Impact of High School Quality on Academic Performance Throughout Medical School

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Abstract
Introduction: Numerous studies currently evaluate medical school success and performance using college Grade Point Average (GPA) and Medical College Admissions Test (MCAT) scores. These studies demonstrate that students who score low on the MCAT will continually perform worse than their peers on medical school exams and board exams. We investigated where a student attended high school and how that factor can affect medical school performance because most studies evaluated performance based on college attendance.

Methods: Our retrospective study evaluated 184 students at Kirk Kerkorian School of Medicine (KSOM) and showed higher-quality high schools, in comparison to lower-quality high schools, affected medical school performance. We categorized two groups for high school quality based on the U.S. News scorecard for programs within Nevada: those students with a high school reading proficiency (HSRP) >50% and those with an HSRP <50%. These two groups were then standardized based on percentile within the school and averaged using HSRP, MCAT, pre-clinical, step 1, clinical, and step 2 scores. A line chart was graphed to demonstrate the difference between the two groups.

Data/results: As might be expected, our results showed significantly higher MCAT scores from students who attended high-quality versus low-quality high schools. Our results also showed that although students from low-quality high schools performed worse for the first part of medical school, by step 2, students will score similarly in both groups.

Conclusion: Students who performed poorly on the MCAT and attended lower-quality high schools will score as competitively as their peers by step 2.

Introduction
Although multiple studies show a correlation between predictive college variables (Medical College Admissions Test [MCAT], undergraduate Grade Point Average [GPA]) and medical school success, little is known about how high school quality may affect medical student performance (United States Medical Licensing Examination [USMLE] step 1, step 2 CK). This dilemma causes one to question whether a predictive model can be used to retrospectively evaluate medical school performance as far back as high school. The purpose of our study is to determine if high school reading proficiency (HSRP) >50% and those with an HSRP <50%. These two groups were then standardized based on percentile within the school and averaged using HSRP, MCAT, pre-clinical, step 1, clinical, and step 2 scores. A line chart was graphed to demonstrate the difference between the two groups.

Data/results: As might be expected, our results showed significantly higher MCAT scores from students who attended high-quality versus low-quality high schools. Our results also showed that although students from low-quality high schools performed worse for the first part of medical school, by step 2, students will score similarly in both groups.

Conclusion: Students who performed poorly on the MCAT and attended lower-quality high schools will score as competitively as their peers by step 2.

Keywords: correlation, step 1, usmle, secondary education, reading proficiency

Categories: Medical Education

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Since KSOM is a state institution, most of this population comes from local high schools or, secondarily, the approved IRB protocol. We obtained UNLV Biomedical IRB approval for this study. This retrospective study analyzed data from 184 students who attended the Kirk Kerkorian School of Medicine (KSOM) for medical school performance. The novelty of our study is that we looked past individual performance and analyzed our data primarily for the impact of neighborhood crime rate on academic performance. The purpose of this study was to compare the academic performance in the medical school of students who attended high schools with greater resources and funding to those with limited resources. We mediated this relationship between neighborhood crime rate and academic performance with parental education and school conditions. The AAMC has conducted numerous studies over the past few decades evaluating medical student performance in relation to their MCAT score. Socioeconomic status (SES) was evaluated in 2010 using a national average mean MCAT score of 28 as a cut-off point. Evaluation of low and high SES in both groups demonstrates a higher dropout rate within the first two years of medical education in the low SES group, regardless of the MCAT score [9]. A more recent study by the AAMC in 2020 evaluated the 2015 MCAT, which shows a higher predictive value for medical school performance than undergraduate GPA and can strongly predict medical school performance in pre-clerkship courses and USMLE exams [10]. This study also demonstrates that GPA and MCAT can be used together to evaluate a student's long-term success in medical school and their chances of graduating within four years.

A comparative study to ours includes the findings of Davis et al., which showed that individuals from disadvantaged backgrounds, including low SES, disadvantaged race, and underrepresented minorities (URM), score lower than their white counterparts. This study demonstrates that black and Latino students score lower on the MCAT, GRE, LSAT, and other admissions tests [4]. Davis et al. provided evidence that no bias exists within the MCAT against minority groups in medical school performance through a differential prediction analysis. This analysis revealed the same predictive success amongst URM students and their counterparts in medical school based on MCAT scores but did suggest factors that may contribute to lower standardized exam scores, such as parental education, neighborhood, and school conditions. These factors were suggested to potentially limit a student's academic potential. Currently, no predictive studies explore how parental education or school conditions may impact academic performance. However, the study by Boxer et al. demonstrated a negative relationship between neighborhood crime rate and academic performance [11]. The study by Ruiz et al. found that low SES is related to lower academic performance, which can be related to lower parental education, and also that a violent neighborhood crime rate partially mediated this relationship [12].

The purpose of this study was to compare the academic performance in the medical school of students who graduated from a high-quality high school to that of students who graduated from a low-quality high school. The novelty of our study is that we looked past individual performance and analyzed our data primarily for the high school students who attended our assessment of medical school performance.

**Materials And Methods**

This retrospective study analyzed data from 184 students who attended the Kirk Kerkorian School of Medicine (KSOM) from 2017 to 2021. We deidentified data for this study from institutional databases under the approved IRB protocol. We obtained UNLV Biomedical IRB approval for this study.

Since KSOM is a state institution, most of this population comes from local high schools or, secondarily,
outlying high schools in Nevada. Furthermore, Clark County, from which the vast majority of this sample comes, is known to be educationally challenged [13]. Schools in this district maintain achievement segregation and a lack of student mobilization, especially in low-quality schools, which is concerning when considering the long-term effects on graduate students [13].

The name of each high school was collected for these 184 students as recorded in the American Medical College Application Service (AMCAS). High- versus low-quality ratings of high schools were assigned using each high school’s average reading proficiency level. The reading proficiency levels of the high school from which each student graduated were input on a 0–100% continuous variable scale. This reading proficiency ranking was provided by the US News website (https://www.usnews.com/best-colleges/rankings/national-universities), which ranked high school rankings regionally and nationally as well as a scorecard using math proficiency, reading proficiency, graduation rate, AP classes offered, and AP class pass rate. Of the five variables analyzed, HSRP demonstrated the greatest statistically significant correlation. For purposes of data analysis, a high school reading proficiency level of greater than or equal to 50% (indicating a high-quality high school) was coded as ‘1,’ whereas less than 50% reading proficiency (indicating a low-quality high school) was coded as ‘0.’ Students in high schools who did not disclose this information, such as out-of-state students or those who attended private high schools, were taken out of the statistical analysis. In this manner, two groups were identified for further descriptive breakdown and unpaired t-tests.

Additionally, group performance over time was calculated as each exam was administered. To determine this calculation, every student who took an examination (including students from both high school quality categories and students for whom no high school quality data were available) was sorted based on ascending performance and normalized into a respective percentile. Once a corresponding percentile for each student was calculated per exam, students were re-sorted into groups by their high school quality. Each group, with its own set of students who now have a calculated percentile for their respective exam, was defined to have a reference value indicative of overall performance by averaging all percentiles found within that group.

**Results**

We first determined whether there were differences in examination results between the high school reading proficiency groups. Examinations of interest were: MCAT, the National Board of Medical Examiners tests given in the preclinical phase (preclinical year exams), step 1, the National Board of Medical Examiners tests given in the clinical year (clinical year exams), and step 2. Comparisons of means with statistical significance and standard deviations are shown in Table 1.

| Exam               | High school quality | N   | Mean  | Std. deviation | P-value |
|--------------------|---------------------|-----|-------|----------------|---------|
| MCAT               | Low-quality         | 80  | 508.24| 4.755          | 0.025   |
|                    | High-quality        | 104 | 509.86| 4.838          |         |
| Preclinical year exams | Low-quality     | 60  | 82.0% | 0.049          | 0.372   |
|                    | High-quality        | 77  | 82.7% | 0.048          |         |
| Step 1             | Low-quality         | 57  | 228.16| 15.370         | 0.227   |
|                    | High-quality        | 75  | 231.40| 15.044         |         |
| Clinical year exams | Low-quality        | 37  | 77.50%| 5.698          | 0.212   |
|                    | High-quality        | 45  | 79.14%| 6.012          |         |
| Step 2             | Low-quality         | 34  | 247.59| 11.330         | 0.925   |
|                    | High-quality        | 43  | 247.86| 13.403         |         |

**TABLE 1: Performances by groups**

Statistically significant differences in average exam performance between the high-quality and low-quality school-attended groups were only found for the MCAT (508.24 vs 509.86, \( p=0.025 \)). While performance between groups was not statistically different during the first part of medical school, the low-quality high school graduates appeared to perform slightly less than their high-quality high school counterparts until step 2.

We then aimed to assess whether both groups (high school reading proficiency less than 50% and high school reading proficiency greater than 50%) remain disparate in exam performance over time or if high school...
reading proficiency ceases to be predictive of exam performance. To determine this, every student who took an examination, regardless of high school reading proficiency, was sorted based on ascending performance, then normalized into percentiles. Once a corresponding percentile for each student was calculated per exam, students were sorted into groups by their high school reading proficiencies. Student percentiles within each group were averaged. The results are depicted in Figure 1 and Table 2.

![Figure 1: Exam performance trends by high school quality](image)

| Percentiles | HSRP less than 50% | HSRP greater than 50% |
|-------------|---------------------|-----------------------|
| MCAT        | 0.420               | 0.512                 |
| P1 NBME     | 0.453               | 0.485                 |
| Step 1      | 0.457               | 0.515                 |
| P2 NBME     | 0.454               | 0.533                 |
| Step 2      | 0.486               | 0.490                 |

**TABLE 2: Exam performance trends by high school quality (numerical)**

Referring to Figure 1, it is apparent that along the examination trajectory of medical school, high school quality eventually became less predictive of exam performance by the step 2 benchmark, as both groups converge with an average score of 248 and average percentile of 48.65% and 49.02% (Figure 1). Between groups, coming from a high-quality high school appears to be predictive of higher exam performance for the MCAT, phase 1 NBME exam scores, step 1 scores, and phase 2 exam scores. This fact is especially true for step 1 scores and phase 2 NBME scores, in which the high-quality high school group diverges sharply from the other (Figure 1). Interestingly, some points in the curriculum (the pre-clinical year exams and step 2) show both groups below the 50th percentile. This finding would indicate that students for whom high school data were not available (mostly private schools) outperformed their counterparts from either high- or low-quality public schools.

It is also necessary to compare each group against national exam distributions in order to determine if there is any favorability for the high school reading proficiency groups for each national board-administered exam (MCAT, steps 1 and 2). In order to assess this, student scores were plotted in a scatter against published data after comparing group averages, as shown in Figures 2-4.
FIGURE 2: HSRP group performance for MCAT compared to national distribution

FIGURE 3: HSRP group performance for USMLE step 1 compared to national distribution
Figure 2 shows that both high school reading proficiency groups (less than 50% and greater than 50%) were completely aligned in their MCAT performance when compared to national percentiles.

To provide an external context to our groups, we compared how both groups were performing against the national average scores (Figure 5). For the MCAT, step 1, and step 2 exams, both groups’ exam scores were averaged, rounded to the nearest integer, and compared to the appropriate percentile nationally. For step exams, in which references are only provided for every 5 points, percentiles were interpolated as appropriate.
When assessing performance between low-quality and high-quality HSRP groups (Table 3), there is an evident 6-point difference in performance on the MCAT. By step 1, this 6-point difference becomes a relatively 5-point difference, which still delineates performance between the two groups. By step 2, performance between both groups had converged at 53.8, suggesting homogeneity over time regardless of high school reading proficiency status. During the preclinical years (MCAT, step 1), this gap in performance is common, but it closes during the clinical years (step 2) in our study.

| Percentiles | Low-quality | High-quality |
|-------------|-------------|--------------|
| MCAT        | 72.0%       | 78.0%        |
| Step 1      | 39.4%       | 44.8%        |
| Step 2      | 53.8%       | 53.8%        |

TABLE 3: Low-quality and high-quality group exam percentiles standardized to national performance

Discussion
This study determined that a significant difference exists in MCAT scoring between individuals who attended a high school with a reading proficiency of less than 50%, deemed a ‘low-quality high school,’ and those students who attended a high school with a reading proficiency of greater than 50%, deemed a ‘high-quality high school.’ Our data analysis used high school quality as a predictive value for performance. Our data show a difference in performance between the two groups, as demonstrated in Figures 1-4, which display a delineation in performance on the MCAT and USMLE step 1. Our data also demonstrate that our analysis of performance within the school population (Figure 1) is also consistent with the national percentile distribution (Figures 2-4). By the step 2 exam, scores converge between the two groups, leaving no obvious disparity between scores. It is also important to note that in our study, the MCAT demonstrated a statistically significant difference in performance even though the average performance between the two groups was numerically close (508 vs. 509; p<0.025). Our results contradict numerous medical school admissions research studies that have suggested MCAT performance as a longitudinal predictive model of medical student success. The divergence in MCAT performance amongst our student body could be due to a lack of resources, as mentioned in previous studies comparing underrepresented minority-status, many of whom attend a less prestigious high school than their counterparts [4,9]. Numerous research studies have shown that high school students with lower resources perform poorer on the SAT and ACT than those who attend a more prestigious school [3,11,12]. This discrepancy may continue contributing to the disparity in standardized scores until the MCAT.

In future studies, we plan to evaluate other high school measures amongst KSOM students in predicting medical student success. Two future measures we plan to study include delineating between first-generation medical students and their counterparts and low-SES students.

Three limitations exist in this study. First, the assessment of group differences decreases with each examination. KSOM is a newer program with a decreasingly limited sample size by step 2. Second, although we can see the separation in group performance when assessing reading proficiency, only the MCAT showed a significant difference compared to the preclinical NBME exams, step 1 clinical NBME exams, and step 2 scores. This separation may also be due to the decreased sample size, and thus an underpowered study when using exams that are tested later in medical school. Third, compared to a traditional medical school, KSOM has a more diverse student body and a higher percentage of underrepresented minority-status students.

Conclusions
This study found high school quality was predictive of medical student performance on the MCAT. Our study also suggests that students who may score lower on the MCAT will score similarly to their peers on the step 2 examination. We plan to incorporate more predictive values (first-generation, financial aid need) in future studies to strengthen our results. With the transition of the USMLE step 1 score to a pass/fail scoring system, this study may help admissions committees overlook a lower MCAT and factor in a student’s prior education and resources available. We hope that with this approach, students who attended a less privileged high school will be considered in the admissions process with the knowledge that, with the same resources during their clinical years, they will perform similarly.

Additional Information
Disclosures
Human subjects: Consent was obtained or waived by all participants in this study. UNLV Biomedical IRB issued approval n/a. UNLV Biomedical IRB approval was obtained. The retrospective study was conducted after obtaining the approval from Kirk Kerkorian School of Medicine institutional review board at UNLV. Consent for the study was waived by the institution Kirk Kerkorian School of Medicine institutional review board at UNLV. Our study is in accordance with ethical and regular guidelines. Availability of data and materials: All data generated or analyzed during this study are included in this published article [and its supplementary information files]. Animal subjects: All authors have confirmed that this study did not involve animal subjects or tissue. Conflicts of interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following: Payment/services info: All authors have declared that no financial support was received from any organization for the submitted work. Financial relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. Other relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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References

1. Al-Mazrou AM: Does academic performance in the premedical year predict the performance of the medical student in subsequent years?, J Family Community Med. 2008, 15:85-9.
2. Allensworth EM, Clark K: High school GPAs and ACT scores as predictors of college completion: examining assumptions about consistency across high schools. Am Educ Res Assoc. 2020, 49:196-211. 10.3102/0013189X20921110
3. Freedle B: How and why standardized tests systematically underestimate African-Americans’ true verbal ability and what to do about it: towards the promotion of two new theories with practical applications. St. John’s Law Rev. 2006, 80:183-226.
4. Davis D, Dorsey JK, Franko RD, Sackett PR, Searcy CA, Zhao X: Do racial and ethnic group differences in performance on the MCAT exam reflect test bias?. Acad Med. 2015, 88:595-602. 10.1097/ACM.0b013e318286803a
5. Milem JF: Increasing diversity benefits: how campus climate and teaching methods affect student outcomes. Semantic Scholar. 2001.
6. Smidley BD, Stith AY, Colburn L, Evans CH; Institute of Medicine (US): The Right Thing to Do, The Smart Thing to Do: Enhancing Diversity in the Health Professions: Summary of the Symposium on Diversity in Health Professions in Honor of Herbert W. Nickens. National Academies Press, Washington; 2001.
7. Saha S, Guiton G, Wimmers PF, Willkerson L: Student body racial and ethnic composition and diversity-related outcomes in US medical schools. JAMA. 2008, 300:1135-45. 10.1001/jama.300.10.1135
8. Casey PM, Palmer BA, Thompson GR, et al.: Predictors of medical school clerkship performance: a multispecialty longitudinal analysis of standardized examination scores and clinical assessments. BMC Med Educ. 2016, 16:128. 10.1186/s12909-016-0652-y
9. Brewer L, Grbic D: Medical students’ socioeconomic background and their completion of the first two years of medical school. AAMC. 2010, 9:
10. MCAT validity data report. (2020). Accessed: November 14, 2022: https://www.aamc.org/system/files/2020-11/services-mcat-validity-data-report-11102020.pdf
11. Boxer P, Drewes G, Kaplan JM: Neighborhood violent crime and academic performance: a geospatial analysis. Am J Community Psychol. 2020, 65:345-52. 10.1002/ajcp.12417
12. Ruiz LD, McMahon SD, Jason LA: The role of neighborhood context and school climate in school-level academic achievement. Am J Community Psychol. 2018, 61:296-309. 10.1002/ajcp.12234
13. Welsh RD: Student mobility, segregation, and achievement gaps: evidence from Clark County, Nevada. Urban Educ. 2016, 51:55-85. 10.1177/004208591666603