Myopia with the focus on the prevention and management thereof.

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There is no shortage on publications on myopia and it remains one of the most researched areas in the eye care world. Notwithstanding this plethora of articles, researchers all over the world are still debating the possible aetiologies and mechanisms behind myopia development and progression. The debate on prevention and or control of myopia is filled with even more conflicting evidence. According to Global Burden of Disease estimates, uncorrected distance refractive error is the second largest cause of blindness and the leading cause of moderate and severe vision impairment in the world [1] and I believe it is for this reason that it is important to find general and acceptable ways of dealing with the threat of myopia. According to a document released by the WHO in 2017, the direct and in direct loss of world productivity due to uncorrected refractive error, amounts several hundred billions US Dollars and is still increasing [2]. Published estimates based on epidemiological studies indicate that myopia affects 1.89 billion people worldwide, and, if the current prevalence rates do not change, projections show that it will affect 2.56 billion people by 2020 [3]*.*

There is therefore no argument that the prevalence of myopia is much higher today than it was even 30 years ago and hopefully everyone should now be in agreement that myopia cannot simply be regarded as a “genetic disease” because the [genetic change](https://www.sciencedirect.com/topics/medicine-and-dentistry/gene-mutation) is too slow to explain the rapid changes in prevalence that have taken place. There are no shortage of theories on the mechanisms of myopia development and progression. Genetics, near work, time indoors, artificial lighting, diet; all these factors have been investigated as potential causes of myopia. While the research to fully understand this phenomenon is still in-progress, where does it leave the optometrist that needs to deal with this on a daily basis?

I have no intention to try and present a total review on myopia but will rather focus on the latest research [since 2016] and attempt to provide some guidance on the management of myopia. If you wish to read more comprehensive reviews you can read the January 2017 version of the myopia manual [4] or try and get hold of a review done by Dirk Booysen in 2012 [5]. Recently the Brien Holden Vision Institute embarked on a worldwide project presenting courses in several counties on the management of myopia confirming that the emphasis in myopia studies is shifting towards the management thereof. They have developed a wonderful tool, called the myopia risk calculator that I will discuss later in this publication [3]. To allow for a goal directed management programme it is essential to understand the epidemiology of myopia and create myopia risk profiles for your patients since the latest research [3, 6, and 7] clearly shows that we are dealing with a condition that can be caused by various factors.

## In January this year Morgan et.al. (2018) published an excellent review on the epidemics of myopia and looked specifically at the aetiology and prevention thereof [6]. Holden et.al. (2016) produced an outstanding systematic review and meta-analysis of the prevalence of myopia and high myopia and estimated temporal trends from 2000 to 2050 using data published since 1995 [3]. The primary data were gathered into 5-year age groups from 0 to ≥100, in urban or rural populations in each country, standardized to definitions of myopia of -0.50 dioptre (D) or less and of high myopia of -5.00 D or less, projected to the year 2010, then meta-analyzed within Global Burden of Disease (GBD) regions. They then used this prevalence data and combined it with urbanization data and population data from United Nations Population Department (UNPD) to estimate the prevalence of myopia and high myopia in each country of the world. These estimates were combined with myopia change estimates over time derived from regression analysis of published evidence to project to each decade from 2000 through 2050[3].

They included data from 145 studies with combined sample size of 2.1 million participants. This allowed them to make the following estimations at a 95% confidence interval:

In 2000:

1406 million people with myopia (22.9% of the world population)

163 million people with high myopia (2.7% of the world population)

Prediction for 2050:

4758 million people with myopia (49.8% of the world population)

938 million people with high myopia (9.8% of the world population)

It should therefore be pretty obvious why myopia is now considered to be an epidemic. The impact of this on society as a whole is going to be immense. The burden this going to put on socio –economics, education and general family life may be beyond what we ever could imagine. Therefore the big challenge for the future would be to plan for this with the primary emphasis on prevention of low myopia and managing and preventing myopia-related ocular complications and vision loss among almost 1 billion people with high myopia.

Aetiology of Myopia:

The prevention and management of myopia can only be successful if we have a clear understanding of the aetiology thereof and herein lies the biggest problem and challenge. There seem to be lack of consensus among researchers on this matter. At least it is now generally accepted that genetics is not the only factor, but just one of the risk components in a condition where several factors seem to contribute. This has also resulted in different organisations and researchers attempting to enter into the “nature vs. nurture” debate by producing various classification systems for myopia to try and separate genotypic causes from other phenotypic factors. The American Optometric Association published an extensive summary [8] comparing the different classification systems. They gave preference to a classification by clinical entity: simplemyopia, nocturnal myopia, pseudomyopia, degenerative myopia, andinduced (acquired) myopia but recognize that other systems may classify myopia by degree(i.e., low, medium, or high) or by age of onset (i.e., congenital, youth onset,early adult-onset, late adult-onset). The importance of this is that a somewhat different diagnosis and treatment strategy may be required for eachtype of myopia. According to them, simple myopia and nocturnal myopia may be viewed asphysiologic forms of myopia because the only deviation from normalstructure and function is the need for minus power lenses for normal distance visual acuity. Degenerative myopia, also called pathological myopia, is due to the development of structural defects in the posteriorsegment of the eye. Induced myopia may be viewed as a secondarymyopia that is pathologic in nature, i.e., some external agent or alterationof normal physiological function has induced the myopia, which is often temporary [8].

Children with one or both parents who are nearsighted are likely to develop nearsightedness themselves. Our cultural shift to online time and close reading over the past one hundred years or more has also contributed. And children’s general lack of time spent outdoors, whether engaged in sports or just playing at the beach, seems to have a significant impact on the risk of developing myopia.

Sadly these classification systems do not provide us with sufficient information to determine the true aetiology of these different kinds of myopia that is so critical in the management and prevention of this condition. All the conflicting reports that we find in the literature are also not helping us. Maybe Claus Schmid’s summary on the latest research [8] confirming that there are certainly several factors that are more helpful. He states that people with a certain variant of the gene ‐ called APLP2 ‐ were five times more likely to develop myopia in their teens if they read for an hour or more each day as a child. Children who carried the APLP2 risk variant, but spent less time reading had no additional risk of developing myopia. This suggests that myopia is not inherited as such but that people with this gene variant are at greater risk in developing myopia under a certain set of environmental conditions. In their review Zorena et al (2018) [9] suggest that there may be several genes involved, It is furthermore well known for some years that the neurotransmitter Dopamine has, as well as the time‐spent outdoors a positive impact on preventing the onset of myopia. The interaction appears to be: Vitamin D as well as a reasonable level of illumination – both increased by the time spent outdoors ‐ favour the built up of dopamine, which at the end of this chain works against the myopic stretching of the eye. The negative effect of extensive accommodation on the onset and the progression of myopia have also been known for a long time. New is the observation that in many cases an existing hyperopia is the basis of this extensive and harmful accommodation, which can be avoided by using plus lenses. This is especially important, as the developing eye of children is generally hyperopic [8].  The rapid increase in prevalence of myopia should therefore be considered as a combination of these factors. As Steven Turpin once put it; “myopia is a predisposition not a destiny” [10].

**Management of myopia:**

**Different therapies:**

With more than 2 billion myopes in the world it is not surprizing to see more people jumping on the bandwagon and proposing different options for intervention. These choices range from several different optical corrections, pharmacological drugs and a variety of therapies. Some of the more unusual therapies relates to myofascial manipulations that will soon see chiropractitioners entering the myopia market. Disturbances in vision is said to lead to increased tension within the trapezius and the sternocleidomastoid muscle, which can lead to cranial tension. Patients commonly compensate vision problems by bending forward or turning their head to the sides. Overuse of the oculomotor muscles can cause headaches and neck pain. Those with myopia commonly present with protractive positioning of the head and cervical segment of the vertebral column, which leads to increased tonus of the thoracic muscles, the descending fibres of the trapezius, the levator scapulae, and the sternocleidomastoid muscle [11]. Therefore the notion is that manipulation of affected areas can prevent myopia progression. Even more interesting is the “Chinese eye exercises” that the Chinese government approved way back in 1963 [9], in order to prevent myopia and this became a daily routine a most schools. Latest reports proof this approach to be totally ineffective [12]. Other studies done in 2016 show that it is still happening and reported some positive effect of eye exercises of acupoints on the myopia in children [13].

Vision therapy (also called vision training, orthoptics, eye training, and eye exercises) is a clinical approach that most optometrists are aware of. According to the American Optometric Association, which strongly supports this practice it is done “for correcting and ameliorating the effects of eye movement disorders, nonstrabismic binocular dysfunctions, focusing disorders, strabismus, amblyopia, nystagmus, and certain visual perceptual (information processing) disorders” [14] It is therefore also proposed as a means of management and prevention of myopia. It is common knowledge that the profession of Optometry is quite divided on the use of visual therapy. In an article published in Ophthalmic and Physiological Optics, Barret [15] stated that although there are areas where the available evidence is consistent with claims made by behavioural optometrists a large majority of behavioural management approaches are not evidence-based, and thus cannot be advocated. As recent as January 2018 Steven Novella launched a stringent attack on vision therapy, calling it quackery. He goes on by saying “behavioural optometrists are selling what people want, a cure without drugs or surgery”. He further stated that the outcomes are highly subjective and susceptible to placebo effects and as with any psychological intervention, the very fact that a treatment is being offered may lead to hope, or to greater confidence.[16]

From my own experience from the world of Sports Vision these visual enhancement exercises certainly works as long as you keep doing it. The moment you stop the visual skills will deteriorate over time. This is to my research the biggest problem with visual therapy and why there are so many conflicting results. Therapy is usually done over a limited period [6 to 12 weeks] and then stopped resulting in a deterioration over time. It is worthwhile to note that none of the myopia risk calculator programmes offer visual therapy as an option. Maybe it will work if you do it every single day for the rest of your life. -

**Pharmacological options:**

Driving the research in this field is the search for methods to prevent or limit axial elongation. When axial elongation is excessive, as in high myopia, there is an increased risk of visual impairment and blindness due to ensuing pathologies such as retinal detachments. The research focus mainly on Atropine, a nonselective muscarinic antagonist notwithstanding the many shortcomings of topical ophthalmic atropine [17]. In some studies, atropine has been shown to be the most effective way of controlling myopia. Rates averaging about 77% has been reported [18] but there was a significant rebound effect when the treatment is stopped, especially with the traditional 1% atropine. Low dose (0.01% or 0.02%) atropine has now become the most popular formulation as it has been shown to have less rebound effect than the 1% concentration.  Additionally, the lower concentrations do not seem to measurably reduce the ability of a child to accommodate which is a major drawback of the higher concentrations [19]. Supporters of this approach claim that the biggest advantage that atropine has over lens correction is its ease of administration. One drop in each eye once a day is all it takes. No taking lenses in and out every evening and morning. The biggest drawback of atropine therapy however, is that it is the most invasive method and there have been a number of case reports contributing mental toxicity and even death to topical ocular administered atropine [20]. I am not keen on this approach because of all the risks involved. What is needed is an exploration of bio-engineering approaches for drug delivery for this to become a safe and viable option [17]. In all fairness, Atropine is considered as an option in several myopia risk calculators [3].

## **Optical options:**

Numerous papers appeared over many years weighing up the different optical options available in dealing with myopia. Again not everybody believes that optical options are good and in their review Zorena et al (2018) [9] were quite critical on the success of optical products. Steven Turpin [10] recently published an extensive review on all the various optical options available and found that the **single vision distance Rx** still remains the “gold standard” notwithstanding the fact that it is now known to be the worst option available. .A worldwide survey on myopia attitudes and practices, published in April 2016 in Contact Lens and Anterior Eye, confirmed that while most practitioners said they were concerned about myopia and felt they were active in myopia control, the majority were still prescribing single vision spectacle corrections, which have demonstrated no useful propensity for myopia control. Gifford [21] summed it up best when she remarked that “There was definitely some hesitancy in putting control strategies in place”. Progression of children with full time correction is greater than those who were not corrected at all. “**Either way, bumping up the minus to temporally optimize distance acuity is a lot like putting studded tires on your car all year long. They’ll work great the few times when you need them; but, the rest of the time you’ll burn more energy trying to get to where you need to be and they’ll also wear out within the year” [10].**

**An option that is certainly growing is the use of Multifocal/Bifocal spectacles** and they are certainly a much better option than single vision lenses [22, 23]. Bifocal lenses are certainly better than Progressive Addition lenses (PALS) and I have made this point frequently. You get about a 33% reduction in myopia progression [[10](https://paperpile.com/c/yNsDqx/jAPH)] and the main reason for this is the fact that you have no control over which part of the lens children are looking through and most of them are dropping their chin when reading and therefore not using the reading area. Children find bifocals much easier to use, - you look above the line to look far away and below it to look close. Some will argue that an executive bifocal provides larger area of peripheral myopic defocus and that’s why they work [10]. Children of today don’t mind to wear spectacles but don’t like the look of bifocal lenses and more so if it is an executive bifocal. So we need some compromise and fortunately we now have companies producing an invisible bifocal, which I am having great success with. Children find it very easy to use but even with a bifocal the risk is to ensure that children are using them correctly. The obvious question then becomes, how much add power? Looking at the literature [4] you will find suggestions that range from +3.00 down to +0.75 based on what people belief of what myopia really is. Those arguing the peripheral blur theory mentioned earlier may say a higher add power (+2.00-+2.50) would provide more peripheral myopic defocus strictly based on the optics but this has not yet been proven. The group arguing the near point stress theory would say that this is much too high and that it should not exceed the fused crossed cylinder measurement[4, 10, 22, 23] From my own experience this this test is the worst indicator because of fluctuating accommodative flexibilities. From a practical point, children find the jump from distance to near produced with high adds to be uncomfortable. A middle of the road approach of +1.50 has proven to work for me. Bifocals are reported to be approximately 45% successful in controlling myopia [2] but I am finding a success rate of more than 70%. The big challenge is compliance – if you can ensure that the glasses are used correctly than you should also be able to achieve higher success rates.

**Multifocal soft lenses** are been promoted by several authors as the option of choice to slow progression in myopia (about 49%). [24, 25, 26]. These studies reported similar results for both concentric ring add designs and aspheric add designs with adds of between +2.00 and +2.50 D. There are a number of custom soft companies making centre distance multifocal designs. Supporters of the peripheral blur theory suggest the smallest centre optic diameter tolerable with the largest add power would provide the best results. I am not fully convinced by the peripheral blur theory and my biggest concern is the impact of peripheral blur on the superior colliculus visual pathway. Another option that is less recognized as a potential modality is the centre near multifocal soft lens. This lens design also meet the requirements of the blur theory and even fits the requirements if the near point stress theory holds true. For whatever reason multifocal contact lenses do not seem to be a preferred choice by many optometrists [10]. I believe it may simply be because of the drive to start prevention as early as possible i.e. with young myopes and then practical considerations come into play. It may be a better option for myopes in the mid-teens. One option I do not find is the use of single vision contact lenses with reading glasses. It is an option worthwhile exploring. Again there are researchers that believe that multifocal contact lenses will not prevent or control the progression of myopia.

With an average reduction in myopia progression of 43%, **Orthokeratology [Ortho-K]** is now seen by several authors as the best option. It is not something new and Paul Ramkissoon did his Ph. D with me in 2003 on this topic. It is probably the most nuanced and technically difficult modality to use and you need a big fitting set and lots of chair time to ensure no permanent changes or damage to the cornea. Critics are claiming that it may indeed cause damage over time [9]. It can be considered an invasive process and therefore requires regular follow-up visits. Sadly non-compliance by most patients is a big problem and again may not be a good practical option for young myopes.

No matter what theories or treatment strategies you ascribe to, it won’t change the fact that number of myopic or soon to be myopic children coming into your practice will continue to increase. The hardest part may be to convince the parent and their child [and the medical aid] that prevention is better than cure. There are several web-based **Myopia Risk Calculators** available to assist you to explain and discuss with children and parents the pros and cons of different management strategies. The one I found most useful is the one been launched by the [Brien Holden Vision Institute](https://www.brienholdenvision.org/). It merges individual patient information with a range of optical and pharmacological treatment options for myopia [2]. The one serious shortcoming for us in South Africa is that it only deals with Asians and Caucasians and does not make provision for Africans. Nevertheless once you uploaded the patient’s ethnicity, age and refractive the myopia ‘calculator’ allows practitioners to predict how myopia will progress under different treatment options, compared to single vision spectacles. The range of management options that can be selected with the calculator, include multifocal soft contact lenses, peripheral defocus spectacles, executive bifocals, progressive addition spectacles, orthokeratology as well as low and high dose atropine. These risk calculators should not be confused with other myopia calculators that allow you to determine you own amount of myopia and order your spectacles over the internet.

With the almost daily increase in numbers of people presenting with myopia the treatment thereof is already seen by many a lucrative market to get involved in. The challenge for all optometrists would be to provide the kind and quality of service that cannot be obtained elsewhere. This will require from you to create, justify and implement an appropriate myopia management plan well beyond the provision of single vision lenses.

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