

Predicting Success: Does Performance on the Anesthesia Knowledge Test – 6 (AKT-6) correlate with the American Board of Anesthesiology (ABA) Licensing Exam first-time pass rate?

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Original Article

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Abstract

Background: We sought to determine the relationship between residents' Anesthesia Knowledge Test 6 (AKT-6) scores and their first-time success/failure on the American Board of Anesthesiology written licensing examination. Reliable early identification of residents at risk for failing the ABA exam would be an invaluable screening tool for program leadership and facilitate timely remediation for struggling residents.

Methods: Program directors were invited to submit anonymous data regarding their residents' performance on the AKT-6 and their subsequent first-time success/failure on the American Board of Anesthesiology written licensing examination.

Results: Eight residency programs responded with AKT6 percentile scores and ABA part 1 first-time pass/fail status from 306 residents spanning 2004-2011. Of these, 292 also included AKT6% correct scores. AKT-6 performance was significantly better for trainees who went on to pass the ABA exam on their first attempt compared to those who failed. Trainees who scored at or below the 4th percentile (or answered $\leq 42\%$ of questions correctly) failed the ABA exam while all those scoring above the 84th percentile (or answered $>68\%$ of questions correctly) passed. A Mantel-Haenszel common odds ratio estimate revealed significantly increased odds of failure below the thresholds of AKT-6 scores $\leq 36^{\text{th}}$ percentile ($\leq 56\%$ correct).

Conclusions: Observations from this work help to validate educators' use of AKT-6 exam performance as a marker for likelihood of success/failure on the ABA written licensing exam. Our analysis, based on data from eight training programs, yielded definitive cut points for ABA exam failure and passing. ROC analysis of our data supports a recommendation for educators to intervene with trainees scoring at or below the 36th percentile or 56% correct on AKT-6 testing. Our results likely require confirmation in a larger subset of anesthesiology residency programs.

Key words:

1. Anesthesia Knowledge Test (AKT) - 6
2. ABA written exam pass rate

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Introduction

The goal of every residency program is to prepare residents for success in their field of choice. As do most specialties, Anesthesiology uses achievement of board certification as a benchmark for this success, as it indicates that trainees have demonstrated the capability to practice as a consultant. Thus, producing board certified graduates becomes a marker for residency program success. In fact, the ACGME Common Program Requirements [V.C.1.c).(2)] state that “at least 70% of a program’s graduates from the preceding five years who are taking the certifying examination for the first time should have passed”. While many tools are available that provide ongoing evaluation of residents’ progress, the AKT series is the only readily available standardized exam that is tailored to the test-taker’s level of training. Thus, when used early in the residency training process, it has the potential to identify residents with deficiencies in basic knowledge. These deficiencies, unless corrected early, may hinder residents’ progress during the course of their residencies and keep them from achieving board certification.

The Anesthesia Knowledge Test 6 was first made available in 1986 and is currently used by 120 programs nationwide. Limited research has been conducted to assess how performance on the AKT-6 correlates with ABA pass rates. In fact, only one such study is available; it was presented in 2010 at the American Society of Anesthesiologists annual meeting¹. That study found a statistically significant difference between the mean score on the AKT- 6 of residents achieving ABA certification versus those not achieving certification and postulated that a resident answering at least 48% of questions correct was significantly more likely to pass the ABA certification examination on his/her first attempt. That study, however, was limited to data collected from one program. Other conceptually similar studies have been conducted, but none specifically assessing AKT-6 performance and ABA part 1 success / failure^{2,3}. Validation reports provided online by Metrics Associates, Inc.⁴, the company that produces the AKT-6, are not intended to help educators directly predict residents’ success/failure on the ABA Part 1 Exam.

In this study, our aim was to determine if there is a statistically significant correlation between residents’ AKT-6 percentile scores and success/failure on their first attempt at the American Board of Anesthesiology written licensing examination. Reliable early identification of residents at risk for failing the ABA exam would be an invaluable screening tool for program leadership and facilitate timely remediation for struggling residents.

Methods

A list of programs that currently utilize the AKT-6 exam was provided by Metrics Inc., the company responsible for the production and distribution of the exam. These program directors were contacted by email and invited to submit anonymous data regarding the performance of their residents from 2004 - 2009 on both the AKT-6 and first-time ABA exam success/failure. Eight programs responded and actually submitted AKT-6 and ABA part 1 pass/fail status for a

total of 306 data points spanning from 2004 - 2011. This information was assessed for statistical correlation between the AKT-6 score and first-time ABA pass rate. All data analysis and statistical computations were performed using IBM SPSS Statistics. IRB approval was obtained prior to initiation of this study.

Results

Eight programs from different states of the Eastern, Mid-Western, and Southern regions of the United States submitted a total of 306 data points with both AKT-6 percentile and ABA part 1 first time pass rate. Table 1 displays the number of data points from each participating program. Table 2 displays descriptive statistics for the collected data. Of 306 data points, 44 failed the ABA on their first attempt and 262 passed.

There was a statistically significant difference in AKT-6 performance between those who went on to pass the ABA exam on their first attempt compared to those who failed (on Student's t-test $p < 0.0001$). The mean AKT-6 percentile of those failing the ABA was 29.3 (SD 20.7; 95% CI -12.1 to 70.7), while the mean AKT-6 percentile of those passing the ABA was 59.4 (SD 25.9; 95% CI 7.6 to 111.1). Receiver Operating Characteristic (ROC) analysis was performed and the resulting ROC curve is displayed in Figure 1 (AUC 0.810). Of all residents scoring at or below this AKT-6 percentile score, exactly 36% also failed the ABA part 1 examination (Figure 3). A Mantel-Haenszel common odds ratio estimate was obtained and revealed the odds of failing the ABA part 1 exam were 9.6 times higher (95% CI : 4.6, 19.8) for trainees with an AKT-6 percentile score at or below 36. Definitive cutoffs for both failure and passing of the ABA exam were identified. All who scored above the 84th percentile on the AKT-6 passed the ABA on their first attempt, while all who scored at or below the 4th percentile failed. The lowest AKT-6 score still passing the ABA was in the 7th percentile. The highest AKT-6 score that still failed was in the 84th percentile.

Of the 306 total data points we received, 292 also reported a percent correct score. This data was also examined, though it should be noted that different versions of the AKT-6 were utilized during the 2004 – 2011 time frame assessed in this study. Table 2 displays descriptive statistics for percent correct data. Of these 292 data points, 40 failed the ABA on their first attempt and 252 passed. The mean AKT-6 percent correct of those failing the ABA was 52.7 (SD 7.5; 95% CI 37.6 to 67.7), while the mean AKT-6 percent correct of those passing the ABA was 63.6 (SD 9.5; 95% CI 44.6 to 82.5). The difference in means was statistically significant (on Student's t-test $p < 0.0001$). As with the previous data set, ROC analysis was performed. The resulting ROC curve is presented in Figure 2 (AUC 0.810). One potential cutoff from this ROC analysis is to intervene for all those scoring at or below an AKT-6 score of 56% correct. 34.9% of all residents scoring at or below this AKT-6 score failed the ABA part 1 examination (Figure 4). A Mantel-Haenszel Common Odds Ratio Estimate was obtained and revealed the odds of failing the ABA part 1 exam to be 10.5 (95% CI 4.8, 22.8) times higher for those with an AKT-6 score at or below 56% correct. Figures 3 and 4 illustrate the ABA part 1 pass and fail rates at varying AKT-6 scores for our data. Additional results of data analysis are shown in tables 3 and 4.

Definitive cutoffs for both failure and passing of the ABA exam were identified. All who scored

above 68 percent correct on the AKT-6 passed the ABA on their first attempt, while all who scored at or below 42 percent correct failed. The lowest AKT-6 score that still passed the ABA exam scored 44 percent correct. The highest AKT-6 score that still failed the ABA exam scored 68 percent correct.

Discussion

Based on data from eight training programs knowledge deficiencies, as determined by performance on the AKT-6, correlated with ABA written licensure exam performance. Trainees who performed well on the AKT-6 were more likely to pass the ABA exam; likewise, those who performed poorly were less likely to pass. Moreover, our analysis yielded definitive cut points for ABA written exam failure and passing.

The percentile metric was chosen for primary analysis mainly due to its consistency from year to year – whereas the average percent correct varied from year to year presumably due to changes in test questions among other things. Percentile analysis served to correct for any variations in the test from year to year providing a more consistent indicator of resident performance over time.

Our analysis yielded definitive cutoff points for both failure and passing of the ABA exam, specifically the 4th (42% correct) and 84th percentiles (68% correct), respectively. Yet the selection of a certain AKT-6 score cutoff score to initiate intervention and remediation efforts balances a desire to identify those at risk (true positives) for ABA exam failure with misclassifying too many who are not at risk (false positives). The suggested cutoff supported by ROC analysis of our data is to intervene for trainees who perform at or below the 36th percentile (or 56% correctly answered questions) on the AKT-6. We selected this value based on the greatly increased odds of failure at or below this level of performance. Program directors interested in selecting their own threshold for intervention and remediation may find figures 3 and 4 of use.

Several limitations of the study data set should be considered when interpreting our results. Our data did not include information on remediation efforts, such as for individuals who scored poorly on the AKT-6. Additionally, we analyzed only individuals who took both the AKT-6 and the ABA part 1 exam, meaning data were not collected on individuals who left their residency program after taking the AKT-6 or never took the ABA part 1. Frequent exam modification by the exam vendor is another limitation of our study; as our data includes AKT-6 scores from 2004 through 2011 during which multiple versions of the AKT-6 were utilized. The relatively small number of programs participating in the study certainly limits the generalizability of our results. Still, compared to a previous investigation (ref#1) our work encompasses data provided by eight training programs from different states of the Eastern, Mid-Western, and Southern regions of the United States. While program class size may be inferred by the number of data points provided per year for some programs (see Table 1), this and additional program demographic information was not specifically collected. Such information could prove useful in seeking an explanation for

the variable AKT6 performance and ABA part 1 examination pass rates among participating programs and would ideally be obtained in any future research. Further investigation is needed to assess how training program remediation policies might explain the numerous low AKT-6 score outliers, i.e. trainees who performed poorly on the AKT-6 but went on to pass the ABA exam.

Despite these limitations we suggest that results from our study help validate anesthesiology educators' use of AKT-6 scores to predict trainees' certification exam performance. Program directors might therefore wish to use these results to identify which residents are "at risk" for ABA part 1 written exam failure and warrant remediation efforts. In the near future the ABA's new two phase written examination will be implemented. The current ABA Part 1 Examination will be replaced with a Basic Examination, taken at the beginning of a resident's CA-2 year, and an Advanced Examination, taken after graduation from residency (ref#5). As this new two phase written certification exam is implemented, early identification of residents at risk for failing these exams may gain even greater importance.

Acknowledgements, Disclaimers

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References

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3. McClintock JC, Gravlee, GP. Predicting Success on the Certification Examinations of the American Board of Anesthesiology. *Anesthesiology* 2010; 112: 212-9.
4. www.metricsinc.org
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Tables

Table 1: Data Contribution by Training Program and Year															
		2004	2005	2006	2007	2008	2009	2010	2011	Total Data Points	Overall first attempt ABA p1 pass rate	Average AKT6 percentile	ABA p1 pass rate for AKT6 score above 36th percentile	Average AKT6 % correct	ABA p1 pass rate for AKT6 score above 56 % correct
Program ^a	1	NA	NA	NA	NA	NA	NA	NA	NA	39	84.6%	60.5%	96.7%	64.2%	96.7%
	2	0	8	8	0	10	11	8	10	55	92.7%	60.8%	95.2%	64.0%	95.1%
	3	9	13	10	12	12	9	8	0	73	93.2%	60.9%	98.3%	63.7%	98.2%
	^b 4	NA	NA	NA	NA	NA	NA	NA	NA	14	71.4%	40.1%	100.0%	NA	NA
	5	NA	NA	NA	NA	NA	NA	NA	NA	47	74.5%	46.1%	79.3%	57.8%	85.2%
	6	0	0	0	0	8	8	7	8	31	96.8%	53.5%	95.7%	61.7%	95.7%
	7	0	0	0	0	0	0	12	13	25	80.0%	52.3%	93.8%	60.9%	93.8%
	8	NA	NA	NA	NA	NA	NA	NA	NA	22	68.2%	45.3%	100.0%	59.1%	100.0%
										306	85.6%	55.0%	94.5%	^c 62.1%	^c 95.1%

^aNumber of data points by year is displayed for programs who provided this data. ^bAKT-6 percent correct data was obtained and assessed for all except the 14 data points from Program 4. ^cIndicated results include only those data points with AKT6 % correct scores (292 data points).

Table 2: Descriptive Statistics					
	<i>n</i>	Mean	SD	Minimum	Maximum
AKT-6 Percentiles	306	55.0%	27.3%	2.0%	99.0%
Failed ABA p1	44	29.3%	20.7%	2.0%	84.0%
Passed ABA p1	262	59.4%	25.9%	7.0%	99.0%
AKT-6 % Correct	292	62.1%	9.9%	37.0%	87.0%
Failed ABA p1	40	52.7%	7.5%	37.0%	68.0%
Passed ABA p1	252	63.6%	9.5%	44.0%	87.0%

AKT6 = Anesthesia Knowledge Test 6; ABA p1 = American Board of Anesthesiology Part 1 Examination

AKT-6 percentile	What % of those scoring AT OR BELOW the corresponding AKT-6 percentile FAILED the ABA part 1?¹	What % of those scoring AT OR BELOW the corresponding AKT-6 percentile PASSED the ABA part 1?²	What % of those scoring ABOVE the corresponding AKT-6 percentile FAILED the ABA part 1?³	What % of those scoring ABOVE the corresponding AKT-6 percentile PASSED the ABA part 1?⁴	What % of those who FAILED the ABA p1 scored AT OR BELOW the corresponding AKT-6 percentile?⁵	What % of those who PASSED the ABA p1 scored ABOVE the corresponding AKT-6 percentile?⁶
2	100.0%	0.0%	14.1%	85.9%	2.3%	100.0%
4	100.0%	0.0%	13.2%	86.8%	9.1%	100.0%
7	71.4%	28.6%	13.0%	87.0%	11.4%	99.2%
10	56.3%	43.8%	12.1%	87.9%	20.5%	97.3%
12	52.6%	47.4%	11.8%	88.2%	22.7%	96.6%
16	50.0%	50.0%	11.1%	88.9%	29.5%	95.0%
19	47.2%	52.8%	10.0%	90.0%	38.6%	92.7%
20	46.2%	53.8%	9.7%	90.3%	40.9%	92.0%
25	41.8%	58.2%	8.4%	91.6%	52.3%	87.8%
30	36.0%	64.0%	7.4%	92.6%	61.4%	81.7%
35	36.5%	63.5%	5.9%	94.1%	70.5%	79.4%
*36	36.0%	64.0%	5.5%	94.5%	72.7%	78.2%
40	34.4%	65.6%	5.6%	94.4%	72.7%	76.7%
45	31.6%	68.4%	4.2%	95.8%	81.8%	70.2%
50	25.7%	74.3%	4.8%	95.2%	81.8%	60.3%
55	23.4%	76.6%	4.7%	95.3%	84.1%	53.8%
60	22.2%	77.8%	3.2%	96.8%	90.9%	46.6%
65	22.0%	78.0%	1.7%	98.3%	95.5%	43.1%
75	19.5%	80.5%	1.2%	98.8%	97.7%	32.4%
80	18.7%	81.3%	1.3%	98.7%	97.7%	28.6%
84	17.7%	82.3%	0.0%	100.0%	100.0%	22.1%
90	16.3%	83.7%	0.0%	100.0%	100.0%	13.7%
99	14.4%	85.6%	--	--	100.0%	0.0%

Table 3: When the AKT-6 scores were used to predict failure on the ABA part 1 for those scoring at or below the corresponding percentiles, (1) represents the PPV, (2) represents 1-PPV, (3) represents 1-NPV, (4) represents the NPV, (5) represents sensitivity, and (6) represents specificity. 306 data points were included. A representative selection of the results is shown. *The potential at or below cutoff we suggest is indicated. (PPV=Positive Predictive Value; NPV=Negative Predictive Value)

Table 4: AKT-6 Percent Correct Data Analysis

AKT-6 % Correct	What % of those scoring AT OR BELOW the corresponding AKT-6 % correct FAILED the ABA part 1? ¹	What % of those scoring AT OR BELOW the corresponding AKT-6 % correct PASSED the ABA part 1? ²	What % of those scoring ABOVE the corresponding AKT-6 % correct FAILED the ABA part 1? ³	What % of those scoring ABOVE the corresponding AKT-6 % correct PASSED the ABA part 1? ⁴	What % of those who FAILED the ABA p1 scored AT OR BELOW the corresponding AKT-6 % correct? ⁵	What % of those who PASSED the ABA p1 scored ABOVE the corresponding AKT-6 % correct? ⁶
37	100.0%	0.0%	13.1%	86.9%	5.0%	100.0%
40	100.0%	0.0%	12.8%	87.2%	7.5%	100.0%
42	100.0%	0.0%	12.5%	87.5%	10.0%	100.0%
44	62.5%	37.5%	12.3%	87.7%	12.5%	98.8%
45	70.0%	30.0%	11.7%	88.3%	17.5%	98.8%
46	41.2%	58.8%	12.0%	88.0%	17.5%	96.0%
48	44.0%	56.0%	10.9%	89.1%	27.5%	94.4%
49	35.3%	64.7%	10.9%	89.1%	30.0%	91.3%
50	40.5%	59.5%	9.8%	90.2%	37.5%	91.3%
52	39.6%	60.4%	7.9%	92.1%	52.5%	87.3%
53	39.0%	61.0%	7.3%	92.7%	57.5%	85.7%
54	33.3%	66.7%	7.3%	92.7%	60.0%	81.0%
55	34.7%	65.3%	6.5%	93.5%	65.0%	80.6%
*56	34.9%	65.1%	4.9%	95.1%	75.0%	77.8%
57	33.0%	67.0%	5.0%	95.0%	75.0%	75.8%
58	28.7%	71.3%	4.9%	95.1%	77.5%	69.4%
59	26.6%	73.4%	4.2%	95.8%	82.5%	63.9%
61	22.3%	77.7%	4.9%	95.1%	82.5%	54.4%
64	20.9%	79.1%	1.8%	98.2%	95.0%	42.9%
65	21.2%	78.8%	0.9%	99.1%	97.5%	42.5%
68	18.9%	81.1%	0.0%	100.0%	100.0%	31.7%
87	13.7%	86.3%	--	--	100.0%	0.0%

Table 4: When the AKT-6 scores were used to predict failure on the ABA part 1 for those scoring at or below the corresponding AKT-6 % correct, (1) represents the PPV, (2) represents 1-PPV, (3) represents 1-NPV, (4) represents the NPV, (5) represents sensitivity, and (6) represents specificity. 292 data points were included. A representative selection of the results is shown. *The potential at or below cutoff we suggest is indicated. (PPV=Positive Predictive Value; NPV=Negative Predictive Value)

Figure 1: ROC curve assessing AKT-6 percentile scores and first-time ABA part 1 pass/fail status for 306 residents. AUC is 0.810. The arrow indicates an AKT-6 percentile score of 36 (Sensitivity 72.7%, Specificity 78.2%). 36.0% of those who scored at or below this AKT-6 score failed the ABA part1 examination.

Figure 1: ROC - AKT-6 Percentile (306 data points)

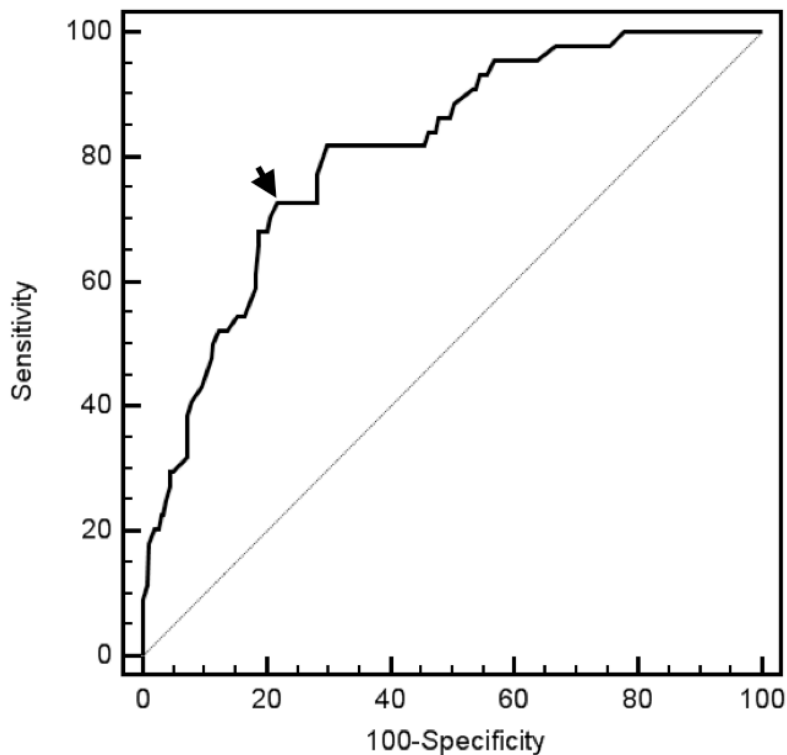


Figure 2: ROC curve assessing AKT-6 % correct scores and first-time ABA part 1 pass/fail status for 292 residents. AUC is .810. The arrow indicates an AKT-6 percent correct of 56 (Sensitivity 75.0%, Specificity 77.8%). 34.9% of those who scored at or below this AKT-6 score failed the ABA p1 examination.

Figure 2: ROC - AKT-6 % Correct (292 data points)

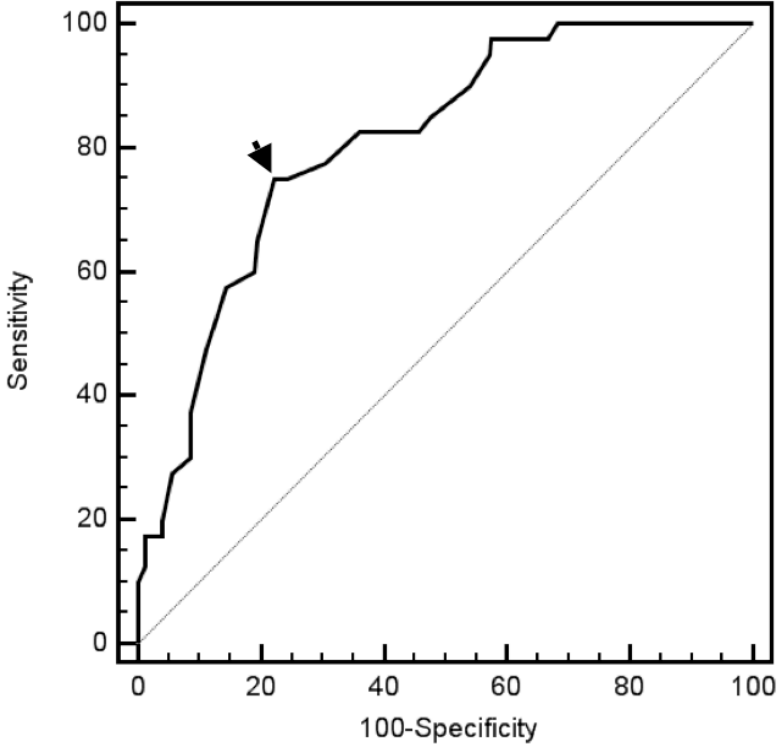
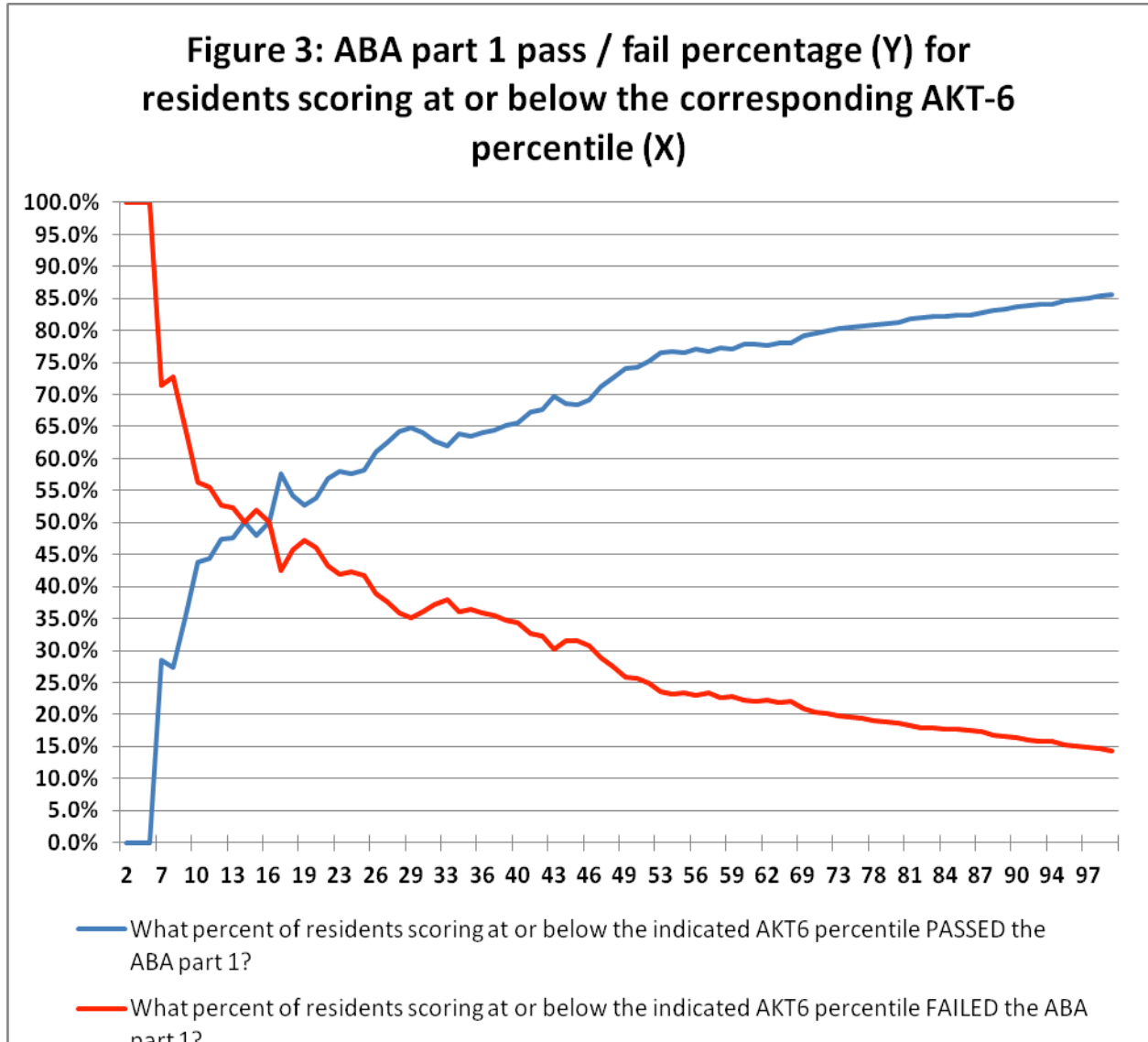


Figure 3: This figure illustrate the ABA part 1 pass (blue line) and fail (red line) rates (Y-axis) at varying AKT-6 percentiles (X-axis) for our data.



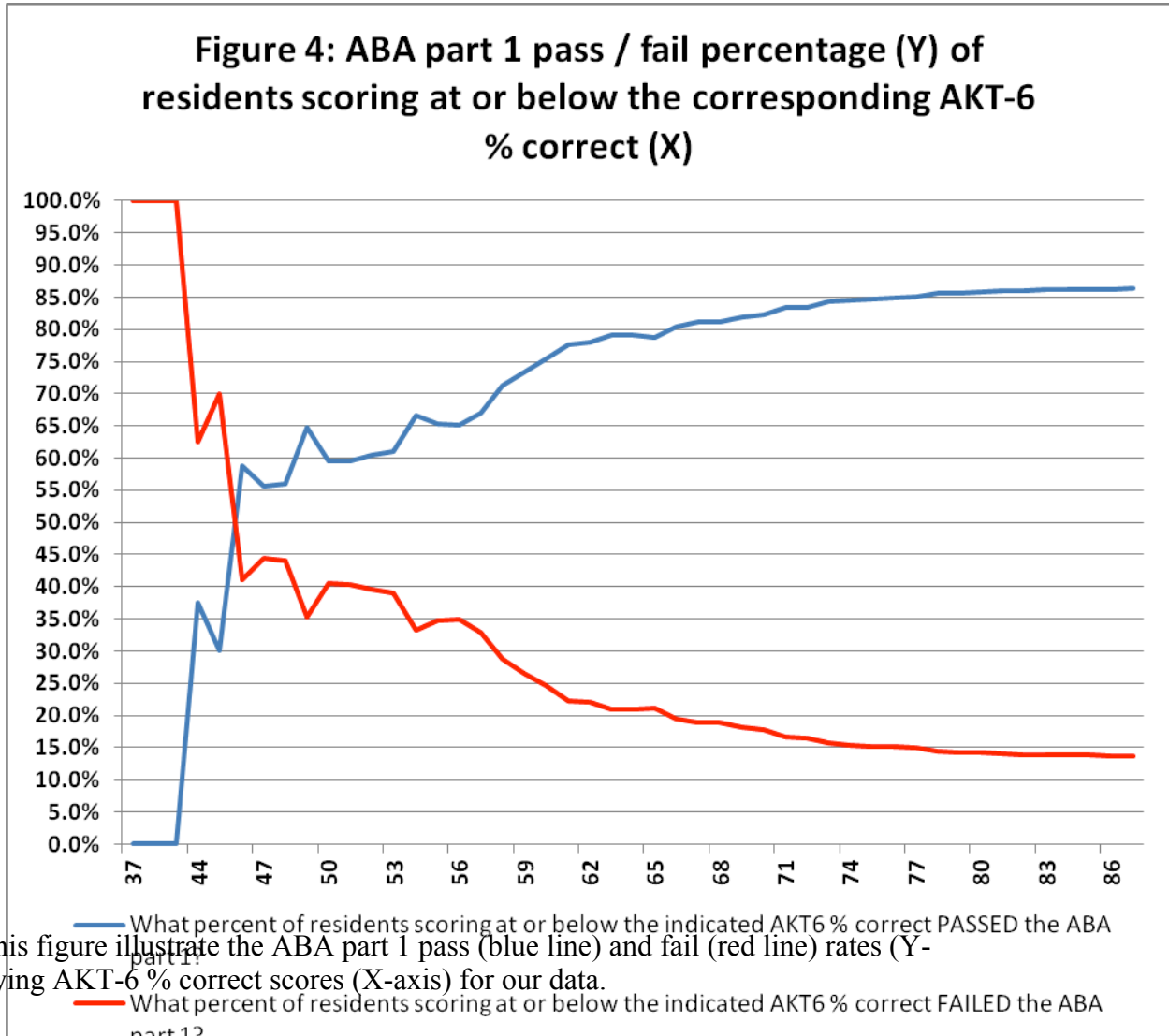


Figure 4: This figure illustrate the ABA part 1 pass (blue line) and fail (red line) rates (Y-axis) at varying AKT-6 % correct scores (X-axis) for our data.