

Understanding the genetic factors of myopia: can we utilize our knowledge of myopia genetics?

Q&A responses by Dr Neema Ghorbani Mojarrad, University of Bradford

- 1 Are the Singaporean Government doing anything to stop the Myopia epidemic? Such as funding Myopia Management Research?
I believe some of the best research is being done in Singapore for myopia, and generally they seem to be quite proactive. Please see the SCORM study, and Seang-Mei Saw about this. I also believe that the government have implemented time outdoors and promotion of this as a national approach and this has reduced the amount of myopia (You can see the national poster here <https://www.nas.gov.sg/archivesonline/posters/record-details/32c21f29-115c-11e3-83d5-0050568939ad>)
- 2 If by 2050 approx 50 % of the population will be myopic, what percentage of people in Asia may be myopic by that point, if they are already at 50% already?
I believe the estimation is in the paper itself, although it divides it by area of Asia (Holden et al 2016 paper found at <https://www.sciencedirect.com/science/article/pii/S0161642016000257?via%3Dihub>). Note that many of the high prevalence reports are from urban areas, interestingly rural China doesn't see the same myopia issue as urbanised children (like 20% prevalence in some cases) .
- 3 We do have a lot of Japanese myopic px, I understand that Japan is a highly dense population. I have African heritage, we live with a large land span, I have 1 myopic family member (out of 60 of us). Would it be fair to say that our upbringing and environment has impacted on our vision? If so, for 2nd, 3rd, even 4th generation px with myopia, can we continue to associate it with genetics?
It's hard to answer on an individual level like yourself, however the data would suggest that lifestyle and environment has played a part with the reduced prevalence of myopia in Africa and those of African ancestry. Remember, it isn't the genetics that is directly forcing most of the myopia we see nowadays, but that it predisposes people to becoming myopic in the right environment, and to a greater amount.
- 4 Any other environmental factors?
This is rather broad as a question. There are many, but I believe many were listed in the slides, and most were covered. Looking at papers can also give you more interesting aspects like date of birth, and season of birth, and parental education etc <https://pubmed.ncbi.nlm.nih.gov/26497977/>
- 5 Can environmental causes, cause the eye to grow later in life or only in adolescence?
Absolutely could do both. Predicting it on an individual basis may be difficult though!
- 6 Doesn't the skeletal orbit space prevent the globe from getting longer?
Within the eye socket/orbit, there is a lot of space towards the back. Remember that we have fatty tissue, the extraocular muscles, and with high myopes, we get posterior staphilomas, which are where you see the back of the eye stretch out of shape. Thus there may be a limit to the axial growth that could occur due to the orbit, but the axial elongation to reach this is much beyond that of -10.00 myopia or greater i.e. it's got a long way to go to get to the end of the globe!
- 7 If myopia is a "failure to emmetropise" the eye didn't know when to stop growing would a dietary supplement in childhood like vitamin D, influence the myopic prevalence
Hard to say. There is no evidence that additional Vitamin D would help with myopia progression, although it has been suggested to be a biomarker for the amount of time spent outdoors.
- 8 Is it necessary to measure axial length with myopia management lenses/cls
This is a difficult question. I think necessary may be too firm, as there are many examples of practices that successfully manage and fit interventions without an axial length measure. I'd use the word 'recommended'. There are also axial length estimators available; see PREMO and Ocumetra, and using the corneal Ks and cycloplegic Rx as examples.

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- 9 Can myopia skip a generation?
In theory it could, for example if you had a recessive gene (i.e. non-dominant), that was then inherited without a dominant gene to your child (so you're a carrier of the gene that you pass on to your child, but your partner potentially passess on the same gene).
- 10 Do you think maybe one day genetic caused myopia could be the reason for myopia more than environmental caused myopia?
It's hard to say. If we all lived in a myopiagenic world, or environment the same way, then our genetic diversity would also explain some of the diversity we'd get in refractive errors. However, people tend to live differently, and thus it's likely to always be a bit of both!
- 11 If someone has developed myopia due to environmental conditions, would this then become part of their genetic code that could be passed onto their offspring?
Typically not. However, if they bring up their child in the myopiagenic way they have, they could. This is an example of indirect heritability or non-genetic heritability. For example, parents that really push on educational attainment, would still pass on the myopia causing factors to their child, but this wouldn't alter their DNA as such.
- 12 Looking at inheritance My 11 year old son has just started wearing spex with -0.50DS both eyes. I am highly myopic at -7.00/-4.00 each eye, and my wife is +1.00 each eye. What is the likelihood of my son having a high myopic rx in adulthood?
This is hard to say, it's difficult to assess a specific case without knowing a full history, genetics, and lifestyle! However, given the start of myopia at 11, it's estimated that they won't be as high as -7.00 in adulthood, from what estimation and growth curves suggest.
- 13 What is myopia progression occurs early 20s for example when a px is fully grown. Is there an effect on the retina growth?
Yes, almost certainly. We all have a finite amount of retina, as a child or an adult, as the axial length of the eye grows, so does the potential effect on the retina.
- 14 Is it normal for a trait to be so far spread across the genes? Why are there so many genes effected as being short sighted is a disadvantage?
Interesting question. Not all traits/conditions show this, but it does suggest that the architecture for myopia is more complex than we anticipated. It's important to note that genes can also be pleiotropic (meaning they can influence many traits from one gene, depending on the organ, cell type etc), so it's not uncommon. However, really genes for myopia, are just the opposite of genes for hyperopia i.e. they're all just genes related to refractive error in general. It's just that we see that one version of the genetic variants on average induces myopia, and the other variant doesn't, and by a small amount (typically less than 0.25D). Height for example, is also polygenic, and in a way this could be looked as similar to refraction (essentially just eye length or height!), and has 12,000 genes associated with it. Comparatively, it's much less!
- 15 So are we saying myopia management lenses are not for all? Some children will be high myopics and if life style is optimised myopic management specs/contact lenses will have minimal effect?
This is a question researchers are looking at, as it may help answer why some children respond well to myopia interventions, and others don't. The data for this isn't quite there yet.
- 16 Is there an argument for children starting school later in life?
Interesting thought! There could be.. However, most of the study on education measures it as length of time or age of finishing education, so it's hard to say whether a later start would make a difference if it would last the same length of time. I'd love to see if there's any modelling that could be done on this!

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- 17 Is there a percentage of risk of a child having/ developing myopia due to genetics compared to environmental causes?
I believe I answered this in the presentation later on with the estimated heritability value. It's hard to estimate strictly, and will vary depending on the sample and the children looked at, but generally, it's estimated that for common genetic differences, it's less than 50%, but may be higher for all genetic variation, and genetic environmental interactions.
- 18 Do those who are home schooled compared to state education have less chance of myopia?
Good question. I haven't seen any data on this personally, and a search shows it hasn't been looked at, although there is a paper now that has suggested that the subject and intensity of study isn't as important as the time spent in education <https://iovs.arvojournals.org/article.aspx?articleid=2785556>
- 19 We can't ethically study taking children out of education, but you could study people who practice regular breaks and longer working distances when being educated and those that don't - has there been a study in this way?
*In some sense yes, but it's hard to control all the variables in these studies. Even trying to measure something like near work behaviour is complex when looking at many children, as it includes loads of things such as distance, intensity, target, duration, lighting etc.
There is interesting data however from children spending time with near work and outdoors from wearable clips on their specs, and their general habits, and this showed children outside at lunch had less myopia than those that stayed indoors. Look up the Clouclip for more data on this if it is of interest.*
- 20 But are hyperopes less likely to wear their specs whilst at school, resulting in being less able to study for long periods and underachieve?
Hard to say really, hyperopes, particularly low hyperopia, is unfortunately not as studied as myopia
- 21 Is there a point of myopia/age development where myopia management is more/most effective ?
I don't believe there is yet, but generally they've advised the earlier the intervention, the more the effect, because there is more eye growth and more myopia development at earlier ages, hence why earlier age of onset tends to be an issue.
- 22 Is there a survey or means to calculate future myopia with patients in practice?
I'm not trying to market any in particular, as they all have their limitations, but there are growth curves for axial length and myopia from the Rotterdam study <https://pubmed.ncbi.nlm.nih.gov/29265742/>, but also the PREMO survey from Ulster, there is also the app from Ocumetra, and a host more questionnaires to help with this.
- 23 What do they think has caused the increase in myopia over the last 20 years
Lifestyle mostly, although we're still not entirely sure.
- 24 Could overplussing a px from subjective cyclo px cause myopia?
In theory, it could do. Over or undercorrection has been shown to be a factor causing further myopia progression.
- 25 What's the split between environmental factors and genetic factors?
I've tried to answer this in the presentation, and a previous question, please see Q 17.

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- 26 What made you to focus on genetics rather than environmental causes during your PhD?
- PhD projects in optometry usually come with a area of research topic in mind, as they are usually funded on these. In this case, the use of genetics to predict myopia was the general funded topic, but there was academic freedom to find the best way to approach this. I am pleased to have focused on genetics however for my PhD. It made it a lot more difficult (what a learning curve!), but I'm thrilled that I can understand both the content of environmental discussions and genetic discussions of myopia, because it can be difficult to harmonise the two.*