Ocular Predictors of the Onset of Juvenile Myopia

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Purpose. The purpose of this study was to identify reliable predictors of the onset of juvenile myopia.

Methods. The data from 554 children enrolled in the Orinda Longitudinal Study of Myopia (OLSM) as nonmyopes with baseline data from the third grade were evaluated to develop a predictive profile for later onset of juvenile myopia. Myopia was defined as at least −0.75 D of myopia in the vertical and horizontal meridians of the right eye as measured by cycloplegic autorefraction (n = 45 children). Chosen predictors were refractive error and the ocular components: corneal power, Gullstrand crystalline lens power, and axial length. Sensitivity and specificity were calculated. Receiver operating characteristic (ROC) curves were generated to evaluate and compare these predictors singly and combined.

Results. Refractive error, axial length, Gullstrand lens and pod corneal power were all significant predictive factors for the onset of juvenile myopia. The best single predictor of future myopia onset in the right eye was the right eye's cycloplegic autorefraction spherical refractive error value (mean sphere across 10 readings) at baseline. For a cut point of less than +0.75 D hyperopia in the third grade, sensitivity was 86.7% and specificity was 73.3%. The area under the ROC curve for this mean sphere was 0.880. Producing a logistic model combining mean sphere, corneal power, Gullstrand lens power, and axial length results in a slight improvement in predictive ability (area under the ROC curve = 0.893).

Conclusions. Onset of juvenile myopia can be predicted with moderate accuracy using the mean cycloplegic, spherical refractive error in the third grade. Measurement of other ocular components at this age improves predictive ability, albeit incrementally. Further improvements in the prediction of myopia onset will require the use of longitudinal data in addition to one-time measurement of refractive error and the ocular components. (*Invest Ophthalmol Vis Sci.* 1999;40:1936–1943)

Myopia has generated enormous research interest during the last century, particularly in the last 20 years. Research efforts now focus on human studies of risk factors for myopia development, animal models of myopigenesis, and myopia treatment trials.[1] Most investigators in the refractive error research community would agree that the animal and human lines of investigation are converging in the following way. As basic scientists study the ways in which the eye grows, how eye growth might be modulated,[2–4] and whether a pharmaceutical agent to control eye growth can be developed,[5] clinical vision researchers investigate the genetic and environmental etiologic factors that accompany myopia development in children[6–10] and adults.[11]

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The particular anatomy of the ocular components has been investigated in numerous studies. Myopic eyes are associated with excessive axial length,[11–15] steep corneas,[12] and thin[16] and less powerful crystalline lenses.[17] However, all these investigations found their associations in samples that included prevalent cases of myopia and did not attempt to associate ocular component values with future myopia development. We have found previously that even premyopic eyes of children (presumably at genetic risk for the development of myopia because they have myopic parents) are longer and less hyperopic than the eyes of children not at such genetic risk.[17]

We believe that the clinical key to these converging lines of research lies in the ability to predict the onset of myopia long before it is clinically measurable by conventional refraction. If experimental models of myopia lead to a pharmaceutical agent for controlling abnormal eye growth and/or if ongoing studies of optical treatments for progressive myopia can be extended to preventing its onset, accurate prediction of myopia onset and identification of children at high risk for myopia onset will be crucial.

In the early 1960s, it was observed that children with less hyperopia at school entry were more likely to go on to develop myopia during their elementary school years.[18] More recently, refractive error in infancy has been suggested as a predictor of future juvenile myopia.[19] Both these studies identified refractive error at some point in time well before the onset of myopia as the relevant predictive variable.

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TABLE 1. Relative Risks from Survival Analysis for a Unit Difference in Each of the Ocular Components Univariately as Risk Factors for Development of Myopia in Fourth Grade or Higher

Variable at Baseline (Grade 3)	Mean ± SD	Relative Risk	*P* Value
Mean cycloplegic autorefraction (sphere) (D)	0.94 ± 0.71	0.040	0.0001
Vitreous chamber depth (mm)	15.70 ± 0.69	1.760	0.0080
Axial length (mm)	22.83 ± 0.70	1.910	0.0026
Gullstrand lens power (D)	20.69 ± 1.36	0.793	0.0300
Corneal power (vertical meridian, third ring of the corneascope) (D)	44.01 ± 1.60	1.162	0.0702
Anterior chamber depth (mm)	3.67 ± 0.23	3.301	0.0798
Crystalline lens spherical volume (mm^3)	135.74 ± 10.57	1.020	0.1499
Crystalline lens refractive index*	1.43 ± 0.0008	1.130	0.2244
Crystalline lens thickness (mm)	3.46 ± 0.16	0.472	0.4343
Calculated crystalline lens power (D)	23.74 ± 2.05	0.952	0.5015

Values are means ± SD for the entire sample.
* The relative risk for the crystalline lens refractive index is expressed for a 0.005 unit difference.

Goss and Jackson[20–23] have extended this analysis to include the ocular components, assessment of the binocular vision system, and parental history of myopia, but their prediction may occur too close to the onset of myopia (just 6 months prior) to prove ultimately useful. Goss and coworkers' predictive analyses are conducted 6 months before the "last emmetropic visit." Thus, it is impossible to identify this critical visit until after the myopia has already occurred. Such a prediction scheme would make treatment administered before the onset of myopia logically impossible.

In this article we use baseline data from the Orinda Longitudinal Study of Myopia to evaluate the ability of refractive error and the ocular components to predict the onset of juvenile myopia.

METHODS

The Orinda Longitudinal Study of Myopia employs a cohort design, in which children are enrolled in successive years at selected ages to provide initial cross-sectional data. Children participated in the study after they and their parents received an explanation of all study procedures. Parents gave consent for their children's participation after all study procedures were explained in accordance with the tenets of the Declaration of Helsinki. The children are then followed for a variable number of years to provide longitudinal data. Data from 554 children from the Orinda Longitudinal Study of Myopia (age at baseline 8.60 ± 0.53 years; mean ± SD) whose right eyes were not myopic by the occasion of their third grade visit (i.e., their refractive error was more hyperopic than −0.75 D on cycloplegic autorefraction in either meridian) and who could provide baseline data from the third grade are reported here. (The third grade visit was chosen as baseline even though some children were enrolled as early as the first grade. The ocular componenets are very similar across children in the first grade and have "differentiated" to a certain extent by third grade. Third graders are still young enough that prediction of future myopia is meaningful in terms of eventual prevention.) Through 1994, 45 of them had developed myopia in the right eye (15 by grade 4, 11 by grade 5, 8 by grade 6, 5 by grade 7, and 6 by grade 8); we expect that more of these children will develop myopia as they are followed to older ages. The 554 children presented here are drawn from a larger sample of 678 children who were seen as third graders between 1989 and 1993. Of these, 148 were followed all the way through the eighth grade, and 23 were myopic by the third grade. Forty-seven children (6.9%) were lost to follow-up during this time period.

We measured the right eye's ocular components and refractive error on the subject sample as described previously in detail.[6] Specifically, we used the Canon R-1 autorefractor (Canon USA, Lake Success, NY) to measure refractive error, averaging 10 consecutive cycloplegic measures to produce a refraction value for the vertical and horizontal meridians and the mean sphere,[24] the Kera photokeratoscope to measure corneal curvature, video phakometry to measure crystalline lens curvatures,[25] and the Humphrey 820 model A-scan ultrasound unit (Humphrey Systems, Dublin, CA) to measure the eye's axial dimensions, anterior chamber depth, crystalline lens thickness, and vitreous chamber depth. Although measurements of the various components were divided between three different examiners, each examiner measured the same components at each annual session. To facilitate the measurements, topical agents were used to induce corneal anesthesia (one drop of 0.5% proparacaine first and then a second drop just before ultrasonography), pupillary mydriasis, and cycloplegia (two drops of 1.0% tropicamide, instilled 5 minutes apart). A new case of myopia was defined as any child in the fourth grade or higher whose cycloplegic autorefraction results were −0.75 or more myopic in both the vertical and horizontal meridians.

Statistical Methods

First, we evaluated the relative risk of measured and calculated ocular component values as measured at baseline. Table 1 shows the relative risk of a unit difference in each of the ocular components for development of myopia as defined above. After this proportional hazards analysis,[26] models were built maximizing the log likelihood. Important variables and potential cut points for these variables were identified using the candidate variables from the proportional hazards results. From this analysis, continuous candidate predictor variables for fur-

Table 2. Ability of Cycloplegic Autorefraction Results (Mean Sphere) at Baseline (Grade 3) to Predict Future Myopia

Refractive Status at Baseline	Myopia Present	Myopia Absent	Total
Less than +0.75 D hyperopia or more myopic	39	136	175
+0.75 D or more hyperopia	6	373	379
Total	45	509	554

Values are numbers of children. Sensitivity, 86.7%; specificity, 73.3%.

ther analysis emerged at the 0.05 level of statistical significance, namely, the mean cycloplegic sphere power from the 10 autorefraction measurements, the corneal power in the vertical meridian from the third ring of the photokeratoscope photograph, the Gullstrand lens power, and the axial length, all as measured at baseline. However, these ocular components are intercorrelated (certainly, in the case of vitreous chamber depth and axial length, as one is contained fully in the other) and contribute in an additive way to produce the eye's refractive error. Thus, analyses to determine the relative contribution of these variables and their value in predicting myopia onset were conducted.

Receiver operating characteristic (ROC) curves were generated as follows for each of the selected ocular component variables alone, for all four combined, by the canonical discriminant analysis[27] and logistic regression[28] models and for the canonical and logistic models without Gullstrand lens power (because videophakometry is difficult to perform clinically).

The index from the canonical discriminant analysis is a linear combination of the four selected ocular component variables that best separates the myopic and nonmyopic groups among all possible linear combinations.

ROC Curves

For two well-defined groups (e.g., myopes versus nonmyopes), let T denote a random variable for the outcome of a predictive test or set of tests. A decision rule is defined by t_0, a threshold value of T, such that if $T > t_0$, the person is classified as positive (myopic) and if $T \leq t_0$, the person is classified as negative (nonmyopic). For a given threshold, sensitivity is the probability that a myopic person is classified as myopic (true positive) and specificity as the probability that a nonmyopic person is classified as nonmyopic (true negative). The theoretical ROC curve is a function of sensitivity versus (1 − specificity) as the threshold t_0 ranges over all possible values. On the y-axis is sensitivity, or the true-positive fraction. On the x-axis is (1 − specificity), the false-positive fraction.[29]

One convenient global measure of the predictive accuracy of a test or set of tests is the area under the corresponding ROC curve. The area under the ROC curve measures the probability, denoted by θ, that in a randomly selected pair of nonmyopic and myopic individuals the predictive test(s) allows them to be correctly identified.[30,31] Let X denote the predictive test T for the nonmyopic population and Y the test for the myopic group. Then $\theta = P\{X < Y\}$. An area of $\theta = 0.8$, for example, means that a randomly selected individual from the myopic group has a predictive test value, Y, larger than the value X for a randomly selected individual from the nonmyopic group 80% of the time. An unbiased estimate of $P\{X < Y\}$ is the area under the empiric ROC plot, which is also the Mann–Whitney version of the two-sample rank-sum statistic of Wilcoxon.[32–34]

Multiple Comparisons of ROC Curves

Point estimates (denoted as $\hat{\theta}$) and SEs for the area under the curve (θ) for the ocular components individually, combined by the canonical discriminant analysis and logistic regression models, and canonical and logistic indices without Gullstrand lens power curves were calculated. Multiple comparisons with the best (MCB) analysis, described by Hsu,[35] was extended based on the asymptotic normality of estimates of the θs to compare each method of prediction with the best of the other methods of prediction.

Results

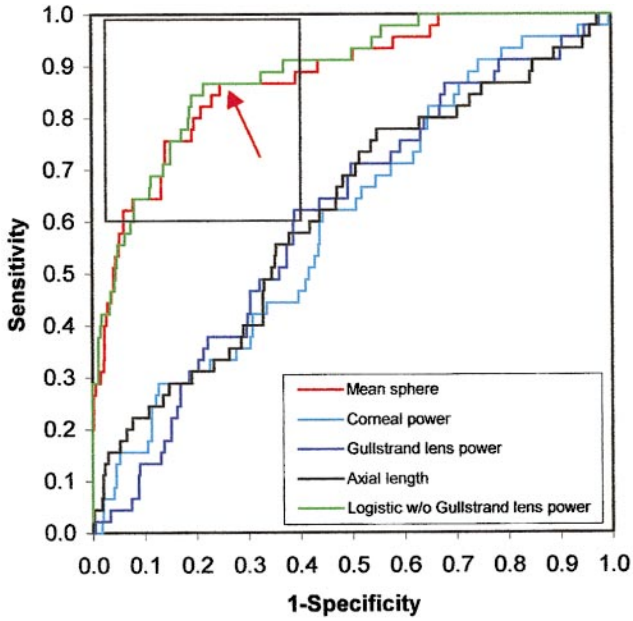
To provide direct comparisons to previous studies,[18,19] the mean sphere cycloplegic refractive error at grade 3 was evaluated (Table 2) as a predictor of myopia, producing a sensitivity of 86.7% and a specificity of 73.3%. Of course, some of the nonmyopic children in the right column of Table 2 may go on to develop myopia, so this analysis will be ongoing. The cut point of at least +0.75 D of hyperopia depicted in Table 2 was chosen so as to maximize the –2 log likelihood in a proportional hazards analysis. (For details, see Klein and Moeschberger, 1997.[26]) Shifting this cut point just 0.25 D in the myopic direction changes the sensitivity of this analysis to 68.9% and the specificity to 87.2%, illustrating the trade-off between sensitivity and specificity with a change in predictive criterion. Previous investigators demonstrated the predictive value of the ratio of axial length to corneal radius of curvature (AL/CR ratio) with a sensitivity of 88% and specificity of 57% for a cutoff of 3.02 for the AL/CR ratio[23]; we find a much lower sensitivity and only slightly higher specificity, even though the children in the previous study were similar in age distribution to our sample (Table 3).

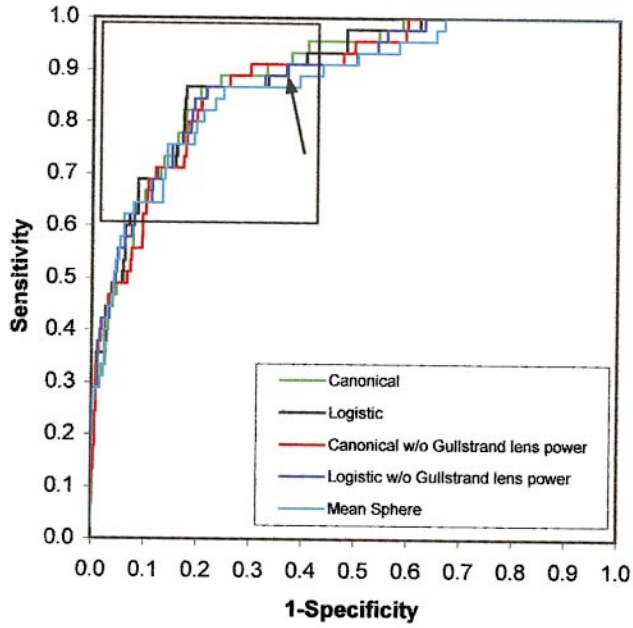
The ROC curves are presented in Figures 1 and 2. The point estimates, $\hat{\theta}$, and SEs for the area under the curve are presented in Table 4. An MCB analysis comparing each of the individual components' ROC curves and the mean sphere ROC curve reveals that corneal power, Gullstrand lens power, and

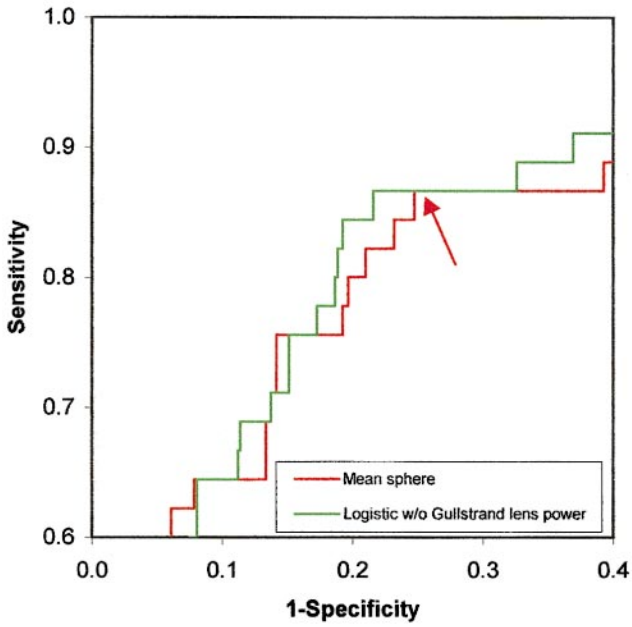
Table 3. Ability of the Axial Length to Corneal Radius of Curvature (Vertical Meridian) Ratio at Baseline (Grade 3) to Predict Future Myopia

AL/CR Ratio at Baseline	Myopia Present	Myopia Absent	Total
≥3.02	31	174	205
<3.02	14	335	349
Total	45	509	554

Values are numbers of children. Sensitivity, 68.9%; specificity, 65.8%.







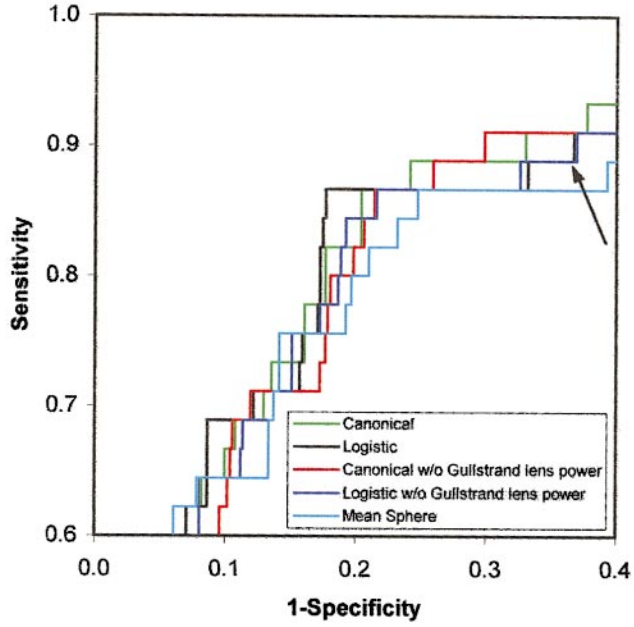


FIGURE 1. ROC curves for each of the ocular components individually and for the logistic model without Gullstrand lens power. Areas under each curve are described in Table 4. The *arrow* denotes the particular point on the mean sphere ROC curve for at least 0.75 D of hyperopia at baseline where sensitivity is 0.867 and specificity is 0.754. The *lower panel* is a magnified view of the curve for sensitivity and specificity values between 0.60 and 1.00 to illustrate differences between the mean sphere and logistic without Gullstrand lens power ROC curves.

FIGURE 2. ROC curves for mean sphere, canonical, logistic (with all four components), canonical without Gullstrand lens power, and logistic without Gullstrand lens power discriminant models. Areas under each curve are described in Table 4. The arrow denotes a particular point on the logistic ROC curve where sensitivity is 0.889 and specificity is 0.642. The *lower panel* is a magnified view of the curve for sensitivity and specificity values between 0.60 and 1.00 to illustrate differences between the ROC curves.

axial length are each inferior to mean sphere at the $\alpha = 0.0001$ level. Therefore, the mean sphere is the best single predictor for myopia of all the variables tested. We wanted to examine whether the other variables in combination with the mean sphere would improve the predictive model over that using the mean sphere alone. A separate MCB analysis comparing the mean sphere, the canonical, the logistic, the canonical without Gullstrand lens power, and the logistic without Gullstrand lens power ROC curves, give the following 95% MCB simultaneous confidence intervals:

Table 4. Point Estimates and SEs for Area under the ROC Curves

Variable or Model	Area under the Curve, $\hat{\theta}$	SE
Mean sphere	0.875	0.028
Corneal power (vertical meridian)	0.608	0.042
Gullstrand lens power	0.605	0.042
Axial length	0.614	0.045
Canonical	0.892	0.023
Logistic	0.893	0.024
Canonical without Gullstrand lens power	0.884	0.025
Logistic without Gullstrand lens power	0.885	0.026

All areas are significantly different from $\theta = 0.500$.

$$\theta_{\text{mean sphere}} - \max\{\theta_{\text{canonical}}, \theta_{\text{logistic}}, \theta_{\text{canonical-GLP}}, \theta_{\text{logistic-GLP}}\} = [-0.042, 0.0000]$$

$$\theta_{\text{canonical}} - \max\{\theta_{\text{mean sphere}}, \theta_{\text{logistic}}, \theta_{\text{canonical-GLP}}, \theta_{\text{logistic-GLP}}\} = [-0.0099, 0.0083]$$

$$\theta_{\text{logistic}} - \max\{\theta_{\text{mean sphere}}, \theta_{\text{canonical}}, \theta_{\text{canonical-GLP}}, \theta_{\text{logistic-GLP}}\} = [-0.0083, 0.0099]$$

$$\theta_{\text{canonical-GLP}} - \max\{\theta_{\text{mean sphere}}, \theta_{\text{canonical}}, \theta_{\text{logistic}}, \theta_{\text{logistic-GLP}}\} = [-0.0197, 0.0009]$$

$$\theta_{\text{logistic-GLP}} - \max\{\theta_{\text{mean sphere}}, \theta_{\text{canonical}}, \theta_{\text{logistic}}, \theta_{\text{canonical-GLP}}\} = [-0.0203, 0.0010]$$

The first confidence interval has zero as its upper bound, indicating that the mean sphere (alone) model is not the best model compared to the other four at $\alpha = 0.05$. Other confidence intervals imply that the canonical model is either the best or is within 0.0099 of the best model, the logistic model is either the best or is within 0.0083 of the best model, the canonical without GLP model is either the best or is within 0.0197 of the best model, and the logistic without GLP model is either the best or is within 0.0203 of the best model. As these four models are indistinguishable, the logistic model can be chosen with confidence as the best model for practical usage, but given the difficulty in assessing Gullstrand lens power,[25] the logistic model without Gullstrand lens power included would be an acceptable substitute. The increment of improved performance of the logistic model without Gullstrand lens power may be seen in the ROC curve depicted in Figure 2.

Figures 3 and 4 apply the mean sphere and logistic without Gullstrand lens power models to the prediction of future myopia in an individual child. These figures extend the models arrived at in the ROC analysis for the purpose of prediction. For example, the arrow in Figure 3 corresponds to a child with a mean sphere of −0.25 D at baseline, translating to a chance of that child becoming myopic of 60%. Likewise, on Figure 4, a child with the logistic without GLP index of 0.456, e.g., with −0.15 D mean sphere at baseline, a corneal power in the vertical meridian of 42.25 D, and an axial length of 24.94 mm at baseline, has a 61% chance of developing myopia sometime in grades 4 through 8.

Discussion

Hirsch ventured into myopia prediction in the early 1960s, basing his analyses solely on noncycloplegic retinoscopy results at school entry (at 5–6 years of age) compared to the same measurement at the end of elementary school (13–14 years of age). He chose the same cut point as in our Table 2 and defined myopia at school exit as −0.50 D or more myopia (spherical equivalent). He achieved a similar result to ours, with only a slightly lower sensitivity of 81.5% and a similar specificity of 72.1%.[18] Our results are based on cycloplegic autorefraction rather than noncycloplegic retinoscopy, and we would expect that as some of our current nonmyopes convert to future myopes, our predictive ability could increase. Our results confirm Hirsch's, namely, that a low hyperopic refractive error is an important risk factor for future myopia. As we have discussed previously,[36] this level of performance does not have the high level of both sensitivity and specificity needed to make decisions regarding which particular child should receive any potential treatment to prevent the onset of myopia (Figs. 1, 2).

Much later, Goss and Jackson compared values of the ocular components in children who became myopic (minus refractive error in both meridians of both eyes and −0.25 D or more myopic spherical equivalent in both eyes as measured by cycloplegic subjective refraction) 6 months after a nonmyopic measurement occasion compared to children who did not become myopic in the same time interval. Their predictions require knowledge of which measurement occasion is the "last emmetropic visit," which makes true prediction in the context of a preventive treatment impossible. They found a statistically significant difference only for the ratio of axial length to corneal radius of curvature in the vertical meridian (cut point of 3.02), producing a sensitivity of 88% and a specificity of 57%,[23] a result our data do not confirm. This same study produced lower sensitivities and specificities for all other variables examined, including positive relative accommodation, the midpoint of the near fusional vergence range,[22] heterophoria,[21] and parental history of myopia.[20]

Although others have analyzed similar variables as predictors, namely, parental history of myopia[19,37,38] and infant refraction,[19] none of these has presented data on sensitivity and specificity, so their results cannot be compared meaningfully to ours. Our reanalysis of the data set based on a myopic infant refraction (any minus power in either meridian by noncycloplegic retinoscopy) revealed a range of sensitivities from 61.9% to 81.2% and a range of specificities from 59.1% to 63.2%, depending on the myopic "fate" of the emmetropic infants (not described in the original data set).[36]

We find that if a single measure is to be made for the purposes of predicting myopia onset in advance of the event, the single best measure of those we evaluated is the spherical portion of the prescription generated by cycloplegic autorefraction (Figs. 1, 3). If we combine the four ocular components discussed here—mean sphere, corneal power, Gullstrand lens power, and axial length, three of which can be readily measured with accessible clinical techniques—then the accuracy of prediction improves somewhat (Figs. 2, 4). It is vital that any attempts to predict future myopia onset choose predictors that can be used without advance knowl-

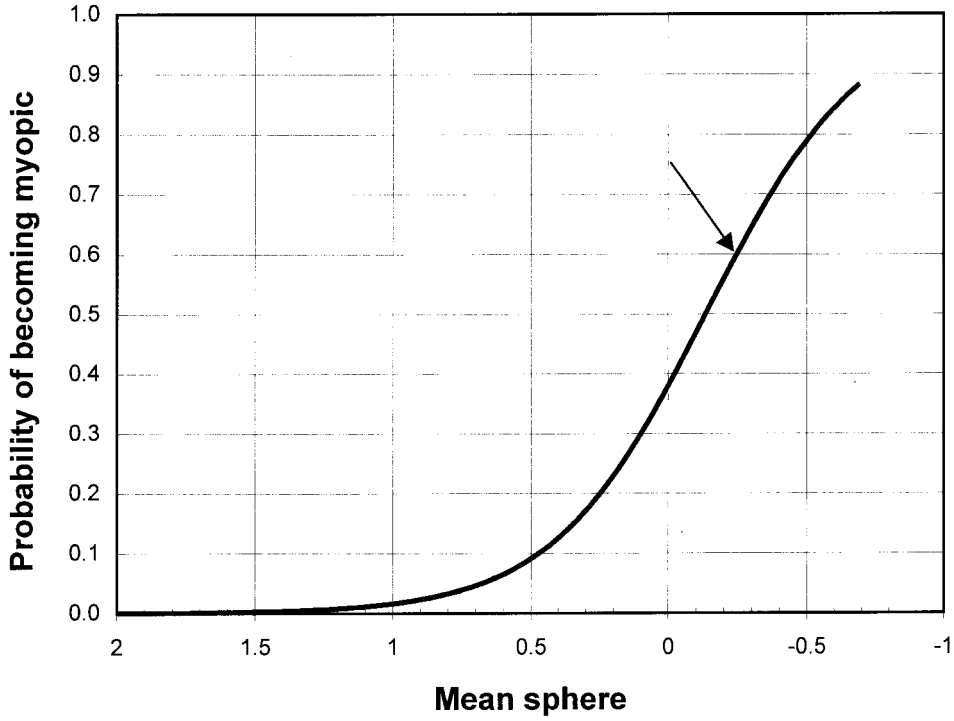


FIGURE 3. Prediction of myopia in an individual child given a certain value of mean sphere from cycloplegic autorefraction. The following equation was used to calculate the "mean sphere index" associated with becoming myopic: Mean sphere index = −0.4876 − (3.6293∗mean sphere). Then, the probability of becoming myopic is calculated:

$$\text{Probability of becoming myopic} = \frac{1}{1 + e^{-\text{mean sphere index}}}$$

The arrow denotes a particular point on the curve where mean sphere from cycloplegic autorefraction is −0.25 D, the index is 0.420, and the probability of becoming myopic in grades 4 through 8 is 0.603.

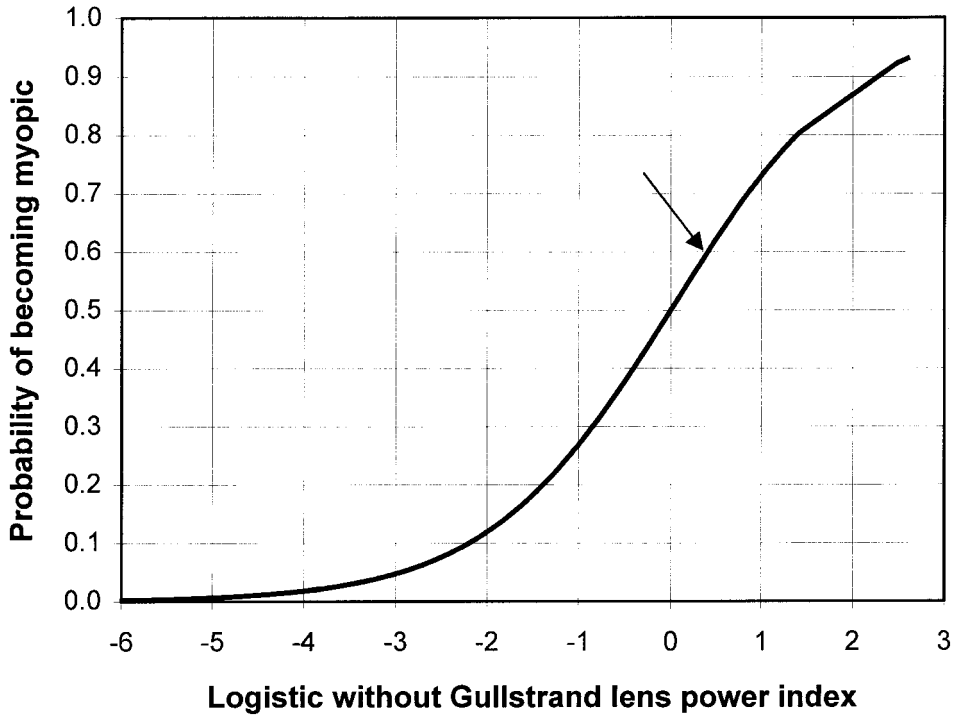


FIGURE 4. Prediction of myopia in an individual child given a certain index calculated using the logistic model incorporating mean sphere from cycloplegic autorefraction, corneal power in the vertical meridian, and axial length, all measured at the third grade baseline occasion. The following equation was used to calculate the "logistic without Gullstrand power index" associated with becoming myopic for an eye with a refractive error of −0.15 D, a corneal power in the vertical meridian of 42.25 D, and an axial length of 24.94 mm: Logistic without Gullstrand power index = −33.1784 + (−3.4271∗mean sphere) + (0.6768∗axial length) + (0.3844∗corneal power in the vertical meridian). Then, the probability of becoming myopic is calculated:

$$\text{Probability of becoming myopic} = \frac{1}{1 + e^{-\text{Logistic without Gullstrand lens power index}}}$$

The *arrow* denotes a particular point on the curve where the "logistic without Gullstrand lens power index" is 0.456, and the probability of becoming myopic in grades 4 through 8 is 0.612.

edge of when the myopia onset occurs to prevent post hoc prediction models that do not truly foretell the future refractive error.

Some of the children who have not developed myopia have not been followed through grade 8 and may yet develop myopia. Nonetheless, these represent the first predictive models of myopia onset in the literature, using ocular component data gathered before the onset of myopia. Figures 3 and 4 enable the clinician to apply the corresponding formulas presented to actual data gathered in the third grade on an individual child to predict the likelihood that the child will go on to develop myopia of at least −0.75 D in both meridians by eighth grade. These models are the first to include both an evaluation of test performance and predictive power, giving clinicians a probability with which to interpret measurements made in young nonmyopes. Our results show that such predictive models are not yet adequate using refractive error and one-time measurement of the ocular components. These models will be refined over time as we add other features, such as longitudinal ocular component data, family history of myopia, and children's near work, as well as increase the length of follow-up and the number of incident myopes.

The usefulness of ROC curve analysis lies in its ability to convey information about prediction across the entire range of sensitivity and specificity, enabling one to view these data in a more comprehensive way. It also presents the level of performance of batteries of tests conveniently. ROC analysis allows the investigator and/or clinician to focus on a range of interest on the ROC curve to evaluate the performance of a predictive test or set of tests.

For example, if a treatment is particularly effective, then the cut point pertaining to the portion of the ROC curve where sensitivity is maximized may be the interesting part of the curve, but if the treatment is effective but somewhat noxious or expensive, then the range of interest might be where sensitivity and specificity are nearly equally balanced. If a treatment had an idiosyncratic side effect in, for example, eyes not destined to become myopic, then the ROC curve range of interest would be in the region where 1 − specificity is minimized (or specificity is maximized).

In the case of myopia, treatments to actually prevent myopia onset, rather than just retard the progression of myopia already initiated, are still on the horizon, but many pharmaceutical agents are being investigated and patented for this purpose. If a topical eye drop is developed to modulate eye growth during childhood and the agent is effective, inexpensive, and has minimal side effects in children, then the range of interest in the ROC curve would be where sensitivity is perhaps emphasized slightly over specificity. A pharmaceutical or optical treatment where the therapy was worse than the cure (e.g., an eye drop that had to be used four times a day for 10 years of a child's life from ages 6 to 16 years and so might be ultimately worse than developing −3.00 D of myopia) might lead to consideration of the range of the ROC curve where specificity was relatively more important.

Feasibility of the tests needed for accurate prediction are also a factor. If a test or battery of tests is expensive or difficult to perform in certain patients, its predictive ability might be moot. If a test is very accurate for prediction but difficult to administer, the ROC curve it can generate might be helpful in deciding whether to perform the test in the first place.

In summary, we document the value of cycloplegic refractive error and three optical ocular components in the prediction of juvenile myopia onset at least 1 year after the baseline measurement taken in the third grade. Mean sphere measured during the third grade school year provides sensitivity of 86.7% and specificity of 73.3% for the traditionally held baseline cutoff point of at least +0.75 D of hyperopia and produces an ROC curve with an area under the curve of 0.880. Adding corneal power, Gullstrand crystalline lens power, and axial length improve the myopia onset prediction slightly. Future analyses will add nonoptical factors such as parental history of myopia and children's near work activities to these predictive models.

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