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ORIGINAL RESEARCH

Performing Under Pressure: Varsity Athletes Excel in Medical School

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Abstract

Purpose The admission process for medical school relies on objective and subjective measures of personal achievement, and selecting successful medical students is a daunting task for admission committees. While there is a significant body of literature examining MCAT scores and undergraduate grade point average (GPA) with medical school performance, there is a paucity of research on impact of specific student accomplishments on future performance. We hypothesize participation in a varsity collegiate sport will correlate with higher performance during medical school.

Methods A retrospective review of four medical school classes at a single institution was completed. Each student's admission application was examined for at least 1 year of participation in a varsity-level sport at their respective undergraduate institution. A total of 62 athletes (16.36%) were identified out of 441 total students. Multiple medical school performance metrics were obtained for each student.

Results There was no difference in MCAT scores between athletes and non-athlete medical students. There was a significant difference in step 1, step 2 CK, NBME shelf exams, cumulative year 3 performance, and AOA status with the athletes outperforming their peers.

Conclusion Students who participate in collegiate varsity athletics excel in medical school. One explanation for this finding may be participation in high-stakes athletic training and competition results in development of specific attributes beneficial in medical school. These attributes may include receptiveness to criticism, time management, resiliency, team participation, and performing under pressure. Additional research is needed to elucidate the attributes that determine improved medical school performance, such that medical educators can utilize this knowledge to better prepare all students for the rigors of medical school.

Keywords Medical school admissions · Collegiate athletes · Performance · This work has not been previously presented.

Introduction

In the USA, the number of students applying to medical school is increasing, as are the available positions within medical schools. For the 2017–2018 academic year, a total of 51,680 students applied to medical school and 21,338 matriculated (41.3%) [1]. Medical school admission committees are charged with carefully selecting a handful of candidates from a large pool of applicants who will not only score well on standardized testing, but who will perform well in the clinical environment and ultimately in the residency match and in graduate medical education. Medical school admissions packets contain both objective measurements of academic performance including MCAT score, GPA, and science GPA, and a record of self-reported applicant attributes. These other attributes are categorized into volunteerism, research, employment, extracurricular activities, military experience, and other significant achievements. A survey conducted by the AAMC in 2015 asked medical school admissions officers from 130 allopathic medical schools to rate the importance of different components of the admission application. The highest rating metrics included MCAT score, GPA, and community service, while collegiate athletic experience was ranked in the lowest category [2]. Multiple prior publications have assessed the relationship between MCAT and GPA scores and medical school performance and noted a moderate correlation between these factors [2–4], but there exist far

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fewer studies examining the relationship between these other application components and performance.

Parallel to medical school admissions, significant literature has been devoted to determining how programs select their residency applicants, with the highest weighted factors being USMLE step 1 score followed by performance in clinical clerkships [5, 6]. While step 1 scores may offer a straightforward and objective way to compare students across medical schools, direct observation of student performance by clinical faculty is a better indicator of future student performance in residency [7]. The lack of strong correlation between USMLE step 1 scores and performance in residency has been demonstrated in multiple studies [8–10]. Similarly, there is criticism of other objective tests such as the MCAT and its ability to predict clinical performance [11–13]. It is intuitive to believe clerkship performance better predicts residency performance, since the clinical clerkship environment more closely mimics residency than a standardized test. However, clerkship performance and evaluation is more complicated, subjective, and less comparable across medical school programs. Nonetheless, program directors value these performance assessments highly in prospective residency candidates [5].

Student expectations and performance assessments are pervasive throughout medical school but tend to evolve as students move through the 4-year curriculum, which can be a source of uncertainty and stress [14]. The high performing medical student adapts easily to an ever-changing environment, engages as a part of a team, responds positively to criticism and feedback, and embraces the challenges with resiliency. These traits are similar to those seen in successful athletes. Athletes who succeed at a high level must possess a level of determination, self-discipline, time management, resiliency in the face of defeat, receptiveness to coaching and criticism, and respect for their teammates [21]. Student athletes may already possess many of the qualities needed for success in medical school and beyond. This study aims to extract one of these self-reported admissions attributes, namely, collegiate varsity athletic experience, and examine whether student athletes outperform their non-athlete peers in medical school.

Methods

We performed a retrospective analysis of students who matriculated to our medical school between the years of 2012–2015. We examined student admission records for evidence of varsity athlete status, defined as at least 12-month participation in a varsity-level sport at their undergraduate institution and extracted demographic information including age, sex, and race/ethnicity. Additional analysis revealed differences between the two cohorts with respect to sex and race and therefore a sub-group analysis of white males was performed and included below. We did not include students who participated in club-level or recreational sports. Those with missing year 3 performance data (withdrawals or dismissals) were removed from data analyses. The total number of participants was 441 students, including 62 athletes and 379 non-athletes. MCAT scores were obtained from admission records, and in cases of multiple MCAT scores, the highest score was used in this analysis. For MCAT scores obtained after 2015, a score converter was used to convert new scores to the former scoring system.

For performance measures during medical school, we used initial step 1 attempt score at completion of the second year of medical school, initial attempt step 2 Clinical Knowledge (CK) score, and several year 3 clerkship performance measures. These included clinical scores which are composite scores generated based on multiple faculty and resident scoring across multiple clerkships, NBME shelf exam scores, and letter grades (Honors/High Pass/Pass/Low Pass/Fail). For clinical scores, a standard form assessing eight aspects of clerkship performance is used in all rotations (medical knowledge, history taking, physical examination, clinical data, clinical skills, communication, team rapport, motivation, and attitude). Raw clinical scores were converted to Z scores to reduce variability across grading among the eight clerkships (family medicine, internal medicine, emergency medicine, obstetrics and gynecology, pediatrics, psychiatry, neurology, surgery). NBME shelf exam scores were also converted to Z scores for easier comparison between exams, using a mean of 70 and standard deviation of 8. Average number of clerkship Honors per student was calculated, as well as average year 3 grade score (0 = Fail, 1 = Low Pass, 2 = Pass, 3 = High Pass, 4 = Honors).

Linear regression analyses were conducted to examine the relationship between athlete status and various performance outcomes during medical school (step 1, step 2 clinical knowledge, year 3 clinical score, year 3 subject exam results). Regression analysis was first conducted to see whether there were differences in MCAT performance prior to medical school. Effect sizes were calculated for the statistically significant differences to identify differences of practical importance. In this study, we used a specific type of effect size, Cohen's *d*, which expresses the mean difference between the two groups in standard deviation units to assess the magnitude of the differences. A Cohen's *d* of 0.01 would be considered very small, while a Cohen's *d* of 2.0 is very large.

In addition, percentage of students in each cohort who achieved Alpha Omega Alpha (AOA) status and Gold Humanism Award status were determined. Logistic regression analyses were conducted and Wald chi-square test was used to determine statistical significance.

Given the fact that white males account for over 50% (32 out of 62 athletes) of the athletes, the significant differences could be associated with the differences in the demographics

for the two groups (Table 1); therefore, sub-analyses were conducted to see whether there are group differences in the same variables within the white males. The same statistical techniques were used for the analyses on white males as for the ones for the entire sample and effect sizes were calculated.

Institutional IRB approval was obtained for this study (IRB00043836) and students were consented for participation. Identifying information was removed from records and students were assigned a unique study number to protect individual identity. Student performance was not examined on an individual basis.

Results

The total number of varsity athletes ($n = 62$) represented 16.36% of subjects. The number of student athletes in each matriculating class was fairly consistent (range 15–17, average 16). Twenty-two different varsity sports were represented in this cohort (Table 2). Baseline matriculation demographics of athletes versus non-athlete students are shown in Table 1. There was no significant difference in ages between the two groups of students. The athlete student group showed a preponderance of male students that self-identify as white (Table 1). For this reason, sub-analysis was performed to examine performance in white male students alone (Table 5).

MCAT scores did not differ between athlete and non-athlete students. However, in all medical school standardized tests examined in this study, the athlete cohort performed significantly better than their non-athlete peers, including on step 1, step 2 CK, and NBME shelf exams during year 3 clerkships (Table 3).

Multiple performance metrics relevant to year 3 were examined and are outlined in Table 4. These included both objective measures (shelf scores) as well as many subjective measures. The cohort of student athletes performed significantly better as a whole on shelf exams, clinical scores, number of Honors clerkships, year 3 overall score, and AOA status. There was not a significant difference between cohorts with respect to Gold Humanism award status. Effect sizes for the group differences indicate that there is very little difference in MCAT performance (Cohen's $d = 0.07$) and a larger difference in step 1 performance at the end of second year of medical school (Cohen's $d = 0.36$), though the overall magnitude of this difference remains small. Effect sizes were larger for year 3 metrics (Cohen's $d = 0.49$ for total year 3 score and Cohen's $d = 0.46$ for number of Honors) and step 2 CK scores (Cohen's $d = 0.4$).

To control for differences in gender and ethnicity, a subgroup analysis of white male (WM) athletes and WM non-athlete students was performed. Comparing these two cohorts revealed similar results, with WM athletes outperforming their WM non-athlete peers in all analyzed metrics except Gold Humanism Award status (Table 5). Similar patterns of group differences were found for WM sub-sample. The group difference increased from Cohen's $d = 0.1$ (very small) for MCAT to Cohen's $d = 0.5$ (medium) for step 1 score and continued to show a medium sized difference throughout the clinical years.

Table 2 College varsity sports included in analysis

Type of sport	Number of students ($n = 62$)*
Baseball	3
Basketball	3
Cheerleading	2
Crew	8
Dance	1
Equestrian	1
Fencing	1
Figure skating	1
Football	7
Gymnastics	2
Hockey	1
Lacrosse	2
Rugby	2
Sailing	1
Soccer	8
Softball	1
Squash	1
Swimming	3
Tennis	6
Track/cross country	7
Volleyball	1
Wrestling	1

*One student played two varsity sports

Table 1 Demographic data of included subjects ($N = 441$)

	Athletes ($N = 62$)	Non-athlete students ($N = 379$)
Average age at matriculation (years)	24.16(SD = 1.96)	24.35(SD = 3.04)
Male	42 (67.74%)	190 (50.13%)
Female	20 (32.26%)	189 (49.87%)
White	48* (78.69%)	226* (64.76%)
Non-white	13* (21.31%)	123* (35.24%)

*Race is self-reported data, 31 students did not report race

Table 3 Comparing athlete and non-athlete medical student performance on standardized testing

	Athletes ($N = 62$)	Non-athlete students ($N = 379$)	p value	Effect size
MCAT score (average)	31.02 (SD = 3.36)	30.79 (SD = 3.43)	$p > 0.62$	0.07
USMLE step 1 score (average)	237.32 (SD = 16.92)	230.43 (SD = 20)	$p < 0.05$	0.36
NBME year 3 shelf exam Z score (average)	1.47 (SD = 0.79)	1.14 (SD = 0.84)	$p < 0.05$	0.40
USMLE step 2 score (average)	252.70 (SD = 15.06)	246.35 (SD = 16.26)	$p < 0.05$	0.40

This is similar to the magnitude of difference found in the larger athlete cohort.

Discussion

This study shows medical students with experience as a collegiate varsity athlete outperform their peers in both standardized tests and in the clinical clerkship environment. To the authors' knowledge, this finding has not been previously published in the undergraduate medical education literature. Despite similar MCAT scores athletes performed better than non-athletes on standardized tests during medical school, including step 1, step 2 CK, and NBME shelf exams. Some studies have shown that college students who have 10–20 h of weekly extra-curricular commitments outperform their peers who have either less or more time commitments. The authors in these studies hypothesize that this amount of extra-curricular activity teaches students important time management skills, regardless of whether this time is spent in athletics or employment [15, 16]. We hypothesize that student athletes may have better time management skills coming into medical school and therefore adapt more easily to the rigorous didactic schedule, and may also be better equipped to manage test-taking anxiety compared to their non-athlete peers [17]. Prior studies have shown self-motivated student athletes employ effective study strategies and achieve higher academic performance than non-athlete students [18]. Further qualitative research is needed to fully explain this finding.

In this study, athletes also outperformed their peer on subjective aspects of medical school performance, namely, the clinical evaluation score. Honors designation, overall average year 3 score, and AOA election combine both subjective and objective measures. Athletes outperformed their peers in all of these categories as well. Though there is a lack of literature examining the relationship between athletic achievement and academic achievement in medical school, there is literature to support this study's finding when examining graduate medical education performance. One study looked at surgical resident performance and found that 40% of residents in the top decile of the program participated in team sports in the past, compared to 0% of residents in the bottom decile [19]. Another study examined predictors of future success in otolaryngology residency applicants and found that "excellence in athletics" significantly correlated with superior faculty ratings of performance [9]. A meta-analysis of 21 articles relating to pre-residency predictors of success in neurosurgical training found that while standardized test scores correlated poorly with faculty performance evaluations, athlete status had a much higher correlation with overall faculty evaluation [20]. Spitzer and colleagues found that residents who were varsity athletes in college were significantly more likely to be appointed chief resident compared to their non-athlete co-residents [21].

Another study examined the effect of athletic involvement on medical student attitudes and burnout. This cross-sectional study of 267 Canadian medical students found that students with more athlete experience suffered significantly less burnout compared to their peers. They also had significantly more desire to gain competence for its own sake and less desire to avoid incompetence due to fear of making errors or looking incompetent in front of others. The authors discuss how "involvement in sport offers invaluable opportunities for an

Table 4 Comparing athlete and non-athlete medical student performance in year 3 clerkships

	Athletes ($N = 62$)	Non-athlete students ($N = 379$)	p value	Effect size
Clinical scores (Z score average)	0.34 (SD = 0.46)	0.04 (SD = 0.57)	$p < 0.05$	0.53
Average number of Honors	3.15 (SD = 2.32)	2.18 (SD = 2.07)	$p < 0.05$	0/46
Average year 3 score	25.34 (SD = 3.72)	23.17 (SD = 4.54)	$p < 0.05$	0.49
AOA status (%)	19 (30.65%)	61 (16.05%)	Wald chi-square is 7.35, $p < 0.01$	
Gold Humanism Award status (%)	8 (12.9%)	39 (10.21%)	Wald chi-square is 0.41, $p > 0.52$	

Table 5 Sub-group analysis comparing white male (WM) athlete and WM non-athlete medical student performance

	WM athletes ($N = 32$)	WM non-athlete students ($N = 123$)	p value	Effect size
MCAT score (average)	32.16 (SD = 2.92)	31.87 (SD = 3.06)	$p > 0.64$	0.10
USMLE step 1 score (average)	245.34 (SD = 13.38)	235.85 (SD = 19.02)	$p < 0.05$	0.54
NBME year 3 shelf exam (Z score average)	1.70 (SD = 0.76)	1.28 (SD = 0.85)	$p < 0.05$	0.51
USMLE step 2 score (average)	258.20 (SD = 12.28)	248.28 (SD = 16.80)	$p < 0.05$	0.63
Clinical scores (Z score average)	0.35 (SD = 0.40)	0.07 (SD = 0.58)	$p < 0.05$	0.5
Average number of Honors	3.69 (SD = 2.36)	2.37 (SD = 2.24)	$p < 0.05$	0.57
Average year 3 score	26.22 (SD = 3.65)	23.79 (SD = 4.43)	$p < 0.05$	0.55
AOA status (%)	13 (40.63%)	26 (21.24%)	Wald chi-square is 4.92, $p < 0.05$	
Gold Humanism Award status (%)	4 (12.5%)	13 (10.57%)	Wald chi-square is 0.10, $p > 0.76$	

individual to develop self-discipline, resilience, and motivations that may subsequently influence their functioning in stressful, high-stakes environments such as medical school and eventual medical practice" [22].

Grit and mental hardiness have also been studied in military medical students. There is evidence to support that students who display excellent performance under a range of stressful conditions (psychological hardiness), adaptability in the workplace, commitment and receptiveness to grow from challenges, and ability to persevere (grit) show improved performance when compared to peers [23, 24]. Grit and mental hardiness can also be attributed to successful athletes. Dr. Jim Taylor, a PhD sports psychologist, has published extensively on the attitudinal attributes of athletes. He describes four principles which are critical to the success of athletes: overcoming fear of failure, recovering from mistakes quickly, managing performance anxiety, and believing in your abilities [25]. Dr. Angela Duckworth, a well-known psychologist who specializes in the psychology of grit, describes a slightly different set of four principles related to acquiring grit. These include deliberate practice, a long-term commitment to a purpose, embracing failure as an opportunity to learn, and time spent developing skills [26]. Though these principles differ some from Dr. Taylor's, they can also be ascribed to successful athletes.

The only assessed metric of medical school performance that did not demonstrate a significant difference between cohorts was the percentage of students receiving Gold Humanism Honor Society membership. Membership in this society requires nomination by one's medical school peers as an individual who exemplifies compassionate patient care. This metric differs from others in this study as it is the only one impacted by peer assessment. Empathy and compassion are not discreetly assessed by faculty in the clinical evaluation scores, but rather students are scored on their overall attitude, motivation, and team rapport.

It remains unanswered as to exactly why this cohort of student outperformed their peers in nearly every aspect of medical school performance, though the discussion above suggests potential explanatory theories. It cannot be said with certainty that this cohort had superior performance due directly to their past athletic endeavors or whether sports participation serves as a proxy for other traits useful in medical school. It cannot also be confidently attributed to time management versus attitudinal traits such as grit, hardiness, and resilience. The authors recognize this paper represents a starting point, a fascinating observation that necessitates replication and thoughtful, directed qualitative research to further explore this relationship. Once this relationship is better characterized, medical school educators will have an opportunity to develop resources and curricula designed to empower non-athlete students with these same skills. It is not the intention of the authors to suggest or promote the notion of using athlete status as a reason for admission, but rather to identify a cohort of students who may have acquired performance strategies that could be useful to the student population at large.

Limitations

There are multiple limitations to this study. This was a single institution study so results many not be generalizable to other institutions. Our two cohorts had some difference in baseline demographics, namely, that the athletes had higher percentages of males and white race compared with non-athlete students. To address this limitation, we performed a sub-analysis comparing white male athletes to white male non-athlete students. This sub-analysis revealed similar statistically different performance metrics to our original cohort, supporting the hypothesis that athlete status, not gender or race, was related to improved performance. We did not have a large enough sample size to run similar sub-analyses on white female athletes, non-white female athletes, and non-white male athletes. Our identification of athletes was based on student admission applications and confirmatory verification of athlete status was not obtained.

Student performance evaluations during year 3 clerkships have subjective scoring elements. Each clerkship at our institution employs a different criterion weighting scale to calculate student final grades and the shelf exam score contribution to the overall clerkship grade varies. The numbers of clinical evaluations vary between students and are comprised of residents, fellows, and faculty evaluators. We attempted to account for this variability by performing and presenting analysis of separate measures of clerkship performance including shelf exam scores, clinical evaluation scores, Honors designation, and overall year end performance score. AOA status is another subjective measure of medical student performance that encompasses many aspects of a student's performance in medical school including pre-clerkship performance, step 1 and 2 scores, clerkship performance, community service, and leadership attributes.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval This study was approved by the Wake Forest School of Medicine IRB. IRB00043836.

References

1. Tables, American Association of Medical Colleges. August 15, 2018; Available from: https://www.aamc.org/download/321442/data/factstablea1.pdf. Accessed December 5, 2018.
2. American Association of Medical Colleges. Available from: https://www.aamc.org/download/462316/data/mcatguide.pdf. Accessed January 17, 2019.
3. Donnon T, Paolucci EO, Violato C. The predictive validity of the MCAT for medical school performance and medical board licensing examinations: a meta-analysis of the published research. Acad Med. 2007;82(1):100–6.
4. 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(5):666–71.
5. National Resident Matching Program. Results of the2016 NRMP Program director survey. Washington, DC: National Resident Matching Program; 2016. Available from: http://www.nrmp.org/wp-content/uploads/2016/09/NRMP-2016-Program-Director-Survey.pdf. Accessed November 12, 2018.
6. Gauer JL, Jackson JB. The association of USMLE step 1 and step 2 CK scores with residency match specialty and location. Med Educ Online. 2017;22(1):1358579. https://doi.org/10.1080/10872981.2017.1358579.
7. Cullen MW, Reed DA, Halvorsen AJ, Wittich CM, Kreuziger LMB, Keddis MT, et al. Selection criteria for internal medicine residency applicants and professionalism ratings during internship. Mayo Clin Proc. 2011;86(3):197–202. https://doi.org/10.4065/mcp.2010.0655.
8. Wagner JG, Schneberk T, Zobrist M, et al. What predicts performance? A multicenter study examining the association between resident performance, rank list position, and USMLE step 1 scores. J Emerg Med. 2016;52(3):332–40.
9. Chole RA, Odgen MA. Predictors of future success in otolaryngology residency applicants. Arch Otolaryngol Head Neck Surg. 2012;138(8):707–12.
10. Schaverien MV. Selection for surgical training: an evidence-based review. J Surg Educ. 2016;73(4):721–9.
11. Dong T, Saguil A, Artino AR, et al. Relationship between OSCE scores and other typical medical school performance indicators: a 5-year cohort study. Mil Med. 2012;177(9 Suppl):44–6. https://doi.org/10.7205/MILMED-D-12-00237.
12. Ferguson E, James D, Madeley L. Factors associated with success in medical school: systematic review of the literature. BMJ. 2002;324(7343):952–7. https://doi.org/10.1136/bmj.324.7343.952.
13. Reed DA, West CP, Mueller PS, Ficalora RD, Engstler GJ, Beckman TJ. Behaviors of highly professional resident physicians. JAMA. 2008;300(11):1326–33. https://doi.org/10.1001/jama.300.11.1326.
14. Van Dijk I, Lucassen PL, van Weel C, et al. A cross-sectional examination of psychological distress, positive mental health and their predictors in medical students in their clinical clerkships. BMC Med Educ. 2017;17:219. https://doi.org/10.1186/s12909-017-1035-8.
15. Hood AB, Craig AF, Ferguson BW. The impact of athletics, part-time employment, and other activities on academic achievement. J Coll Stud Dev. 1992;33(5):447–53.
16. Dundes L, Marx J. Balancing work and academics in college: why do students working 10 to 19 hours per week excel? J Coll Stud Retent. 2006;8(1):107–20. https://doi.org/10.2190/7UCU-8F9M-94QG-5WWQ.
17. Taylor J. Predicting athletic performance with self-confidence and somatic and cognitive anxiety as a function of motor and physiological requirements in six sports. J Pers. 1987;55(1):139–53. https://doi.org/10.1111/j.1467-6494.1987.tb00432.x.
18. Simons HD, Rheenen DV, Covington MV. Academic motivation and the student athlete. J Coll Stud Dev. 1991;40(2):151–61.
19. Papp KK, Polk HC, Richardson D. The relationship between criteria used to select residents and performance during residency. Am J Surg. 1997;173:326–9.
20. Zuckerman SL, Kelly PD, Dewan MC, et al. Predicting resident performance from preresidency factors: a systematic review and applicability to neurosurgical training. World Neurosurg. 2018;110:475–84. Feb 2018.
21. Spitzer AM, Gage MJ, Looze CA, et al. Factors associated with successful performance in an orthopedic surgery residency. J Bone Joint Surg Am. 2009;91:2750–5.
22. Babekno O, Mosewich A. In sport and now in medical school: examining students' well-being and motivations for learning. Int J Med Educ. 2017;8:336–42.
23. Bartone PT, Kelly D, Matthews MD. Psychological hardiness predicts adaptability in military leaders: a prospective study. Int J Sel Assess. 2013;21(2):200–10.
24. Ray R, Brown J. Reassessing student potential for medical school success: distance traveled, grit, and hardiness. Mil Med. 2015;180(4):138–41.
25. Taylor J. Available from: https://www.psychologytoday.com/us/experts/jim-taylor-phd. Accessed August 21, 2018.
26. Duckworth A. Grit. 2016, New York: Scribner (DLC) 2015044753.