

# A Multicenter Analysis of the Ophthalmic Knowledge Assessment Program and American Board of Ophthalmology Written Qualifying Examination Performance

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**Objective:** To compare the performance on the American Board of Ophthalmology Written Qualifying Examination (WQE) with the performance on step 1 of the United States Medical Licensing Examination (USMLE) and the Ophthalmic Knowledge Assessment Program (OKAP) examination for residents in multiple residency programs.

**Design:** Comparative case series.

**Participants:** Fifteen residency programs with 339 total residents participated in this study. The data were extracted from the 5-year American Board of Ophthalmology report to each participating program in 2009 and included residency graduating classes from 2003 through 2007. Residents were included if data were available for the USMLE, OKAP examination in ophthalmology years 1 through 3, and the WQE score. Residents were excluded if one or more of the test scores were not available.

**Methods:** Two-sample *t* tests, logistic regression analysis, and receiver operating characteristic (ROC) curves were used to examine the association of the various tests (USMLE, OKAP examination year 1, OKAP examination year 2, OKAP examination year 3, and maximum OKAP examination score) as a predictor for a passing or failing grade on the WQE.

**Main Outcome Measures:** The primary outcome measure of this study was first time pass rate for the WQE.

**Results:** Using ROC analysis, the OKAP examination taken at the third year of ophthalmology residency best predicted performance on the WQE. For the OKAP examination taken during the third year of residency, the probability of passing the WQE was at least 80% for a score of 35 or higher and at least 95% for a score of 72 or higher.

**Conclusions:** The OKAP examination, especially in the third year of residency, can be useful to residents to predict the likelihood of success on the high-stakes WQE examination.

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The Ophthalmic Knowledge Assessment Program (OKAP) is the in-training ophthalmology examination of the American Academy of Ophthalmology for ophthalmology residents in the United States and Canada. The OKAP was started in the early 1960s as an evaluative examination for residents at the University of Florida, and the first national OKAP examination took place in May 1968, with more than 85% of all eye training programs participating. Today, all residents in ophthalmic residency programs in the United States and many in Canada participate in the OKAP. The OKAP eventually was incorporated into the Continuing Education Program of the American Academy of Ophthalmology, and then in January 1980, the OKAP was combined with the American Board of Ophthalmology (ABO) examination as a single, unified national examination. Since

then, changes in the OKAP examination and the ABO Written Qualifying Examination (WQE) process have resulted in separate examinations. The OKAP examination was designed for resident self-assessment, self-reflection, and educational improvement and is only one tool for residency programs to assess overall program effectiveness.<sup>1–3</sup> The American Academy of Ophthalmology does not encourage use of OKAP examination scores for punitive purposes or for fellowship selection. Although the OKAP examination score is meant to promote resident self-assessment and improvement during residency, it also is a preparatory examination for the WQE. The WQE is a high-stake examination that obviously has significant implications for eventual board certification; in many cases, it is a prerequisite for employment and academic appointment, and in some cases, it is a

prerequisite for hospital credentialing and licensure. In addition, residency programs are being asked to develop tools for assessment of medical knowledge and other competencies and are being assessed by the Residency Review Committee in ophthalmology for programmatic benchmarks that include the pass rate for the WQE.<sup>4,5</sup>

A few studies have looked at the relationship between the OKAP examination and WQE at a single institution. Johnson et al<sup>6</sup> reported on the relationship between the United States Medical Licensing Examination (USMLE), the OKAP examination, and the WQE among 76 residents from 15 consecutive training classes (1991–2006) at a single ophthalmologic residency training program. The main outcome measure was first-attempt pass rate on the WQE, successful completion of the WQE within 3 years of graduation, or both. The WQE first-attempt pass rate in this study was 72.6% (consistent with the national average). Resident USMLE scores were not significantly associated with WQE performance, but the WQE pass rate was associated significantly with OKAP examination scores during the 3-residency years (year 1: odds ratio [OR], 8.85, and 95% confidence interval [CI], 1.82–42.79; year 2: OR, 5.28, and 95% CI, 1.15–25.27; year 3: OR, 11.08, and 95% CI, 1.86–68.96). Passing the OKAP examinations in all 3 years during residency training was associated with 5.43-fold increased odds of passing the WQE, and failing all 3 OKAP examinations was associated with more than 9-fold lower odds of passing the WQE on the first attempt. These authors suggested that poor OKAP examination performance in a similar range to the present study was a predictor of the first-time failure (FTF) on the WQE. Chen and Bhandari,<sup>7</sup> in a smaller study, found that the mean overall percentile score averaged over the 3 years of residency in their program was  $60.3 \pm 20.2$  for the group of residents that passed the WQE and was  $26.1 \pm 13.0$  for the residents that failed the WQE on the first try ( $P < 0.001$ ).

This article describes a multicenter study to determine if the OKAP examination score and the USMLE score can predict the WQE pass rate. In addition, the potential relationship between the step 1 USMLE score, the OKAP examination score stratified by postgraduate year of training, and the maximum OKAP examination score (over an individual resident 3 years of residency) was examined to define any correlation with the FTF rate for the WQE.

## Materials and Methods

Fifteen residency programs with 339 total residents participated in this study. The programs included The University of Iowa Hospitals and Clinics, Iowa City, Iowa; University of California, Irvine, Irvine, California; Casey Eye Institute, Portland, Oregon; Indiana University, Indianapolis, Indiana; Tufts University, Boston, Massachusetts; North Shore-Long Island Jewish Health System, Great Neck, New York; Washington University, St. Louis, MO; West Virginia University, Morgantown, West Virginia; Massachusetts Eye and Ear Infirmary, Boston, Massachusetts; University of Minnesota, Minneapolis, Minnesota; University of Florida, Gainesville, Florida; Penn State College of Medicine, Hershey, Pennsylvania; University of California, San Francisco, San Francisco, California; University of Texas Southwestern Medical Center,

Dallas, Texas; and University of California, San Diego, San Diego, California. The data were extracted from the 5-year ABO report to each participating program in 2009 and included residency graduating classes from 2003 to 2007 inclusive. Residents were included if data were available for the USMLE, OKAP examination in ophthalmology years 1 through 3, and the WQE score. Residents were excluded if 1 or more of the test scores were not available. Two-sample *t* tests, logistic regression analysis, and receiver operating characteristic (ROC) curves were used to examine the association of the various tests (USMLE, OKAP examination year 1, OKAP examination year 2, OKAP examination year 3, and maximum OKAP examination score) as a predictor for a passing or failing grade on the WQE. The primary outcome measure of this study was first-time pass rate for the WQE.

## Results

Three hundred thirty-nine residents from 15 institutions participated in this study, of whom 296 had a WQE score. Further excluding those with missing data for USMLE or any of the 3 OKAP examination scores, 249 (73%) residents were included in the statistical analysis. Of the 249 residents with complete data, the pass-to-fail ratio for the WQE was 223:26 (90%:10%). The distribution of the USMLE and the OKAP examination scores grouped by outcome on the WQE (pass or fail) is shown in Figure 1. The mean score on the USMLE and all 3 OKAP examinations of those that passed the WQE was significantly higher compared with that of those who failed. The association of USMLE and OKAP examination scores with passing the WQE also was examined by logistic regression, with the size of the effect expressed in terms of OR (Table 1). Receiver operating characteristic curves were constructed for each predictor, and the area under the ROC curve was computed as a measure of the predictive ability of the USMLE and OKAP examination. The ROC curves for each of the predictors are shown in Figure 2. The area under the curve was highest for OKAP examination taken at the third year of ophthalmology residency (OR, 0.83; 95% CI, 0.74–0.91) and lowest for USMLE (OR, 0.70; 95% CI, 0.60–0.81; Table 1). Using the fitted logistic regression model with OKAP examination third-year score as predictor for passing the WQE, a predicted probability curve (with 95% CI) for passing the WQE as a function of OKAP examination score was constructed (Fig 3). From this curve, the probability of passing the WQE was at least 80% for a score of 35 or higher, at least 90% for a score of 53 or higher, and at least 95% for a score of 72 or higher. At the lower end of the score range, where only a few scores were observed ( $n = 12$  between 1 and 9, and  $n = 16$  between 10 and 19), the probability estimates have much less precision. For example, the 95% CI of the predicted probability of passing the WQE is 60% to 81% for an OKAP examination score of 19, 53% to 78% for an OKAP examination score of 15, and 44% to 74% for an OKAP examination score of 10.

## Discussion

This multicenter study from 15 institutions and including 249 residents defined the relationship between the OKAP examination and the WQE. In this study, only 10% of residents failed the WQE. Nevertheless, using the area under the ROC curve analysis as a predictor of the WQE pass rate, the USMLE score had the smallest area under the ROC curve (0.70), and the area under the ROC curve for

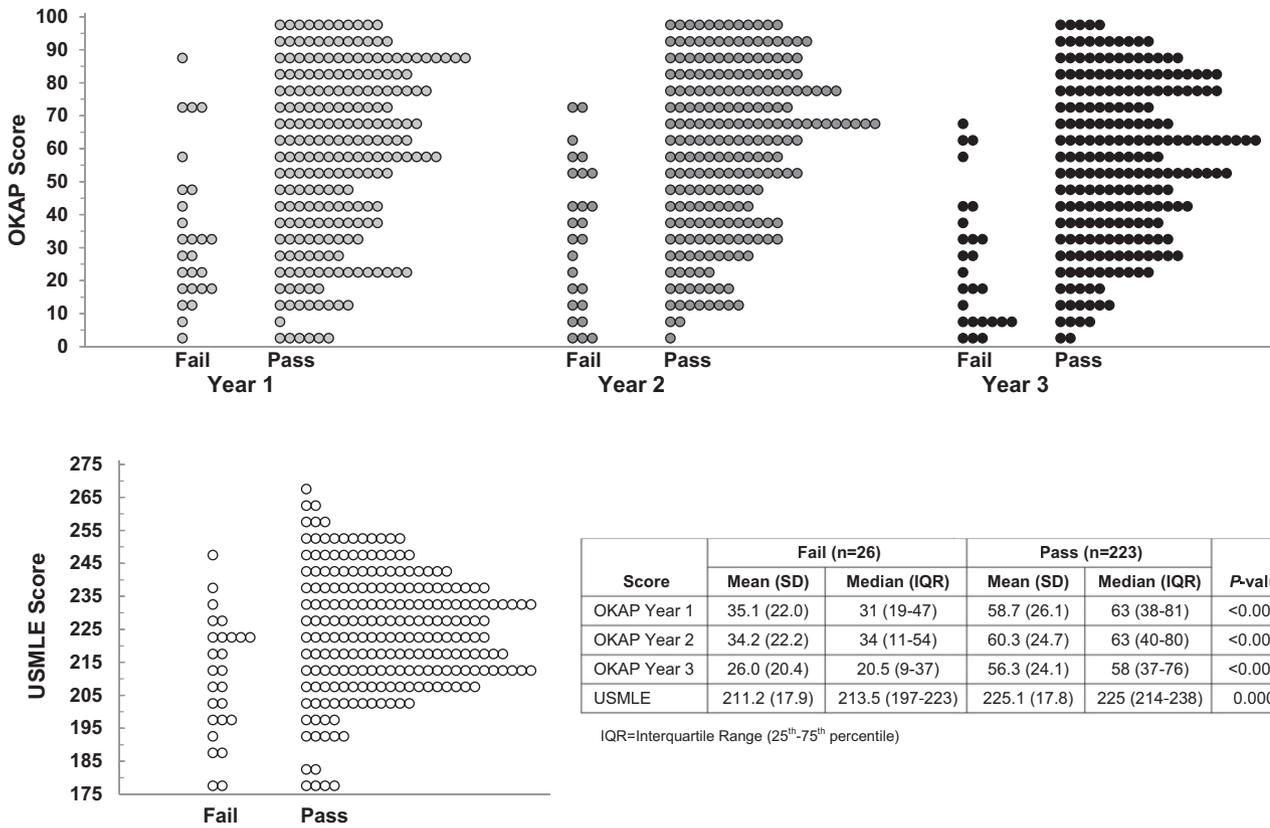


Figure 1. The distribution of the United States Medical Licensing Examination (USMLE) and the Ophthalmic Knowledge Assessment Program (OKAP) examination scores grouped by outcome of the Written Qualifying Exam (WQE; i.e., pass or fail). IQR = interquartile range; SD = standard deviation.

OKAP examination results for first-year (0.75) and second-year (0.78) ophthalmology residents also was fair. Among the 5 predictors that were examined, the third-year OKAP examination score is the best predictor of passing or failing the WQE, with an area under the ROC curve of 0.82 (Fig 2). In contrast, a resident with an OKAP examination score of

72 or higher had a significantly greater than 95% chance of passing the WQE on the first attempt.

The authors recognize the limitations of this work. First, the studied residents came from programs presumably actively engaged and interested in OKAP data, and there may have been an ascertainment bias created by the programs that participated in this study. There is additional potential selection bias in this study because the analysis purposefully excluded residents if one or more of their test scores were not available. Thus, potentially, residents who did not perform well on testing may have dropped out of the residency program or may have chosen not to take the WQE. This might have led to an under ascertainment of those residents.

The FTF on the WQE of 10% in this study was significantly less than the average FTF rate (26%) reported by the ABO. The self-aggregating and self-selected nature of residency programs who participated in this study was likely a factor in the lower FTF rate of 10% in this cohort. In addition, the FTF rate is not the only criterion for eventual ABO board certification. O’Day and Li<sup>8</sup> evaluated the (1) FTF in the written examination or FTF in the oral examination after passing the written examination the first time and (2) failure to certify within 2 years of graduation using the tracking system at the ABO to access and analyze information from 1998 through 2005. Ninety-seven percent of graduates entered the certification process, and the FTF

Table 1. Odds Ratios and Area under the Receiver Operating Characteristic Curve from Logistic Regression Analysis of Each Candidate Predictor of Pass/Fail Written Qualifying Examination

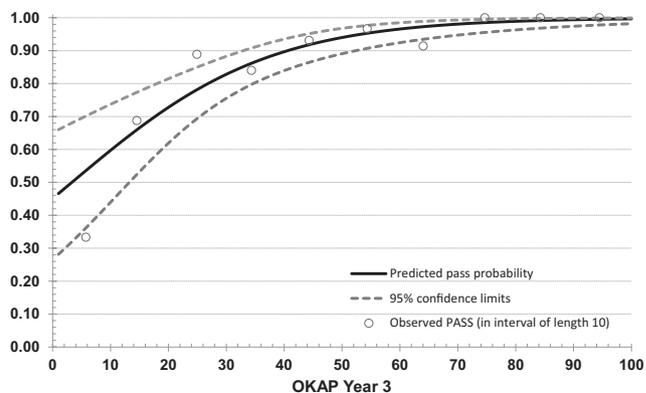
Predictor	Odds Ratio* (95% Confidence Interval)	P Value	Area under the Receiver Operating Characteristic Curve (95% Confidence Interval)
USMLE	1.52 (1.21–1.93)	0.0004	0.70 (0.60–0.81)
OKAP first year	1.43 (1.20–1.71)	<0.0001	0.75 (0.66–0.85)
OKAP second year	1.53 (1.27–1.85)	<0.0001	0.78 (0.70–0.86)
OKAP third year	1.80 (1.43–2.28)	<0.0001	0.83 (0.74–0.91)
Maximum OKAP	1.57 (1.30–1.90)	<0.0001	0.79 (0.70–0.87)

OKAP = Ophthalmic Knowledge Assessment Program; USMLE = United States Medical Licensing Examination.

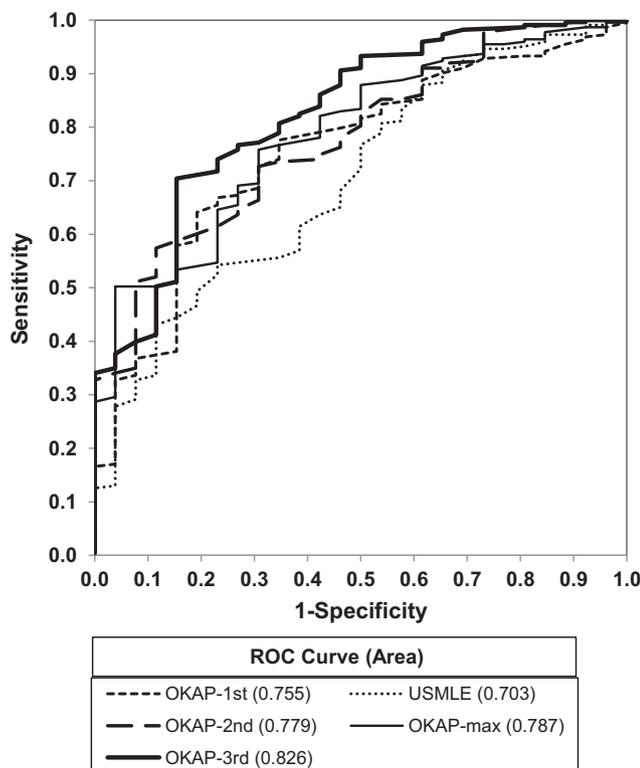
\*Odds ratio is for a +10 score difference.

rate was 28%. The programmatic FTF rate ranged from an amazing 0% to an even more astounding 89%, with a median of 28%. Programs with fewer than 16 graduates per 5 years were significantly more likely to have higher FTF rates than larger programs, and the failure to certify within 2 years of graduation rate was 21%. The included programs tended to be larger programs. In the O'Day and Li analysis, 32 residency programs accounted for 50% of the FTFs and 27 accounted for 50% of the failures to certify within 2 years of graduation. In the current study, the low FTF rate compared with the overall residency program pool might have skewed the data, and inclusion of smaller programs or different programs might have produced a different result. In the O'Day and Li study, residents who voluntarily transferred programs performed significantly worse than non-transferring residents by both measures. This potentially important issue was not addressed in this data analysis.

The WQE pass rates and OKAP scores may not predict resident performance in the real world. Catalano and Jenkins<sup>9</sup> described the relationship between perceived clinical performance and objective measures of resident knowledge of 19 graduates. Six faculty members and 6 ancillary staff personnel independently ranked residents on the basis of "dutiful performance of duties and quality of care provided" by the end of residency. Clinical performance ranks then were compared with ranks of results on standardized tests of knowledge and number of publications before and during residency. Additionally, a resident's ranking on clinical



**Figure 3.** Using the fitted logistic regression model with the Ophthalmic Knowledge Assessment Program (OKAP) third-year examination score as predictor for passing the Written Qualifying Examination (WQE), a predicted probability curve (with 95% confidence interval) for passing the WQE as a function of the OKAP examination score was constructed. From this curve, the probability of passing the WQE (pass) is at least 80% for a score of 35 or higher, at least 90% for a score of 53 or higher, and at least 95% for a score of 72 or higher. At the lower end of the score range, where only a few scores were observed ( $n = 12$  between 1 and 9, and  $n = 16$  between 10 and 19), the probability estimates have much less precision. For example, the 95% confidence interval of the predicted probability of passing the WQE is 60%, 81% for OKAP examination score of 19, 53%, 78% for an OKAP examination score of 15, and 44%, 74% for an OKAP examination score of 10.



**Figure 2.** Receiver operating characteristic (ROC) curve computed as a measure of the predictive ability of United States Medical Licensing Examination (USMLE) and Ophthalmic Knowledge Assessment Program (OKAP) examination.

performance and knowledge-related criteria was compared with his or her ranking at the time of the ophthalmology match. The perceived clinical performance of residents was not related to their results on standardized examinations or their number of publications. The residents who were highly regarded at the time of the ophthalmology match were not the same as those so regarded at the end of residency. Using data available before the commencement of the residency, the only correlation to quality of care provided was the National Board of Medical Examiners part I scores, but these scores did not correlate with the OKAP results. Likewise, Graff et al<sup>10</sup> performed a retrospective analysis of the percentile rank OKAP examination score for 15 ophthalmology resident physicians over 3 years at The University of Iowa Hospitals and Clinics, and there was no correlation between OKAP examination results and masked faculty scoring of resident overall performance ( $r = 0.11$ ). Thus, as emphasized by Rubin<sup>1,2</sup> and other designers of the OKAP examination, the test should not be used in isolation as a measure of resident competence, even if it were to be shown to be predictive of the WQE and eventual board certification.

Despite these limitations, ophthalmic residency programs may wish to concentrate their teaching and improvement efforts on residents who are at highest risk for failing the WQE (e.g., score less than 35 on the OKAP examination). Conversely, an OKAP score of 72 (with more than 95% chance of passing the WQE) may be a useful aspirational target for residents who take the OKAP examination to prepare for the WQE.

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## Footnotes and Financial Disclosures

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