carrying out pilot studies on the effect of Neurovision on unaided visual acuity in children with myopia. It is not used for retardation or prevention of myopia.

Other Interventions

Atropine 1%: The instillation of 1% atropine eyedrops daily over a 2-year period reduces myopia progression significantly in children, with a mean progression of myopia of –1.20D in the control group and –0.28D in the atropine-treated eyes[38] (level 1 evidence). Side effects include photophobia secondary to mydriasis and loss of accommodation. The child has to wear expensive photochromatic and progressive addition lenses if both eyes are treated simultaneously. Photophobia may also limit outdoor activities. In addition, following the cessation of atropine treatment, there appears to be an initial increased rate of myopia progression (–1.1D in the atropine group and –0.39 in the control group) although overall the mean progression after 3 years was still lower in the atropine-treated eyes (–0.95D) than in the placebo group (–1.58D).[39] Daily atropine usage over a period of 2 years for the treatment of myopia has no significant effect on retinal function as demonstrated by recordings of multifocal electroretinogram.[40] Safe duration of treatment and long-term side-effects are not known.

Although the Asian Pirenzepine Study[41] has shown that the relatively selective M1 antagonist, pirenzepine ophthalmic gel (2% twice daily) was effective and relatively safe in slowing the progression of myopia over a 1-year treatment period, this gel is currently not commercially available.

There is no evidence to date that wearing undercorrected spectacles or part-time wear may retard myopia progression. One study (level II evidence) suggested that undercorrected spectacles may worsen myopia progression but this was not clinically significant.[42] In Singapore, optometrists and opticians are not licensed to use cycloplegic eye drops in optical shops. As such, manifest refraction rather than cyclorefraction is done for children at optical shops. The practice of prescribing undercorrected glasses is probably employed to counteract excessive accommodation found in young children. Another study[43] found that the difference in myopia progression between a group of children with fully corrected myopia and a group with undercorrected myopia was not statistically significant.

Various clinical studies, including a prospective randomised trial involving local schoolchildren, showed that progressive addition lenses have no clinically significant effect in slowing myopia progression.[44-50] Some studies showed statistically significant results but overall, the effect size was not clinically important except in certain subsets, in particular those with accommodative lag and esophoria[45] (adjusted treatment benefit of 0.64D after 3 years or lower baseline myopia –0.48D). The findings require further research. Thus, progressive addition lenses are not recommended for control of myopia progression in the general paediatric population.

There is no evidence to date that wearing contact lenses (soft, RGP, orthokeratology) retards myopia progression.[48,51-55]

National Myopia Prevention Programme

The NMPP was launched in August 2001 and implemented under School Health Service, Health Promotion Board (HPB). Two committees were formed: NMPP Steering Committee (July 2001) which is currently chaired by Associate Professor Donald Tan and comprises of representatives from MOE, Singapore Armed Forces (SAF), Ministry of Community Development, Youth and Sports (MCYS), National University of Singapore (NUS), Singapore Eye Research Institute (SERI) and professional groups; and Myopia Registry Committee which oversees a database that provides functional support for NMPP (currently subsumed under NMPP steering committee).

In 2000, the prevalence of amblyopia among Primary 1

students was 1.7%. The prevalence of Primary 1 students with defective vision (this was measured using a surrogate marker of myopia - unaided visual acuity of 6/12 or worse) was 33%.[56] The prevalence rate of Primary 6 students with defective vision was 65%.[56] The prevalence rate of Primary 6 students with severe defective vision (defined as unaided visual acuity worse than 6/60) was 13%.[56]

The NMPP's chosen outcome targets were as follows:

1) Reduce the prevalence of amblyopia among Primary 1 students by 10% to 1.5% in 2007 and by 40% to 1% in 2012.
2) Maintain prevalence of Primary 1 students with defective vision at not more than 33% in 2007 and reduce this prevalence by 10% in 2012 to 30%.
3) Maintain prevalence of Primary 6 students with defective vision at not more than 65% in 2007 and reduce this prevalence by 5% in 2012 to 62%.
4) Maintain the prevalence of Primary 6 students with severe defective vision at not more than 10% in 2007 and reduce this prevalence to 8% in 2012.

Strategies employed under the NMPP included annual vision screening in preschools, primary and secondary schools by trained ophthalmic assistants and nurses, eye care education such as vision break messages, promotion of good eye care habits, small group education/individual counselling, school-based programmes such as Eye Care Week and the setting up of the Spectacles Fund to help needy students pay for spectacles. There is currently heavy emphasis on the use of vision breaks in the NMPP messages, with little emphasis on outdoor activity. Although awareness among the schoolchildren on taking vision breaks was high, actual compliance was poor as a result of factors such as time constraints, demands of academic curriculum, obstructed view of distant targets and lack of discipline.

The use of the visualiser and computer projection requires dimming of classroom lighting. Consequently, some students have complained of eyestrain. However, no studies have been done to prove or disprove the relationships between visualiser and eyestrain, and that between eyestrain and myopia progression. Vision screening is currently carried out annually on all students with no specific focus on high-risk groups, such as children born prematurely and children with strong family history of high myopia.

Conclusions

Based on the above findings, the National Myopia Prevention and Control Workgroup made several recommendations to the Ministry of Health.

It is necessary to continue monitoring the scientific evidence for the role of near work in myopia. Further research with better quantification of near work is recommended. The role of vision breaks in myopia prevention should be de-emphasised in the NMPP, until its efficacy in myopia prevention is shown by studies in selected schools. Schools should continue to avoid prolonged periods of near work, ensure adequate illumination in classrooms and give greater emphasis to outdoor sports and activities. To avoid unnecessary near work, extra reading in schools should be selectively targeted according to the child's reading habits, such as selective reading for children who do not read well instead of the whole class.

Prevention of myopia should begin in preschools. NMPP can improve the education of parents and caregivers as well as preschool teachers with regards to healthy eye habits. In early childcare centres, there should be more emphasis on outdoor play activities with minimal or no time spent on viewing videos and computers.

As new evidence suggests that outdoor activities play a role in myopia prevention, more facilities for outdoor play should be provided in daycare centres, schools and residential areas. Prospective studies that quantify outdoor hours could be done to confirm the protective effect of outdoor hours in our local population. The importance of outdoor activities in myopia prevention should be incorporated into NMPP messages and programmes. Each student should be encouraged to take up at least one recreational sport. Playing fields in school can be better utilised, with protected time during school hours for outdoor activities. The MCYS should be invited to help organise outdoor activities and community sports.

As the evidence for breastfeeding is from one study only, it is premature to significantly emphasise this benefit when promoting breastfeeding. Breastfeeding should continue to be promoted for its other health and nutritional benefits. Further studies to quantify and evaluate any protective effect are required.

There is clearly no scientific evidence that any of the commercial devices for myopia treatment can truly reduce myopia or retard the progression of myopia. In view of possible harmful side effects of some interventions like orthokeratology, there should be stricter regulations and better monitoring of adverse events by the relevant authorities. Companies bringing in these products should be asked to carry out properly conducted scientific studies of the products before making unsubstantiated claims. The public needs to have a better understanding of the safety and efficacy of the methods and devices currently available in order to make informed choices. Relevant authorities such as the HSA and Consumers Association of Singapore (CASE) should be equipped to provide the relevant information. Till the efficacy of such devices is scientifically proven, they should not be openly supported or endorsed by schools or the MOE.

The use of topical atropine to retard myopia progression is recommended only in cases of rapid myopia progression or high, progressive myopia. Safe duration of treatment and long-term side effects are still not known. The routine use of other methods, like part-time wear, undercorrected spectacles, progressive additional lenses and contact lenses, for retardation of myopia progression is not recommended.

The frequency of vision screening can be reduced. Instead of performing vision screening yearly at all levels, it can be carried out only for children at pre-school, Primary 1 and 6 levels. Screening at Primary 3 is optional.

For research purposes, funding should be channelled towards selected schools so as to allow evaluation of specific risk factors and reassessment of selected programmes of the NMPP in a controlled environment. Proper outcome measures including cycloplegic refraction and not merely logMar visual acuities should be collected. Studies need to be done to better understand the basic science of myopia, to determine risk factors of myopia, the risk of developing visual threatening complications of myopia, and to develop better treatment of these complications. The aim of all this is to determine how and at whom myopia prevention strategies should be targeted. Current treatment of myopia is unsatisfactory. Further research efforts should also focus on identifying future treatment options for myopia. Randomised clinical trials should also test the validity of new and current treatment options and examine the effects of prevention or treatment strategies on ocular function, structure and morbidity. Issues that must be addressed in order to develop successful, long-term treatment for myopia include: 1) identifying which children might benefit from a particular treatment (drugs, lenses), 2) finding a treatment with minimal side effects while providing longer lasting benefit, 3) determining when to institute a treatment and for how long to continue it.

To improve awareness on prevention and control of myopia, the workgroup recommends that reading material and brochures summarising the updated evidence and recommendations of the workgroup should be distributed to medical and eye care practitioners and possibly, the general public, under the auspices of the NMPP.

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