

Academic Metrics and Predictive Models for First-Attempt Residency Placement Success in a U.S. Accredited Medical School.

Métricas Académicas y Modelos predictivos del Éxito en la Colocación en Residencia en el Primer Intento en una Escuela de Medicina Acreditada.

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Recibido: 23/2/26; Aceptado: 25/3/26; Publicado: 27/3/26

Abstract.

Objective: This study examined the contribution of academic performance indicators across the medical education continuum to predicting first-attempt residency placement success. **Methods:** A predictive, non-experimental, quantitative design with logistic regression analysis was used to analyze academic records of medical students from a U.S.-accredited medical school in Puerto Rico. Predictor variables included Medical College Admission Test (MCAT) scores, grade point average (GPA), class rank, Comprehensive Basic Science Examination (CBSE), USMLE Step 1, USMLE Step 2 Clinical Knowledge (CK), and number of Electronic Residency Application Service (ERAS) attempts. Logistic regression models were applied to evaluate predictive validity. **Results:** USMLE Step 2 CK emerged as the strongest predictor of first-attempt residency placement. A Step 2 CK score of approximately 240 corresponded to a predicted probability of $\geq 90\%$ for successful first-attempt matching. **Conclusions:** Academic metrics, particularly Step 2 CK, remain critical predictors of residency placement success. These findings support integrating predictive dashboards and targeted curricular interventions to enhance student readiness and institutional outcomes.

Keywords: residency placement, predictive models, USMLE Step 2 CK, academic metrics, medical education

Resumen.

Objetivo: Este estudio examinó la contribución de los indicadores de desempeño académico a lo largo de la formación médica para predecir el éxito en la colocación en residencia en el primer intento. **Métodos:** Se utilizó un diseño cuantitativo predictivo, no experimental, con análisis de regresión logística para analizar los expedientes académicos de estudiantes de una escuela de medicina acreditada en los Estados Unidos y ubicada en Puerto Rico. Las variables predictoras incluyeron las puntuaciones del Medical College Admission Test (MCAT), el promedio de calificaciones (GPA), el rango de la clase, las puntuaciones del Comprehensive Basic Science Examination (CBSE), el desempeño en el USMLE Step 1, las puntuaciones del USMLE Step 2 CK y el número de intentos en el Electronic Residency Application Service (ERAS). Se aplicaron modelos de regresión logística para evaluar la validez predictiva. **Resultados:** El USMLE Step 2 CK emergió como el predictor más fuerte del éxito en la colocación en residencia en el primer intento. Una

puntuación aproximada de 240 en el Step 2 CK se asoció con una probabilidad de $\geq 90\%$ de colocación exitosa en el primer intento. **Conclusiones:** Las métricas académicas, en particular el USMLE Step 2 CK, continúan siendo factores críticos del éxito en la colocación en residencia. Estos hallazgos respaldan la integración de tableros predictivos y de intervenciones curriculares dirigidas a mejorar la preparación estudiantil y los resultados institucionales.

Palabras clave: colocación en residencia, modelos predictivos, USMLE Step 2 CK, métricas académicas, educación médica

1. Introduction

Residency placement represents a critical outcome of undergraduate medical education and serves as a key indicator of institutional effectiveness and quality (7,9). As medical schools face expanding class sizes, limited growth in graduate medical education positions, and evolving residency selection criteria, competition for residency placement has intensified (8). Consequently, residency outcomes have become not only individual career milestones but also institutional performance benchmarks that inform curricular design, academic advising strategies, and Continuous Quality Improvement (CQI) efforts.

Traditionally, standardized academic metrics, including Medical College Admission Test (MCAT) scores, grade point average (GPA), class rank, and United States Medical Licensing Examination (USMLE) performance, have played a central role in residency selection decisions (1-2, 12). However, the transition of the USMLE Step 1 from a numeric score to a pass/fail format has shifted greater emphasis toward alternative indicators, particularly USMLE Step 2 Clinical Knowledge (CK), clinical evaluations, and holistic review processes (6, 11). While this change aims to reduce student stress and promote equity, it has simultaneously complicated early identification of students at risk for unsuccessful residency placement and challenged medical schools to redefine objective markers of readiness.

Within this evolving landscape, Competency-Based Medical Education (CBME) frameworks emphasize measurable outcomes and preparedness for clinical practice, aligning academic assessments with demonstrated competencies (3, 4, 8, 12). CBME promotes the integration of academic performance indicators with clinical readiness, supporting data-driven approaches to curriculum refinement, targeted student support, and institutional accountability. Predictive models that synthesize academic metrics across the medical education continuum may therefore provide actionable tools for academic advising, curricular innovation, and continuous quality improvement initiatives.

Despite the continued reliance on academic indicators, gaps remain in understanding how premedical, preclinical, and clinical performance variables collectively contribute to residency placement success, particularly following recent shifts in licensing assessment practices. Existing literature often evaluates these metrics in isolation, limiting their utility for comprehensive institutional planning and student advising.

Accordingly, the research question that guided this study was: How do academic performance variables across the medical education continuum including MCAT, GPA, class rank, Comprehensive Basic Science Examination (CBSE), USMLE Step 1, USMLE Step 2 CK, and Electronic Residency Application Service (ERAS) attempts, contribute to predicting first attempt residency placement success when integrated into a predictive model?

The primary objective of this study was to examine the predictive value of academic metrics from premedical preparation through undergraduate medical education and licensing

examinations in relation to first attempt residency placement outcomes. By developing and testing multivariable predictive models, this study sought to identify the relative contribution of each academic indicator and to generate empirical evidence to support data-informed academic advising, curricular alignment, and institutional quality improvement.

Grounded in CBME principles, this investigation aimed to move beyond isolated performance measures toward an integrated framework that links academic progression with residency readiness. The findings offer important implications for admissions policies, student support strategies, and curricular design, supporting medical schools in aligning educational practices with competencies most predictive of successful transition to residency training. To date, limited empirical evidence exists regarding residency placement predictive models within Puerto Rico medical schools.

2. Methods

A predictive, non-experimental, quantitative research design was employed to examine the relationship between academic performance indicators and first-attempt residency placement outcomes. The study was conducted at an LCME-accredited medical school in Puerto Rico and included academic records from individuals who participated in the National Resident Matching Program (NRMP) Main Residency Match across three graduating cohorts (2023-2025). The analysis focused on identifying predictors of residency placement success through multivariable statistical modeling, consistent with Competency-Based Medical Education and Continuous Quality Improvement (CQI) frameworks.

2.1 Variables

The dependent variable was the first attempt at resident placement, defined as successful placement through the NRMP Match during the initial cycle. Independent variables included standardized academic performance indicators collected across the medical education continuum: Medical College Admission Test (MCAT) scores, medical school grade point average (GPA), class rank, Comprehensive Basic Science Examination (CBSE) scores, United States Medical Licensing Examination (USMLE) Step 1 performance (pass/fail), USMLE Step 2 Clinical Knowledge (CK) scores, and the number of Electronic Residency Application Service (ERAS) attempts (table 1).

Table 1. Study Variables and Operational Definition.

Variable	Description
MCAT	Standardized, multiple-choice examination designed to assess problem solving, critical thinking, and knowledge of natural, behavioral, and social sciences concepts and principles prerequisite to the study of medicine.
Medical School GPA	A summary statistic that represents a student's average performance in their studies over a stated period
CBSE	Subject examination offered by the National Board of Medical Examiners (NBME) that assesses medical students' knowledge in basic sciences. Primarily used by US medical schools to evaluate student preparedness for the United States Licensing Examination (USMLE) Step 1
USMLE Step 1	Examination designed to measure basic science knowledge
USMLE Step 2 CK	An examination that assesses the clinical skills that are essential for safe and effective patient care, such as history taking, physical examinations, communication skills, and written documentation
ERAS	An online application platform designed to streamline the process of applying for medical residency programs in the United States

MCAT = Medical College Admission Test. CBSE = Comprehensive Basic Science Examination administered by the National Board of Medical Examiners (NBME). USMLE Step 1 = United States Medical Licensing Examination

assessing foundational science knowledge (pass/fail). USMLE Step 2 CK = Clinical Knowledge examination assessing application of medical knowledge in patient care. GPA = Grade Point Average on a 4.0 scale. ERAS = Electronic Residency Application Service used for residency applications.

2.2 Data Source and Procedure

Academic and examination data were obtained from institutional academic records and National Board of Medical Examiners (NBME) reports. The study included (n = 284) academic records corresponding to individuals who participated in the National Resident Matching Program (NRMP) Main Residency Match across three graduating cohorts (2023 - 2025). The distribution of records by cohort was as follows: 2023 (n = 68), 2024 (n = 97), and 2025 (n = 119). All data were retrospectively extracted and de-identified before analysis. No direct participant contact occurred. Records were compiled into a secure database for statistical analysis in accordance with institutional data security protocols.

2.3 Data Analysis

Descriptive statistics summarize academic characteristics and performance. Binary logistic regression analysis was conducted to evaluate the predictive relationship between independent variables and first-attempt residency placement success. Multivariable models were developed to assess individual and combined predictor effects. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated to estimate the strength of associations. Multicollinearity diagnostics were performed before model interpretation to ensure the stability of regression estimates. All statistical analyses were conducted using SPSS, with statistical significance set as $p < .05$.

2.4 Ethical Considerations

The study received Institutional Review Board exempt approval due to its retrospective design and use of de-identified academic data. All procedures complied with institutional policies regarding data confidentiality and security, as well as ethical principles outlined in the Declaration of Helsinki. No personal identifiers were retained, and results were reported exclusively in aggregate form.

3. Results

Descriptive analyses demonstrated variability across academic performance indicators (table 2). The mean MCAT score was 508 (SD = 8.5; range = 480 - 528), while the mean Comprehensive Basic Science Examination (CBSE) score was 70 (SD = 8.0; range = 50-90). The average USMLE Step 2 Clinical Knowledge (CK) score was 240 (SD = 12), with scores ranging from 200 to 270. Academic performance during medical school was high overall, with a mean GPA of 3.65 (SD = 0.27; range = 3.0-4.0).

Regarding licensing outcomes, 251 academic records (88.4%) reflected passing USMLE Step 1 results, whereas 33 records (11.6%) indicated failure on the initial attempt. Most records (92.3%) corresponded to individuals who submitted a single ERAS application cycle, while 7.7% required more than one attempt. Overall, 226 records (79.6%) demonstrated successful residency placement on the first attempt, compared to 58 records (20.4%) with no match. Higher USMLE Step 2 CK scores were observed among those who achieved first attempt residency placement, suggesting its potential relevance as a predictor of match success.

3.1 Logistic Regression Results

Binary logistic regression analysis indicated that USMLE Step 2 Clinical Knowledge (CK) score was a statistically significant predictor of first attempt residency placement (B = 0.044, SE = .014, Wald = 9.565, $p = .002$). Each one-point increase in Step 2 CK score was associated with a 4.5%

increase in the odds of successful first-attempt residency placement (OR = 1.045). The overall classification accuracy of the model was 79.6%, indicating a strong predictive performance.

Consistent with the predictive probability curve (figure 1), a Step 2 CK score of approximately 240 corresponded to a predicted probability of $\geq 90\%$ for successful first-attempt matching. These findings highlight the central role of Step 2 CK performance in residency placement outcomes and support its value as a key academic indicator within predictive advising and competency-based educational frameworks.

Logistic regression results demonstrated that USMLE Step 2 CK was the strongest predictor of first-attempt residency placement. A Step 2 CK score of approximately 240 corresponded to a predicted probability of $\geq 90\%$ for successful first attempt matching (figure 1).

Table 2. Descriptive statistics of academic predictor variables.

Variable	Mean	S.D.	Minimum	Maximum	n (%) categorical
MCAT Score	508	8.5	480	528	-
CBSE Score	70	8.0	50	90	-
USMLE Step 1 (Pass)	-	-	-	-	251 (88.4%)
USMLE Step 1 (fail)	-	-	-	-	33 (11.6%)
USMLE Step 2 CK Score	240	12	200	270	-
GPA	3.65	0.27	3.0	4.0	-
Class rank	-	-	-	-	Quartiles 1-4
ERAS Attempts	-	-	-	-	262 (92.3%) / 22 (7.7%)
Match vs No Match	-	-	-	-	226 (79.6%) Match / 58 (20.4%) No match

S.D. standard deviation. Continuous variables are presented as mean \pm standard deviation (SD) with range (minimum–maximum). Categorical variables are presented as frequency and percentage.

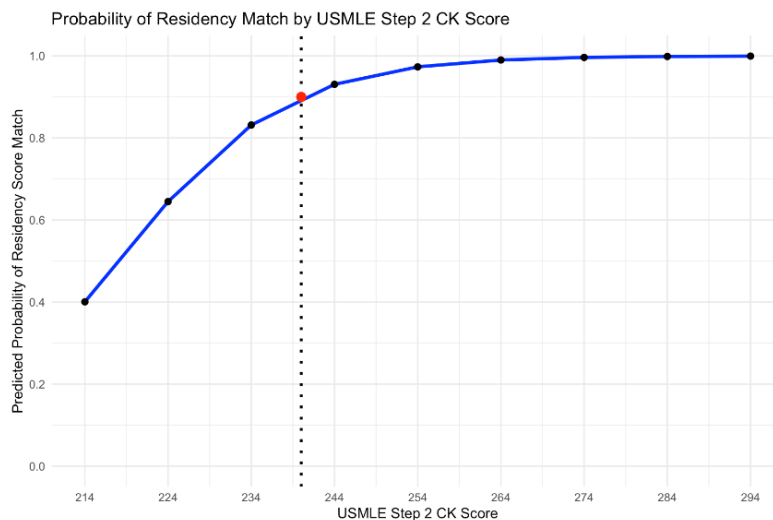


Figure 1. Predicted probability of first-attempt residency placement as a function of USMLE Step 2 CK score based on logistic regression analysis.

4. Discussion

This study confirms the central role of USMLE Step 2 CK in predicting first-attempt residency placement success, particularly in the post-Step 1 pass/fail era. These results reinforce emerging evidence that USMLE Step 2 CK has become a primary objective metric in residency selection and align with prior literature demonstrating its increasing use as a standardized indicator of clinical knowledge and readiness for residency training (8-9). Accordingly, Step 2 CK performance represents a critical component of student assessment within contemporary medical education frameworks.

Consistent with Competency-Based Medical Education (CBME) principles, the findings emphasize measurable outcomes linked to clinical competence and transition readiness (4, 13). Predictive modeling provides medical schools with a data-driven approach to identify students at academic risk earlier in the educational continuum, enabling timely interventions, targeted advising, and curricular refinement (3). Furthermore, the integration of predictive dashboards within Continuous Quality Improvement (CQI) frameworks may strengthen institutional monitoring of residency outcomes, support accreditation-related metrics, and inform strategic educational planning.

Although this study is grounded in a U.S.-accredited medical education system, the findings may have relevance for international medical training contexts. Many countries similarly rely on standardized academic metrics and licensing examinations to assess readiness for postgraduate training. In addition, international medical graduates (IMGs) represent a substantial proportion of physicians entering residency training in the United States, highlighting the global relevance of standardized metrics such as the USMLE Step 2 CK in the evaluation of residency applicants (4).

However, differences in residency selection processes, licensing structures, and competency frameworks may influence the applicability of predictive models across diverse educational systems, particularly in settings with alternative or competency-based selection approaches. Furthermore, IMGs seeking residency training in the United States are required to complete USMLE examinations, including Step 2 CK, and apply through a standardized system such as ERAS and the NRMP, further supporting the broader relevance of Step 2 CK-based predictive models across global applicant populations.

Several limitations should be considered. The retrospective design and single-institution dataset may limit generalizability to other medical schools or educational contexts. Additionally, the model focused exclusively on academic performance indicators and did not incorporate non-academic factors such as mentorship, engagement, professionalism, or extracurricular experiences, which may also influence residency outcomes. Future research should explore multi-institutional predictive models and incorporate broader competency-based and psychosocial variables to provide a more comprehensive understanding of residency placement success.

5. Conclusions

- USMLE Step 2 CK emerged as the strongest predictor of first-attempt residency placement success in this institutional sample.
- Predictive modeling demonstrates significant potential to enhance the early identification of students at risk for unsuccessful placement and support proactive academic advising.
- The integration of data-driven strategies with Competency-Based Medical Education (CBME) and Continuous Quality Improvement (CQI) frameworks offers a promising pathway for aligning curricula, advising practices, and institutional outcomes to better prepare medical students for successful transition into residency training.

Funding: There was no funding.

Declaration of conflict of interest: The authors declare that they have no conflict of interest.

Author contributions: ELCV conceived the study, conducted the study, conducted the analysis, and drafted the manuscript. Co-authors contributed to interpretation and manuscript revision.

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