Ministry of Defence

Synopsis of Causation

Myopia

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Disclaimer

This synopsis has been completed by medical practitioners. It is based on a literature search at the standard of a textbook of medicine and generalist review articles. It is not intended to be a meta-analysis of the literature on the condition specified.

Every effort has been taken to ensure that the information contained in the synopsis is accurate and consistent with current knowledge and practice and to do this the synopsis has been subject to an external validation process by consultants in a relevant specialty nominated by the Royal Society of Medicine.

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1. Definition

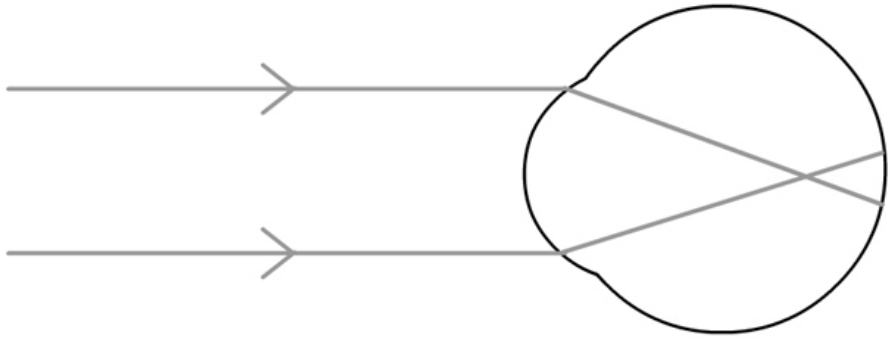
1.1. Myopia (short-sight or nearsightedness) is a condition where distant objects appear blurred but near objects are seen clearly. In myopia the refractive elements of the eye focus parallel light rays (distant objects) to a point in front of the retina rather than on the retina. The visual defect is typically corrected with concave (minus) lenses.

1.2. Axial myopia occurs when the eyeball is too long.

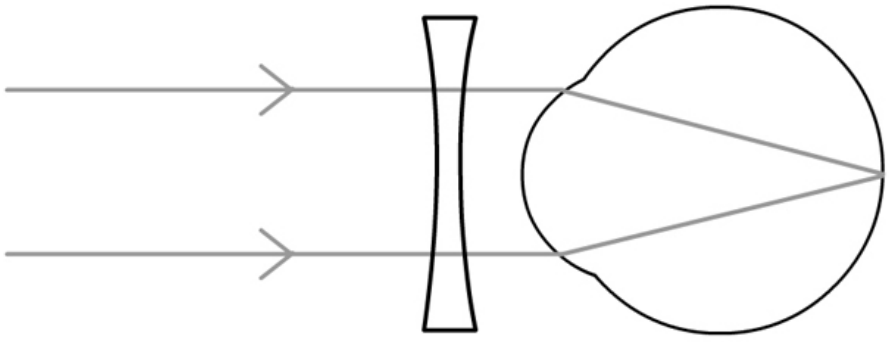
1.3. Refractive myopia occurs when the cornea and/or lens is too powerful.

1.4. Pathological myopia is a high level of myopia (–8 dioptres or more) accompanied by degenerative changes occurring at the posterior segment of the globe.

Figure 1 Myopia and correction of myopia with concave lens.



Myopia



Myopia with correction

2. Clinical Features

2.1 **Prevalence** of myopia ranges from 17-25% in the general population.[1,2] There are large racial differences; in Asia the prevalence is higher ranging from 40% in the general population up to 80% in student populations.[3] Both males and females are affected equally.

2.2 **Age of onset** Myopia typically occurs in childhood between the ages of 8 and 14. It is unclear whether later onset myopia differs except in the age of onset.[4] Some research has attempted to demonstrate an increased susceptibility to transient near work myopia in late onset myopes due to a difference in the accommodative properties of these individuals[5] but evidence as yet is inconclusive. The main difference described regarding later onset myopia is that it tends to progress about three times more slowly than early onset myopes.[6] It usually affects both eyes similarly.

2.3 **Diagnosis** Myopia may be discovered on screening programmes or by teachers noticing school pupils unable to see items on the board. Children and teenagers may complain of difficulty seeing distant objects. Diagnosis is confirmed by performing a refraction examination. This quantifies the level of myopia by identifying the power of concave lenses required to correct the defect.

2.4 **Pathological myopia** has a prevalence rate of 0.2-0.4% in the general population of the United States[2] and 1% in Japan.[7] In pathological myopia, typically there is high myopia (>–8 dioptres) and posterior segment features which may include posterior staphyloma, tigroid fundus, geographic atrophy, lacquer cracks, macular holes and choroidal neovascularisation.

3. Aetiology

3.1. Both genetic and environmental factors are implicated in the aetiology of myopia. There is an ongoing debate regarding the relative contributions of these two factors in developing myopia. There is good evidence to support a genetic aetiology for myopia. There is also a large body of evidence demonstrating the correlation between myopia and environmental factors. However, actual causality of these environmental factors has been difficult to verify due to limits in study design. The likelihood is that the aetiology of myopia is multifactorial, with some cases having a particularly strong genetic component.

3.2. **Genetic factors**

3.2.1. It has been observed that identical twins show close agreement in their refractions whereas non-identical twins show little more agreement than control pairs of siblings.[8]

3.2.2. The marked difference in ethnic groups indicates the importance of genetic factors on refractive state.

3.2.3. Children of myopic parents tend to have longer eyes even before developing myopia.[9]

3.2.4. The gene for myopia has been identified in particular families.[10,11]

3.2.5. Studies in young adult populations in the United Kingdom and Denmark compared genetic and environmental factors, concluding that there was high heritability of ocular refraction and environmental impact was not significant.[12,13]

3.3. **Environmental factors**

3.3.1. Near work has been strongly implicated in the aetiology and progression of myopia. Several epidemiological studies have identified higher rates of myopia and progression amongst university students and related to the length of time studying.[6,14] Also, occupations requiring intense close work (microscopists, textilers) have been associated with the development and progression of myopia.[15] As mentioned previously, however, association does not equate to causality.

3.3.2. Many animal studies have identified induction of myopia secondary to altering the environment of the developing eye. Deprivation of visual stimulation induces myopia in primates.[16] Eyes of children with unilateral visual deprivation from concurrent pathology also have been shown to become myopic.[17] The inferences from these studies are that there is a local feedback mechanism involving the unfocussed image that controls ocular growth in early development.

3.3.3. Ambient night-time lighting during the first 2 years of childhood has been implicated in subsequent myopia development[18] but this has not been replicated in more recent studies.[12] There is a normal physiological ‘night myopia’ that younger adults experience in very

low illumination levels e.g. driving at night. This phenomenon has been recognised for hundreds of years. It is thought to be related to a nearer resting focus point of the eye in dark conditions (because one is unable to focus on distant objects in the dark). Also, there are increased refractive aberrations due to an enlarged pupil. It may result in up to a 1 dioptre myopic shift in refractive error. The phenomenon disappears when normal illumination is restored or bright enough distant objects can be identified.

3.3.4. Studies on the use of visual display units (VDU) have failed to identify the use of VDUs as a cause of onset or progression of myopia.[19,20] A small transient myopic shift, insufficient to reduce distance acuity, may occur immediately following VDU use, but the significance of this is unknown.[21] Dry eyes appear to be the major contributor to asthenopic symptoms related to computer use.

3.3.5. Unsuitable lighting conditions of computer workstations may contribute to ocular discomfort. Symptoms of eyestrain, blurred vision, and particularly glare may be a problem. Measures such as removing intense fluorescent lights, attention to light positioning and computer screen anti-glare filters may improve visual comfort.[21]

4. Prognosis

4.1. Progression of myopia is typically rapid at younger ages, but age of onset, progression and cessation varies widely amongst children, with an average progression of 0.5 dioptres (D) per year.[22,23] As age increases, progression is less. In high myopia, a mean progression of 2D from the age of 16 to 26 has been reported.[24] This reduces to 1D between the age of 26 and 40. Refractive changes in all adults, over the age of 40, are small (<0.5D) and dependant on age (mild hypermetropia in 40's, mild myopia in 70's).[25]

4.2. People with myopia are at greater risk of retinal detachments, primary open angle glaucoma, corticosteroid responsiveness, and early cataract formation than the general population.[26] Prognosis for vision in people with high myopia is worse. The risk of retinal detachment increases with level of myopia.[27] Also, 5-10% of patients with high myopia develop choroidal neovascularisation which carries a poor prognosis for vision in the long-term, secondary to chorioretinal atrophy.[28,29]

4.3. The mainstay of treatment of myopia is correction of the refractive error by concave spectacle or contact lenses. There has been some attention to trying to prevent the progression of myopia using convex lenses for near work during childhood, with equivocal results.[22,30] In adulthood, excimer laser (LASIK, PRK, LASEK) is becoming increasingly popular with different techniques achieving good postoperative results.[31,32] Intraocular surgery in the form of clear lens extraction or phakic intraocular lens implants have been used in cases of high myopia,[33,34] however, their potential complications are still prohibitive for routine use.

5. Summary

5.1 Myopia is a condition where distant objects appear blurred, with the image focussed in front of the retina, rather than on it.

5.2 It is a common condition that varies in severity and generally develops in childhood or early adulthood.

5.3 Both genetic and environmental factors are implicated in the aetiology of myopia. There is good evidence to support a genetic aetiology for myopia. Environmental factors such as near work and early visual experiences have been associated with its development. Causality due to these environmental factors is inconclusive.

6. Related Synopses

Refractive Error.

7. Glossary

asthenopia	Group of symptoms that describe ocular discomfort due to refractive error, e.g. “eyestrain”, “tired eyes”, blurred vision.
atrophy	Wasting away.
cataract	Opacification of the lens.
cornea	Clear, dome shaped structure at the front of the eye responsible for focussing light.
choroidal neovascularisation	Bed of vascular tissue that grows inappropriately under the retina that may leak, haemorrhage or involute and leave scar tissue.
dioptre	Unit by which the strength of lenses is measured.
excimer laser	A method of sculpting the corneal curvature using a variety of techniques e.g. LASIK, PRK, LASEK.
hypermetropia (hyperopia)	Long-sightedness. Error of refraction where image is focussed behind the retina.
lacquer cracks	Breaks in Bruch's membrane with accompanying choroidal atrophy.
lens	Bi-convex structure in the eye that focuses light towards the retina.
macula (macular)	Small, highly sensitive and specialized central area of the retina.
myopia	Short-sightedness. Error of refraction where image is focussed in front of the retina.

posterior staphyloma	Elongation of the globe.
retina	Membranous structure at the posterior aspect of the eye that converts the visual image into neural impulses before transmission to the brain.
tigroid fundus	Exposure of the choroidal vessels due to scanty pigmentation.

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