

Studies of Self-Refration in Children: Technical Summary

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Study settings and methods:

Three studies of self-refraction with adjustable glasses among school-children aged 12-18 years old were carried out with identical protocols in Boston, urban and rural China in 2009-2010. All children had vision $\leq 6/12$ in at least one eye, and all underwent vision measurement in three ways: after self-refraction without dilation of the pupil, after automated refraction without dilation (as another potential method to carry out refraction in areas with limited services) and after subjective refraction with pupil dilation by an experienced refractionist (as the "gold standard" for refractive accuracy). Medications which dilate the pupil also prevent the eye focusing on close objects, which would result in a more myopic refraction, and potentially later eye strain from inaccurate glasses. All children were supervised by their teachers during self-refraction. The glasses used could correct up to 6D of myopia (near-sightedness) and 6D of hyperopia (far-sightedness), but could not correct astigmatism.

Vision results:

A total of 554 children were tested in urban China, 648 in rural China and 364 in Boston. Vision of $\geq 6/7.5$ in the better eye was achieved among 92.4%, 96.9% and 95.6% among children in urban and rural China and Boston respectively, which was significantly less ($P < 0.001$) than the rate with subjective refraction (99% in all three centers). In urban China, rural China and Boston, 34.8%, 30.3% and 31.3% of children respectively had vision $\geq 6/7.5$ with their current glasses (if any).

Refractive accuracy:

In urban and rural China, there was no tendency for children to have a more myopic power with self-refraction compared to the "gold standard" of subjective refraction, even though the pupil was not dilated (the mean inaccuracy was zero). In these two centers, mean inaccuracy in the myopic direction with automated refraction when the pupil was not dilated (about 3/8 of a diopter) was significantly

greater. In Boston, there was $\frac{1}{4}$ diopter of myopic inaccuracy with self-refraction. In urban China, an error of ≥ 1.0 diopter when compared to the gold standard of subjective refraction was more common with self-refraction (11.2%) than with automated refraction not using pupil dilation (6.0%, $P = 0.002$), but in rural China, such inaccuracy occurred more commonly with automated refraction (10.8%) than with self-refraction (4.8%, $P < 0.001$).

Potential predictors of sub-optimal results with self-refraction:

In both urban and rural China, greater myopic or hyperopic refractive error and more astigmatism were each associated with lower likelihood of achieving good vision. In Boston, among 78 eyes with moderate astigmatism (between -1.25 and -2.50D), 100% were able to achieve vision $\geq 6/9.5$.

Prevalence of non-refractive causes of vision loss:

In rural China, 24/648 (3.6%) of children with poor vision in at least one eye had non-refractive causes, but 22 were due to amblyopia (lazy eye), which is untreatable in this age range. Only two children had treatable, non-refractive causes of poor vision (cataract).

Significance:

The large majority of children with poor vision in these settings with a heavy burden of uncorrected refractive error could obtain excellent vision and good accuracy with self-refraction. Self-refraction might allow programs to eliminate expensive automated refractors and dispense with the cost, side effects and reduced service uptake associated with pupil dilation. In areas such as China with high prevalence of refractive error, it appears that only a small number of children with other treatable eye problems might be missed by programs that carried out self-refraction without a full eye examination, though such children could be referred.

Limitations and need for future work:

Wearability, cosmetic appeal and long-term power stability of adjustable glasses were not assessed in this set of studies, and require further investigation. These studies all used only one of the several types of adjustable glasses currently available, and the accuracy of other devices for self-refraction in children is not known. Further research is needed to determine whether refinements in self-refraction protocols can further improve accuracy in the hands of children. Accuracy of self-refraction when used by younger children is not known.