Myopia, commonly called ‘nearsightedness’ because of the difficulty focusing on distant objects is a leading cause of visual disability and has a rapidly growing prevalence – 30-50% of Western adults and up to 80 or 90% among high school students from high-income Asian countries. Two studies tackle the issue. First, an observational study published in JAMA Ophthalmology among Chinese students; the goal was to describe myopia’s “natural history” or progression in school-age children. The researchers looked at two groups over time, grades 1 through six and grades 7 through 9. In both cases, the children’s myopia was assessed annually until they completed sixth or ninth grade. In all 4741 children were studied over a six-year period, with the right eye being the measure of myopia. Of the children beginning the study, roughly 81-85% completed all measurements.

Increasing Myopia correlates with more education

The researchers found that the annual incidence of myopia was around 20 to 30% from grade one through grade nine, with a peak and plateau at around grades 5 to 6. The yearly incidence of “high myopia,” defined as -6.0 diopters or less (and 12 fold higher than the threshold for myopia of 0.5 diopters) was only 1% among primary school children and 2% among the seventh to ninth graders. Baseline height and weights were not associated with myopia in any of the groups although females had a greater hazard ratio than males at about 1.39. Put in other terms 79.4% of these children had myopia by the end of ninth grade, and 7% had high myopia. The study’s limitations include the measurement of myopia by refraction, the test we all those lens changes and questions about which lens is better - which is a subjective and may over-estimate the degree of myopia. More importantly, additional confounders including parental myopia, as well as the time spent outdoors or doing near-work, were not considered, leaving education and myopia correlated
but without a causal direction. Does education lead to myopia or are myopic individuals more educable and educated? It is a variation on the original question of causality, which came first the chicken or the egg?

We will never have a randomized controlled trial (RCT) to look at the effects of education and myopia on one another for a variety of ethical reasons, do you want your child’s myopia to go uncorrected to see how they fare in school? In the absence of an RCT, instrumental variables have been put forward as a way to use observational data’s associations to come to more definite beliefs about causality.

**Instrumental variables**

A quick refresher for those, like the author, have a problem understanding the concept of an instrumental variable. To convert the observed correlation into a causal chain, we need a variable that effects only education. This variable effects education directly but its effect on myopia is indirect, acting through education. When we then look for myopia in individuals based on that measure we see the impact of education on myopia. Genetic information is more frequently being used as an instrumental variable and while the technique is based on statistical values it provides better evidence of causality and in this instance leads us to the second study.

**Can correlation lead to causation?**

We know the mantra, correlation isn’t causation. RCTs have shown that outdoor activity reduces the effect of myopia, but the impact of indoor activities on myopia are more mixed, and percentages of indoor and outdoor activity do not necessarily correlate. To tease out whether education is a causal factor for myopia the researchers use genetic profiles as their instrumental variable, bringing us as close as we get to a randomized study because our genotypes are randomized at conception. The source of data is once again the UK Biobank, which has characterized the genotypes of about 500,000 British citizens. The randomization was provided by genetic profiles based upon genome-wide association studies or GWAS previously shown to be associated with either self-reported myopia or educational attainment. [1] The Biobank had genetic data, measurements of visual acuity and self-reported educational level for roughly 70,000 participants. Using all of this information they asked two questions, what was the effect of the alleles of education on myopia and what was the effect of alleles of myopia on the educational level.

For the group randomized by the “education” alleles, associated with more education, every year of education resulted in a greater myopic error. For the group randomized by the “myopic” alleles associated with a higher incidence of myopia, there was virtually no association with length of education. Bottom line, while still not as robust a finding of causality as a randomized controlled study, the results suggest that the more time spent in school, the greater the myopia and that this effect is cumulative. By their estimates college education is associated with enough myopia to require glasses when you drive so we need not worry that education will lead to blindness.

With genetic data more readily available, its use as an instrumental variable, helping us to convert correlation to causation without the expense and time of RCTs is on the rise. Their power to persuade is strengthened by how well they account for one effect over another. Currently, the
allele scorings explain about 15% of an impact so they strength but do not prove causality and RCTs will remain more definitive at this time. As these studies go into the mainstream media, it will be vital for us to understand this distinction.

[1] They identified 44 genetic variations associated with myopia and 69 for educational attainment and then created “allele” scores that weight the variants to improve their use as predictors.


Education and myopia: assessing the direction of causality by Mendelian randomization BMJ DOI: 10.136/bmj.k2022