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Admissions Multiple Mini-Interview and Traditional Interview Scores and Subsequent Academic Performance: A Study of Five California Medical Schools

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Purpose. No studies have directly compared the predictive validities of medical school admissions Multiple Mini-Interviews (MMIs) and traditional interviews (TIs).

Method. This was a longitudinal observational study of 2011-2013 matriculants to five California public medical schools, examining the associations of admissions MMI scores (two schools) and TI scores (three schools) with subsequent medical school performance measures. Regression models adjusted for socio-demographics and pre-medical academic metrics examined the associations of standardized admissions MMI and TI scores with: (1) U.S. Medical Licensing Examination [USMLE] Step 1 and Step 2 Clinical Knowledge [CK] scores; and, on required clerkships, (2) mean National Board of Medical Examiners [NBME] Clinical Science Subject [shelf] examination scores and (3) total Honors awarded.

Results. Of the 1460 matriculants, 746 (51.1%) interviewed at >1 study school; 579 (39.7%) had both ≥ 1 MMI and ≥ 1 TI. Neither interview type was associated with USMLE Step 1 scores. Higher MMI scores were associated with more clerkship Honors (adjusted incidence rate ratio [IRR] 1.28 [95% CI 1.18, 1.39; $P < 0.01$] per SD increase in MMI score), and higher shelf examination and USMLE Step 2 CK scores (adjusted mean 0.73 points higher [95% CI 0.28, 1.18; $P < 0.01$] and 1.25 points higher [95% CI 0.09, 2.41; $P = 0.035$] per SD increase in MMI score, respectively). Higher TI scores were

associated only with more Honors (IRR 1.11 more Honors [95% CI 1.01, 1.20; P=0.03] per SD increase in TI score).

Conclusions. Admission MMI performance was more strongly associated with subsequent medical student performance measures than was TI performance.

Admissions interview ratings are weighted heavily in medical school acceptance decisions.¹ Yet many studies suggest that unstructured one-on-one traditional interviews (TIs) may have limited *predictive validity*, or the ability to identify applicants likely to succeed in training.²⁻⁴ By contrast, in studies mostly conducted outside the United States (U.S.), higher scores on Multiple Mini-Interviews (MMIs) – in which applicants work through a series of brief, semi-structured stations attended by trained raters⁵ – predict better objective structured clinical examination scores,⁶⁻⁸ licensing examination scores,^{9,10} and clinical clerkship ratings.^{8,10} Partly based on such findings, many medical schools have abandoned TIs in favor of MMIs.¹¹

A key limitation of prior studies is that they were each conducted at single institutions employing *either* TIs or MMIs, and at varying time points. Such studies are valuable, but have limited utility in comparing the relative abilities of MMIs and TIs to identify applicants likely to succeed academically.

A useful next step would be to examine the associations of interview scores with academic performance simultaneously across several schools that have overlapping applicant pools, with some schools employing MMIs and others TIs, with some applicants completing both interview types. Currently, such studies are lacking. The dearth of U.S. studies is also unfortunate, given substantial differences in application screening processes and academic performance measures among countries,¹²⁻¹⁴ and the greater socio-demographic diversity of U.S. applicants.¹⁵⁻¹⁷ Also, in prior studies the MMI processes varied substantially among schools, as did the academic outcomes examined.⁷⁻¹⁰ The findings of a recent systematic review concluded that consistent validity across countries, institutions, and outcomes cannot be assumed, underscoring the need for multi-institutional studies to more robustly examine the predictive validity of admissions interviews.¹⁸

Using data from the five California Longitudinal Evaluation of Admission Practices (CA-LEAP) consortium medical schools, we examined the associations of concurrent medical students' admissions MMI scores and TI performance with U.S. Medical Licensing Examination (USMLE) Step 1 and Step 2 Clinical Knowledge (CK) scores, National Board of Medical Examiners (NBME) clerkship subject (shelf) examination scores, and number of clerkship Honors.

Methods

We conducted the study activities from July 2014-October 2017. We obtained ethics approval from the institutional review boards of the participating schools via the University of California Reliance Registry (protocol #683).

Study population

The study population included applicants who completed one or more medical school interview and subsequently matriculated at a CA-LEAP school in one of the admissions cycles during 2011-2013. The five CA-LEAP schools, all public institutions participating in a consortium to evaluate medical school interview processes and outcomes,¹⁹ are: David Geffen School of Medicine at UCLA (UCLA); University of California, Davis, School of Medicine (UCD); University of California, Irvine, School of Medicine (UCI); University of California, San Diego, School of Medicine (UCSD); and University of California, San Francisco, School of Medicine (UCSF). Applicants to the following medical school tracks, which had non-standard interview or selection processes, were excluded from the study: MD-PhD programs; UCSD combined bachelor's-MD program; UCSD PProgram in Medical Education (PRIME) program; UCLA DDS-MD program; UCLA PRIME program; Charles R. Drew/UCLA Medical Education Program; and the University of California, Berkeley-UCSF Joint Medical Program. Two of the five CA-LEAP schools (MMI1 and MMI2) used MMIs and three (TI1, TI2, and TI3) used TIs.

Interview processes and scoring

The MMIs at MMI1 and MMI2 consisted of individually scored 10 minute stations (10 and 7 stations, respectively), most of which were adapted from commercially marketed content.²⁰ All stations were multidimensional: At every station, a structured rating form was used to assess interpersonal communication ability along with one or more additional competencies (e.g., integrity/ethics, professionalism, diversity/cultural awareness, teamwork, ability to handle stress, problem solving). All stations were attended by one rater, except for one two-rater station at MMI2. Raters interacted directly with applicants at some stations and observed applicant interactions (e.g., with actors) at others. Raters at both schools included physician and basic science faculty and medical students. Raters at MMI1 also included alumni, nurses, patients, lawyers, high-level administrative staff, and other community members. Raters at both schools received 60 minutes of training before each admissions cycle; at MMI2, raters also received a 30-minute re-orientation prior to each MMI circuit. Raters were given no information about applicants. Raters at both MMI schools assigned a single global score (higher=better performance), although each school employed a different scale (MMI1: 0-3 points; MMI2: 1-7 points).

Applicants at each TI school completed two 30-60 minute unstructured interviews, one with a faculty member and one with a medical student or another faculty member. At all TI schools, at least sixty minutes of training was provided to interviewers before each application cycle. Interviewers at TI1 and TI2 reviewed the candidate's application before the interview, with

academic metrics redacted at T11. At T13, interviewers reviewed the candidate's application after assigning initial interview ratings, and then could adjust their ratings (if desired) after reviewing the application, yielding a final interview rating (used in our analyses). Interviewers at all three schools rated applicants on standardized scales, though the domains rated and scales differed among schools. Interviewers at T11 and T13 assigned a single global rating (exceptional, above average, average, below average, unacceptable at T11; unreserved enthusiasm, moderate enthusiasm, or substantial reservations at T13). At school T12, interviewers rated candidates in four domains (thinking/knowledge, , using a 1-5 point scale for each domain (thinking/knowledge, communication/behavior, energy/initiative, empathy/compassion); these domain scores were summed yielding a total score (range 4-20).

Other applicant characteristics

Applicant characteristics obtained from the American Medical College Application Service included: age; self-designated gender, race and ethnicity, and disadvantaged (DA) status (yes/no); cumulative grade point average (GPA); total Medical College Admissions Test (MCAT) score; and application year. Students were classified as under-represented in medicine (UIM) - Black or African-American, Hispanic, Native American, and Pacific Islander applicants - or not.

USMLE Step 1 and Step 2 CK scores

USMLE Step 1 assesses understanding and application of basic science concepts relevant to medical practice (possible score range 1-300).²¹ Students in our sample took this examination from 2013 through 2015, approximately two years after matriculating. USMLE Step 2 has two parts. Step 2 Clinical Knowledge (CK) assesses the ability to apply the medical knowledge, skills, and understanding of clinical science needed to contribute to solving patient care problems under supervision (possible score range 1-300).²¹ Students in our sample took this examination from 2014 through 2016, approximately three years after matriculating. The other part of Step 2, the Clinical Skills (CS) exam, is pass/fail; few students failed, precluding meaningful analysis. The USMLE adjusts for differences in difficulty across forms and years using statistical procedures, and considers scores to be comparable across a 3-4 year window.²¹

Clinical clerkship NBME examination scores and Honors

We considered Honors grades in all required clinical clerkships, which varied from 6 to 8 clerkships among schools. While grading formulas varied, key components for all clerkships and schools included supervising residents' and attending physicians' subjective ratings, and the student's score on the corresponding NBME Clinical Science subject examination, widely referred to in the U.S. as the clerkship shelf examinations (possible score range 1-100). Per the NBME, the shelf examinations "are achievement tests in a broad sense, requiring medical students to solve scientific and clinical problems."²² Students in our sample took the shelf examinations from 2013 through 2016, from two to four years after matriculating.

Analyses

Analyses were conducted using Stata (version 15.1, StataCorp, College Station, TX). For each applicant, we calculated mean MMI and mean TI scores for all interviews (i.e., up to two MMIs or three TIs). Both sets of scores were standardized (mean 0, SD 1) based on school and year. Key outcome measures were USMLE Step 1 and Step 2 CK scores, mean NBME shelf examination scores (from scores on all required clerkships), and the total number of Honors in required clerkships. TI3 did not provide consortium applicant data until the 2012 cohort.

We employed two sets of four separate regression models, one set each for MMIs and TIs. The models examined, respectively, the adjusted

associations of mean MMI score or mean TI score with the following dependent variables: (1) USMLE Step 1 score (linear regressions); (2) USMLE Step 2 CK score (linear regressions); (3) mean NBME shelf exam score (linear regressions); and (4) total number of clerkship Honors (negative binomial regression, to adjust for over-dispersion in this count variable). Each regression included only students with data for the dependent variable of interest. Covariates in all models were age (<23, 23, 24, 25, or ≥ 26); gender (male or female); UIM race/ethnicity (no or yes); self-designated DA status (no or yes); GPA (<3.4, 3.4-3.6, >3.6-3.8, or >3.8); total MCAT score (<27, 27-30, 31-32, 33-34, or >34); school (MMI1, MMI2, TI1, TI2, or TI3); and year (2011, 2012, or 2013). We included these covariates because apart from year (included to capture secular trends), each had been associated with aspects of medical school academic performance in prior studies.^{6,10,23-28} The models for clerkship Honors also included terms for the interaction of school with year, to adjust for between-school and between-year variation in the average and maximum number of Honors at each school. Analyses were conducted using the standardized mean MMI and TI scores in two ways: as continuous variables to examine linear trends and coded by sample quintiles to examine non-linear effects.

We tested whether there were statistically significant differences between TI and MMI performance in their associations with the study academic performance measures using the Stata program *suest*.^{29,30} The program uses model parameter estimates and their associated covariance

matrices to allow statistical testing (Wald tests) of differences among parameter estimates across models.

To explore the robustness of findings from the primary analyses, we also conducted secondary analyses restricted to applicants who completed both ≥ 1 MMI and ≥ 1 TI, affording more direct comparison of the interview types.

Results

There were 4993 individuals who completed at least one CA-LEAP school interview during the study. Of these, 1460 (29.2%) matriculated to one of the schools and comprised the study sample; **Table 1** shows their entry characteristics and **Table 2** their subsequent academic performance. Of 1460 matriculants during the study, 746 (51.1%) interviewed at >1 school; 579 (39.7%) had both ≥ 1 MMI and ≥ 1 TI. The correlation between mean TI and MMI scores was 0.26.

Beyond the school not providing data for 2011, 24 (1.6%) students had missing USMLE Step 1 data. Shelf scores and clerkship ratings were missing for 59 (4.0%) students. USMLE Step 2 data were missing for 133 (9.1%) students. Of the pre-matriculation variables, only gender predicted the likelihood of missing a shelf exam score or clerkship grading data. Women had more missing shelf score or Honors data than men (38 [5.1%] versus 21 [1.9%], respectively; Chi-square 4.5; $P=0.03$).

Unadjusted performance on the academic outcomes was as follows: USMLE Step 1 mean 233.3 (SD 19.6), range 163-271; USMLE Step 2 CK mean 245.3 (SD 15.7), range 184-280; shelf exam mean 78.4 (SD 6.6), range 54.0-97.7; and clerkship Honors mean 1.7 (**Table 3** summarizes the key results of the eight primary analyses examining the adjusted associations of mean MMI and TI scores (using both z scores and quintiles) with the study academic performance outcome measures (full model findings are available from the authors upon request). The **Figure** depicts relationships of TI score and MMI score (by quintile) with USMLE Step 2 CK score, mean clerkship shelf exam score, and total number of clerkship Honors.

Neither interview type was associated with subsequent USMLE Step 1 scores. The linear relationship between MMI performance and Honors was significant, as was the relationship between TI performance and Honors (**Table 3**). The MMI/Honors association was significantly larger than the TI/Honors association (IRR = 1.16 [95% CI 1.04, 1.30; P=0.01] more honors). We conducted a post-hoc analysis exploring whether the relationship between MMI score and clinical Honors was independent of clerkship shelf examination score. The association between MMI and Honors was attenuated by 36.6% (95% CI 18.9%, 54.3%; P<0.01) with additional adjustment for shelf examination score (IRR 1.17, [95% CI 1.10, 1.25; P<0.01]).

Positive associations also were observed between MMI (but not TI) performance and mean clerkship shelf examination and USMLE Step 2 CK

scores. There was a linear relationship between MMI and shelf examination score (**Table 3**). The MMI/shelf examination association was significantly larger than the TI/shelf relationship (0.47 points higher [95% CI 0.26, 0.89; P=0.02] per SD increase in interview score). There was also a linear relationship between MMI score and USMLE Step 2 CK (**Table 3**). Comparing the association between MMI score and USMLE Step 2 CK score with the association between TI score and USMLE Step 2 CK score, there was no significant difference (USMLE Step 2 CK score 0.82 points larger [95% CI -0.89, 2.52; P=0.35] per SD increase in MMI score).

Secondary analyses limited to students who completed both at least one MMI and at least one TI yielded similar findings to those of the primary analyses (summary in the **Online Appendix**).

Discussion

We believe this is the first study to directly compare the predictive validity of MMIs with TIs in a multi-school sample. Higher MMI scores were associated with receiving more Honors in required clerkships, and with higher USMLE Step 2 CK scores and clerkship shelf examination scores. By contrast, TI performance exhibited only a more modest relationship with Honors. The effect sizes for the MMI associations both with Honors and with clerkship shelf examination scores were significantly greater than the respective TI associations. The contrasting findings for MMIs vs TIs were also

observed in secondary analyses limited to students who had completed both interview types.

Our study was not designed to determine the mechanisms of the relationship of MMI performance with clerkship Honors. One possible explanation is that higher performance on the MMI signifies superior candidates for medical training – someone likely to attain higher levels of clinical performance than their peers. That the relationship of MMI score with clerkship Honors remained significant after adjusting for mean shelf examination score, an indicator of medical knowledge, is consistent with the notion that the MMI/Honors association may be driven in part by other characteristics (e.g. interpersonal skills). A second possibility is that MMIs select for characteristics that also weigh heavily in assigning clerkship grades, but do not necessarily contribute to superior clinical performance. For example, we previously demonstrated significantly higher MMI scores among applicants with higher levels of the personality factor Extraversion,³¹ while others have shown that more Extraverted individuals receive higher interpersonal communication ratings on clerkships.^{32,33} Yet to our knowledge the net impact of Extraversion on physician functioning in practice is unstudied. Ideally, to better gauge the net impact of adopting MMIs in medical school admissions, long-term, multi-institutional efforts should examine the association of MMI scores with real patient clinical performance. Such initiatives would be challenging to field, but might be feasible with collaboration among and support from organizations charged with oversight

of medical education and physician specialty boards entrusted with ensuring ongoing competence.

Why higher MMI performance was associated with higher clerkship shelf examination and USMLE Step 2 CK scores, but not with USMLE Step 1 scores, is unclear. All the examinations are cognitive. Both the shelf examination and USMLE Step 2 CK (but not Step 1) assess the ability to apply clinical knowledge to patient care dilemmas posed in written case scenarios – in other words, clinical problem solving^{21,22} – which MMIs also aim to assess.^{34,35} This overlap in testing goals could account for the modest observed relationship between MMI and USMLE Step 2 CK scores, a speculation warranting further study. Our MMI findings are consistent with an earlier study, showing higher MMI performance was associated with higher scores on the Medical Council of Canada Qualifying Examination Parts 1 and 2.⁹

In previous CA-LEAP studies we found that, while within- and between-school reliabilities of TIs were lower than for MMIs,³⁵ TIs performed as well as MMIs in predicting acceptance offers within and between schools.¹⁰ In the current study, TIs exhibited a modest relationship only with clerkship Honors. Nonetheless, we believe it would be premature to abandon TIs, since our findings do not negate the possibility that TIs are effective in selecting students likely to succeed as clinicians. Rather, they may simply select for attributes that confer more limited net advantage in standardized testing or

subjective clerkship ratings. Also, there is little evidence (all from Canada) suggesting that higher scores on licensing examinations for non-international medical school graduates predict superior performance in clinical practice.^{36,37} Further, to our knowledge no studies have examined how clerkship shelf examination scores or Honors predict future performance. Additional multi-school studies including both TIs and MMIs would be helpful, to compare the applicant characteristics rewarded by MMIs vs. TIs, and the quality of care provided by physicians selected through each process.

Strengths of our study include a large sample of applicants to five public medical schools in California, one of the most socio-demographically diverse states, and a direct comparison of MMI and TI predictive validity. Our study also had limitations. The degree to which the findings may generalize to non-CA-LEAP schools is uncertain. We adjusted for potentially confounding applicant factors included in prior single-school admissions studies, and for other potential confounders such as school and year of matriculation. Nonetheless, confounding by unmeasured applicant or contextual (e.g., interviewer/rater) factors may still have occurred. While we examined several important academic performance measures, other potentially important outcomes (e.g., USMLE Step 3 scores) also merit study. We had incomplete data, including one consortium school not contributing data for 2011; however, our analyses adjusted for year.

In conclusion, in a study of the five CA-LEAP schools, better admission MMI performance was associated with more clerkship Honors and higher USMLE Step 2 CK and clerkship shelf examination scores. By contrast, TI performance exhibited a more modest relationship with clerkship Honors only.

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Other disclosures. None.

Ethical approval. On May 19, 2014, the authors obtained ethical approval to conduct the study from the institutional review boards of the participating schools, via the University of California Reliance Registry (protocol #683).

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References

1. Monroe A, Quinn E, Samuelson W, Dunleavy DM, Dowd KW. An overview of the medical school admission process and use of applicant data in decision making: what has changed since the 1980s? *Acad Med.* 2013;88:672-681.
2. Goho J, Blackman A. The effectiveness of academic admission interviews: an exploratory meta-analysis. *Med Teach.* 2006;28:335-340.
3. Patterson F, Rowett E, Hale R, et al. The predictive validity of a situational judgement test and multiple-mini interview for entry into postgraduate training in Australia. *BMC Med Educ.* 2016;16:87.
4. Sladek RM, Bond MJ, Frost LK, Prior KN. Predicting success in medical school: a longitudinal study of common Australian student selection tools. *BMC Med Educ.* 2016;16:187.
5. Eva KW, Rosenfeld J, Reiter HI, Norman GR. An admissions OSCE: the multiple mini-interview. *Med Educ.* 2004;38:314-326.
6. Eva KW, Reiter HI, Rosenfeld J, Norman GR. The ability of the multiple mini-interview to predict preclerkship performance in medical school. *Acad Med.* 2004;79(10 Suppl):S40-S42.
7. Husbands A, Dowell J. Predictive validity of the Dundee multiple mini-interview. *Med Educ.* 2013;47:717-725.

8. Reiter HI, Eva KW, Rosenfeld J, Norman GR. Multiple mini-interviews predict clerkship and licensing examination performance. *Med Educ.* 2007;41(4):378-384.
9. Eva KW, Reiter HI, Rosenfeld J, Trinh K, Wood TJ, Norman GR. Association between a medical school admission process using the multiple mini-interview and national licensing examination scores. *JAMA.* 2012;308:2233-2240.
10. Jerant A, Henderson MC, Griffin E, et al. Medical school performance measures of socioeconomically disadvantaged and underrepresented minority students matriculating after a Multiple Mini-Interview. *J Healthcare Poor Underserved.* 2018;In Press.
11. Glazer G, Startzman LF, Bankston K, Michaels J, Danek JC, Fair M. How many schools adopt interviews during the student admission process across the health professions in the United States of America? *J Eval Health Prof.* 2016;13:12.
12. Medical school in Canada.
(https://en.wikipedia.org/wiki/Medical_school_in_Canada). Accessed October 20, 2017.
13. Medical school in the United Kingdom.
(https://en.wikipedia.org/wiki/Medical_school_in_the_United_Kingdom). Accessed October 20, 2017.

14. Medical school in the United States.
(https://en.wikipedia.org/wiki/Medical_school_in_the_United_States).
Accessed October 20, 2017.
15. AAMC Facts & Figures 2016. Diversity in medical education.
Washington, DC: Association of American Medical Colleges.
(<http://www.aamcdiversityfactsandfigures2016.org/>). Accessed October 5, 2017.
16. Dhalla IA, Kwong JC, Streiner DL, Baddour RE, Waddell AE, Johnson IL. Characteristics of first-year students in Canadian medical schools. *CMAJ*. 2002;166:1029-1035.
17. Tiffin PA, Dowell JS, McLachlan JC. Widening access to UK medical education for under-represented socioeconomic groups: modelling the impact of the UKCAT in the 2009 cohort. *BMJ (Clin Res)*. 2012;344:e1805.
18. Rees EL, Hawarden AW, Dent G, Hays R, Bates J, Hassell AB. Evidence regarding the utility of multiple mini-interview (MMI) for selection to undergraduate health programs: A BEME systematic review: BEME Guide No. 37. *Med Teach*. 2016;38:443-455.
19. Henderson MC, Kelly CJ, Griffin EJ, et al. Medical school applicant characteristics associated with performance in Multiple Mini-Interviews versus traditional interviews: a multi-institutional study. *Acad Med*. 2017 Oct 31. doi: 10.1097/ACM.0000000000002041. [Epub ahead of print].

20. Welcome to ProFitHR. (<http://www.profithr.com/>). Accessed October 7, 2017.
21. USMLE score interpretation guidelines. (http://www.usmle.org/pdfs/transcripts/USMLE_Step_Examination_Score_Interpretation_Guidelines.pdf). Accessed October 5, 2017.
22. National Board of Medical Examiners. Subject examinations. (<http://www.nbme.org/schools/Subject-Exams/>). Accessed October 5, 2017.
23. Dunleavy DM, Kroopnick MH, Dowd KW, Searcy CA, Zhao X. The predictive validity of the MCAT exam in relation to academic performance through medical school: a national cohort study of 2001-2004 matriculants. *Acad Med.* 2013;88:666-671.
24. Kleshinski J, Khuder SA, Shapiro JI, Gold JP. Impact of preadmission variables on USMLE step 1 and step 2 performance. *Adv Health Sci Educ Theory Pract.* 2009;14:69-78.
25. Haist SA, Wilson JF, Elam CL, Blue AV, Fosson SE. The effect of gender and age on medical school performance: an important interaction. *Adv Health Sci Educ Theory Pract.* 2000;5:197-205.
26. Lee KB, Vaishnavi SN, Lau SK, Andriole DA, Jeffe DB. "Making the grade:" noncognitive predictors of medical students' clinical clerkship grades. *J Natl Med Assoc.* 2007;99:1138-1150.

27. Andriole DA, Jeffe DB. Prematriculation variables associated with suboptimal outcomes for the 1994-1999 cohort of US medical school matriculants. *JAMA*. 2010;304:1212-1219.
28. Campos-Outcalt D, Rutala PJ, Witzke DB, Fulginiti JV. Performances of underrepresented-minority students at the University of Arizona College of Medicine, 1987-1991. *Acad Med*. 1994;69:577-582.
29. Stata user's guide, Release 15.
(<http://www.stata.com/manuals13/rsuest.pdf>). Accessed September 27, 2017.
30. Clogg CC, Petkova E, Haritou A. Statistical methods for comparing regression coefficients between models. *Am J Sociol*. 1995;100:1261-1312.
31. Jerant A, Griffin E, Rainwater J, et al. Does applicant personality influence multiple mini-interview performance and medical school acceptance offers? *Acad Med*. 2012;87:1250-1259.
32. Lievens F, Ones DS, Dilchert S. Personality scale validities increase throughout medical school. *J Appl Psychol*. 2009;94:1514-1535.
33. Chibnall JT, Blaskiewicz RJ. Do clinical evaluations in a psychiatry clerkship favor students with positive personality characteristics? *Acad Psychiatr*. 2008;32:199-205.
34. Manual for Interviewers. Michael G. DeGroote School of Medicine: McMaster University, Hamilton, Ontario, Canada.
(<http://mdprogram.mcmaster.ca/docs/default-source/admissions/intervi>

ewer-manual-mmi_websiteversion.pdf?sfvrsn=2). Accessed October 5, 2017.

35. Jerant A, Henderson MC, Griffin E, et al. Reliability of Multiple Mini-Interviews and traditional interviews within and between institutions: a study of five California medical schools. *BMC Med Educ.* 2017;17:190.
36. Tamblyn R, Abrahamowicz M, Brailovsky C, et al. Association between licensing examination scores and resource use and quality of care in primary care practice. *JAMA.* 1998;280:989-996.
37. Tamblyn R, Abrahamowicz M, Dauphinee WD, et al. Association between licensure examination scores and practice in primary care. *JAMA.* 2002;288:3019-3026.

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Figure Title. By Quintile Associations of Traditional Interview and Multiple Mini-Interview Scores with USMLE Step 1 and Step 2 Clinical Knowledge Scores, NBME Clinical Science Subject Examination Scores, and Number of Clerkship Honors among Matriculants at CA-LEAP Consortium Schools in 2011-2013

Figure Legend

All analyses adjusted for age category (<23, 23, 24, 25, \geq 26); gender; underrepresented in medicine racial/ethnic minority (yes/no); self-designated disadvantaged (yes/no); undergraduate grade point average category (<3.4, 3.4-3.6, >3.6-3.8, or >3.8); total Medical College Admission Test score category (<27, 27-30, 31-32, 33-34, or >34); school (MMI1, MMI2, TI1, TI2, or TI3); and application year (2011, 2012, or 2013). The models for clerkship Honors also adjusted for interactions between school and year.

Abbreviations: CA-LEAP, California Longitudinal Evaluation of Admissions Practices; MMI, Multiple Mini-Interview; NBME, National Board of Medical Examiners; TI, traditional interview; USMLE, U.S. Medical Licensing Examination