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ORIGINAL RESEARCH

Admission Routes and Demographics as Predictors of Academic Performance in Medical Students: A Retrospective Cohort of Grade Point Averages (GPAs) and Comprehensive Exam Scores

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Background: Understanding factors associated with medical school academic performance can inform selection and student support. Traditional measures such as high school grades and standardized test scores are incomplete. Emerging data emphasize the importance of age, gender, entrance route, and exam history on academic outcomes. This study explored associations of age, gender, admission route, nationality, and CBSE attempt number with cumulative basic sciences overall grade point average (GPA) and Comprehensive Basic Sciences Examination (CBSE) scores at Tehran University of Medical Sciences, providing insights for optimizing selection strategies and educational interventions.

Methods: Academic records of medical students from 2019 to 2022 were retrospectively collected. Data from the first 5 semesters (2.5 years) of course grades, cumulative GPAs, and CBSE scores were included in the analysis. We conducted univariate and multivariate analyses to examine associations and predictors.

Results: A total of 1727 individual records were analyzed. Repeated attempts at the CBSE were associated with progressively lower GPA ($P<0.001$) and CBSE scores ($P<0.001$). The admission route had a significant impact on performance ($P<0.001$), with highly competitive exam entrants achieving the highest mean GPA and CBSE scores, while non-Iranian students had the lowest. Iranian students outperformed their non-Iranian counterparts in both GPA and CBSE (both $P<0.001$). Male students achieved slightly higher CBSE scores than females ($P=0.011$), although there was no gender difference in GPA. GPA exhibited modest variation across entry semesters ($P=0.003$), while CBSE scores remained consistent. The multivariable analyses revealed that admission route and entry year were the leading independent and consistent predictors of academic performance.

Conclusion: Repeated CBSE attempts, admission route, and nationality were associated with academic performance. Highly competitive entrants achieved the highest, while non-Iranian students and repeat examinees showed comparatively lower outcomes. These findings highlight the need for targeted academic support and early intervention strategies to promote equitable achievement among diverse medical student groups.

Keywords: medical education, academic performance, grade point average, comprehensive basic sciences examination, admission route

Introduction

Understanding and monitoring medical student performance is more than an academic exercise: longitudinal studies show that early academic and professional behaviours during training are linked to later clinical competence and even to subsequent regulatory and disciplinary outcomes, underscoring the societal importance of robust selection and support

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systems.[1] It remains a pivotal concern for educators and policymakers, as it directly influences the selection and support of future healthcare professionals.[1–3] Consequently, contemporary admission systems increasingly seek a balance between cognitive metrics and structured assessments of non-cognitive attributes,[4] because these composite approaches have demonstrated greater fairness and links with later performance.[5] Traditional selection metrics, such as high school grades and standardized test scores, are associated with subsequent performance in medical school, yet the strength of these associations varies across contexts.[4,6–8] Recent studies highlight the significant role of demographic and non-cognitive factors, such as age, gender, admission route, nationality, and examination history, in shaping academic outcomes.[9–11] Given the complexities of medical curricula, reliance solely on traditional selection criteria may not be sufficient to identify at-risk students.[12,13] Studies have shown that factors associated with performance extend beyond initial academic achievements.[5,14,15] Recent research indicates that combining cognitive and non-cognitive measures is generally associated with improved performance differentiation compared with cognitive measures alone; however, reported effect sizes and practical utility vary substantially by context, assessment design, and population.[15–18] Concurrently, grade inflation and evolving assessment modalities have further complicated the interpretation of academic metrics, underscoring the need for comprehensive analyses that consider a wide array of variables. At the same time, institutional and national contexts shape how these variables perform in practice. Evidence from multi-national and cross-institutional studies shows substantial heterogeneity in outcomes by student background, admission route, and institutional practices, implying that national benchmarks and local analyses are complementary for policy and programmatic decisions.[19,20]

In Iran, medical school admissions include multiple pathways, reflecting distinct selection routes and support policies. The Comprehensive Basic Sciences Examination (CBSE) is a national, high-stakes assessment taken usually after the fourth or fifth semester of the medical curriculum and serves as a key progression milestone. Students need to pass this comprehensive exam before proceeding to the pre-clinical phases. Accordingly, age (progression timing), university admission route, nationality (language and adaptation demands), and CBSE attempt number (progress trajectory) are plausible correlates of GPA and CBSE outcomes. Prior research has documented significant associations between these variables and performance outcomes.[7,9] In addition, studies have revealed that students admitted through highly competitive pathways, such as national entrance exams, tend to exhibit superior academic trajectories compared to those admitted via alternative routes.[21–23] Moreover, the history of failed (or repeated) attempts at high-stakes summative assessments is consistently associated with lower course averages and licensure outcomes across several contexts, forming a readily identifiable subgroup of repeat examinees for early remediation strategies.[24,25] Although multi-setting studies report consistent associations between repeat attempts and poorer outcomes, the existing literature is limited in its detailed, institution-level analyses of how local admission practices, entry effects, and support resources modify this relationship. Therefore, institution-specific evaluations remain important for guiding local remediation and policy decisions. Although gender and nationality have been examined in many studies, with inconsistent findings regarding their influence, current evidence suggests that these demographic attributes play a less substantial role relative to factors such as admission route and exam attempt frequency.[21,26–29] Moreover, the impact of age on examination offers additional nuance. Older students may encounter challenges related to delayed progression, and the overall effect size is modest compared to other variables.[10,30] Finally, disruptions to teaching and assessment practices during the COVID-19 pandemic, including rapid shifts to remote instruction and various online assessment formats, have introduced additional complexity into contemporary indicator systems by altering grading practices, candidate preparation, and the ecological validity of in-course assessments, so pandemic-era entries merit extreme interpretive caution.[31,32] Recent national evidence has confirmed that pre-clinical academic achievement is moderately associated with CBSE performance among Iranian medical students. These findings underscore the importance of early academic performance as a determinant of licensing examination success and provide a national benchmark for institutional studies such as ours.[33] While national multi-institutional analyses provide essential benchmarks, institution-level investigations remain valuable because they can detect local admission patterns, entry effects, and operational factors (for example, grading practices or student support availability) that are not visible in aggregate national datasets and that can directly inform internal remediation and admission policy.[4]

The objectives of this study were (1) to examine associations between age, gender, nationality, admission route, and CBSE attempt number and academic performance (basic-sciences GPA and CBSE scores); and (2) to provide institutional benchmarks to guide future adjusted analyses and student-support strategies.

Material and Methods

Study Design and Setting

This retrospective cohort study examined the factors influencing academic performance among Doctor of Medicine (MD) students at Tehran University of Medical Sciences (TUMS). This study examined routinely collected educational data from students admitted during the summer semester of the 2019 (Iranian solar calendar: 1397) through the winter semester of the 2022 (Iranian solar calendar: 1400). Ethical approval was secured from the Ethics Committee of TUMS (IR.TUMS.REC.1401.1234), which waived the necessity for individual informed consent due to the anonymity of all required data.

In Iran, medical education is regulated at the national level and provided by both public and private universities, under the oversight of the Ministry of Health and Medical Education. Admission to medical programs is highly competitive, with students generally enrolling in medical school immediately following secondary education. The standard medical degree program is an integrated curriculum encompassing both pre-clinical and clinical training, typically lasting 7 years. This program comprises four major phases: basic sciences (2–2.5 years), physiopathology (1 year), clinical clerkships (2 years), and an internship (1.5 years).

In this retrospective study, we examined associations between multiple independent variables and academic outcomes in the basic sciences phase of the MD program at Tehran University of Medical Sciences.

Definitions and Clarifications

This study categorizes university admission routes in Iran as follows: Konkur entrants are admitted via the national university entrance exams, a comprehensive, about 4-hour exam held yearly called "Konkur". "Special" entrants are applicants granted admission under legally established routes for the relatives of martyrs, veterans, and war casualties. "Semi-special" entrants comprise applicants granted admission under preferential yet restricted routes, including relatives of faculty members and partly veterans. "Olympiad" entrants are candidates awarded direct or priority admission due to exceptional achievement in national academic Olympiads, which are yearly, nationally organized, competitive academic exams designed to identify high-achieving students in specific subjects through multi-stage evaluations that extend beyond the standard school curriculum. International entrants, irrespective of nationality (Iranian or non-Iranian), are applicants who have completed part or all of their secondary or higher education abroad and are admitted under distinct regulations independent from the conventional entrance-exam system (Table 1).

Table 1 Student Characteristics

Characteristic	N (Total = 1,727)	Category	n (%)/Mean±SD
Age at CBSE (year) CBSE Score (out of 200) Basic Science GPA (out of 20)	1510 1365 1679		20.98±2.04 123.48±27.45 16.37±1.77
Gender	1681	Female Male	670 (39.86) 1011 (60.14)
Nationality	1681	Iranian Non-Iranian	1334 (79.36) 347 (20.64)
CBSE Attempt Number	1566	1st attempt (no fails) 2nd attempt (one previous fail) ≥3rd attempt (more than one fails)	1453 (92.78) 100 (6.39) 13 (0.83)

(*Continued*)

Table 1 (Continued).

Characteristic	N (Total = 1,727)	Category	n (%)/Mean±SD
Admission Route	1681	Konkur entrants	945 (56.22)
		Special entrants	359 (21.36)
		Semi-special entrants	50 (2.97)
		International entrants	241 (14.34)
		Olympiad entrants	86 (5.12)
Entry Semester	793	Summer, 2019 (1397)*	131 (16.52)
		Winter, 2019 (1398)*	122 (15.38)
		Summer, 2020 (1398)*	131 (16.52)
		Extra, 2020 (1398)*	36 (4.54)
		Winter, 2020 (1399)*	98 (12.36)
		Summer, 2021 (1399)*	128 (16.14)
		Winter, 2022 (1400)*	147 (18.54)

Notes: *In the Iranian solar calendar. Admission routes are defined as: Konkur: Admission through Iran's national university entrance examination (a 4-hour exam), with placement determined primarily by exam score and rank. Special: Applicants admitted under highly special routes allocated to families of martyrs, veterans, and war casualties. Semi-special: Applicants admitted under preferential routes for faculty families and partial veterans, with limited admission privileges. Olympiad: Admission privileges granted to winners of national academic Olympiads, allowing direct or preferential university entry, sometimes without the entrance exam.
International: Iranian or foreign nationals who completed part or all of their secondary or higher education outside Iran.

The CBSE is a national standardized evaluation of medical students' integrated understanding of foundational sciences before they commence clinical training, and it usually takes place two and sometimes up to four times a year. It consists of 200 multiple-choice questions (MCQs), with 1 point per correct answer and no penalty for incorrect ones. Students need to pass the exam to proceed to the further stages of the medical curriculum. The minimum passing score (cut score) set by CBSE is independently determined for each exam administration, in accordance with the scoring process and national guidelines. The cut score is set to 70% of the mean score of the top 5% of examinees for a specific administration; therefore, it is not intended for comparison across exam dates.[34] Examinees who achieved scores below the designated cut score for this administration were categorized as not meeting the passing criteria for that attempt.

The GPA, on the other hand, serves as a cumulative quantitative measure of academic performance, determined by the weighted mean of grades earned in all completed courses throughout all semesters. The contribution of each course to the GPA is proportional to its assigned credit value, whereby courses with higher credit hours exert a greater influence on the overall average. The pass/fail thresholds for each semester's GPA to proceed to higher levels in the curriculum were set at 12, the median score range due to traditional faculty regulations. However, the threshold was 10 per course during the basic science phase of the medical curriculum. Notably, almost all formative assessments during the basic science phase of the medical curriculum are MCQs, similar to CBSE. The GPA serves as an indicator of students' academic performance in specific courses as well as their overall consistency and advancement within the curriculum.

Data Collection, Variables, and Processing

De-identified records were acquired from the Office of General Practitioner Medical Education at TUMS following institutional approval. The dataset comprised individual-level data on demographic characteristics, admission details, course grades, cumulative GPAs, and CBSE scores.

Academic outcomes were set as follows:

- Cumulative overall GPA for the Basic Sciences phase of MD on a 0 to 20 scale.
- CBSE score on a scale from 0 to 200.

Independent variables:

- Age at CBSE (years)
- Gender (male/female)
- Nationality (Iranian/non-Iranian)
- Admission year and semester
- CBSE attempt numbers (first, second, third, or more)
- Admission route (five aggregated categories reflecting entry route; Table 1).

The following criteria determined eligibility for inclusion: (1) possession of a valid university student identifier, (2) completion of at least one CBSE attempt, and (3) availability of data for all major Basic Science courses, cumulative GPA, and CBSE score. Records that did not include demographic variables, such as date of birth or gender, or that had multiple missing course grades, were excluded from the analysis. Students who withdrew prior to the CBSE or were marked as "absent" on the examination day were excluded from comparative analyses. Additionally, to convert GPA into a categorical variable for further analysis, grades were classified into three categories: "A" for scores of 17 or higher, "B" for scores between 14 and 17, and "C" for scores below 14.

Raw Excel files for each entry were standardized and integrated, utilizing student identifiers as the key variable. Variables were recoded for uniformity, and numeric values were examined for out-of-range or duplicate entries.

Statistical Analysis

All analyses were carried out using SPSS version 26. Univariate associations between each independent variable and outcome were evaluated using one-way ANOVA and t-tests for categorical predictors. Alongside univariate analyses, multivariable logistic regression models were developed to evaluate independent associations between demographic and admission-related variables and academic performance outcomes. Forward stepwise (conditional) selection was utilized, incorporating age at CBSE, gender, admission route, CBSE attempt number, and entry year as candidate predictors. Adjusted odds ratios (ORs) accompanied by 95% confidence intervals (CIs) were presented for the variables included in the final models. A two-tailed significance threshold of $P < 0.05$ was consistently applied. Missing data were not utilized in the analysis.

Results

Descriptive Statistics

A total of 1,727 individual records were gathered, of which 1,679 records (97.22%) had reported GPA, and 1,365 records (79.03%) had reported CBSE score. Analyses used the available cases for each outcome, resulting in varying sample sizes across analyses due to data completeness and eligibility criteria. The average age at CBSE was 20.98±2.04 years. The female population consisted of 670 (39.86%), while 347 (20.64%) were non-Iranians. First-attempt examinees accounted for 1,453 (92.78%), second attempts for 100 (6.39%), and third-plus attempts for 13 (0.83%). Admission routes were allocated as follows: National University Entrance Exam (Konkur) entrants, 56.22%; special entrants, 21.36%; semi-special entrants, 2.97%; Olympiad entrants, 5.12%; and international entrants, 14.34%. The mean basic sciences GPA was 16.37±1.77, and the mean CBSE score was 123.48±27.45. The detailed descriptive characteristics are presented in Table 1.

CBSE Attempt Number

Repeated attempts at the CBSE were associated with a decline in academic performance. Students attempting the course for the first time attained a mean GPA of 16.69±1.42, whereas those making second attempts achieved a mean GPA of 15.88±1.89, and those making third or subsequent attempts achieved a mean GPA of 14.17±1.13 ($P < 0.001$). CBSE scores declined from 124.85±26.92 to 110.95±29.36 and 87.15±9.52 across the attempt categories ($P < 0.001$). The age at examination was positively correlated with the number of attempts (20.87±1.81 vs 22.68±3.79 vs 25.00±5.18; $P < 0.001$), suggesting a delay in progression for those who repeated the examination (Table 2).

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Table 2 Mean Age, GPA, and CBSE Scores by CBSE Attempt Number (N = 1,566)

CBSE Attempt Number	N	GPA (Mean±SD)	N	CBSE Score (Mean±SD)	N	Age (Mean±SD)
First Attempt	1453	16.69±1.42	1253	124.85±26.92	1438	20.87±1.81
Second Attempt	100	15.88±1.89	99	110.95±29.36	59	22.68±3.79
Third or More Attempts	13	14.17±1.13	13	87.15±9.52	13	25.00±5.18
Intergroup ANOVA p-value		<0.001*		<0.001*		<0.001*

Notes: *Significant differences between groups (CBSE attempt number).

Admission Route

The admission pathway significantly impacted both GPA and CBSE performance. ANOVA indicated significant differences among admission routes categories for GPA ($P < 0.001$) and CBSE score ($P < 0.001$). Students admitted through the Olympiad entrants achieved the highest mean GPA and CBSE score, while those in the non-Iranian entrants recorded the lowest (Table 3). Comparable significant patterns were observed in almost all essential course grades ($P < 0.001$).

Entry Semester

The overall mean GPA varied by entry semester ($P = 0.003$), peaking in the 2020 winter semester entrants (17.36±1.19) and subsequently decreasing in later entries. Comparable patterns were observed in almost all essential course grades ($P < 0.001$). However, this pattern was not significant regarding CBSE scores (Table 4).

Demographics

Male students had significantly higher CBSE scores ($P = 0.011$) than females, while the difference in GPA was not significant ($P = 0.219$). Iranian students exhibited significantly better performance than non-Iranian students (GPA and CBSE score, both P values < 0.001) (Table 5).

Table 3 Mean Age, GPA, and CBSE Score by Admission Route (N = 1,681)

Admission Route	N	GPA (Mean±SD)	N	CBSE Score (Mean±SD)	N	Age (Mean±SD)
Konkur	943	16.84±1.60	787	130.18±27.01	878	21.00±2.11
Special	359	16.10±1.62	293	120.08±23.02	328	20.82±1.97
Semi-special	50	15.96±1.78	42	122.79±25.10	47	21.13±2.83
Olympiad	86	17.09±1.37	67	137.81±19.86	81	20.56±1.46
International	241	14.77±1.70	176	93.94±15.38	176	21.34±1.70
Intergroup ANOVA p-value		<0.001*		<0.001*		0.023*

Notes: *Significant differences between groups (admission routes).

Table 4 GPA and CBSE Score by Entry Semester (n = 793)

Entry Semester	N	GPA (Mean±SD)	N	CBSE Score (Mean±SD)	N	Age (Mean±SD)
Summer, 2019 (1397)*	129	17.09±1.03	120	127.74±22.85	128	20.88±1.47
Winter, 2019 (1398)*	117	17.06±1.42	115	130.80±25.51	65	21.63±2.23
Summer, 2020 (1398)*	129	17.33±1.11	128	131.69±20.52	128	20.36±0.60
Extra, 2020 (1398)*	32	17.18±1.41	31	137.74±26.49	32	20.59±0.76
Winter, 2020 (1399)*	94	17.36±1.19	94	128.64±25.20	93	20.62±1.39
Summer, 2021 (1399)*	124	17.02±1.37	119	133.87±24.70	119	20.87±1.68
Winter, 2022 (1400)*	145	16.75±1.46	143	127.13±24.65	143	20.89±2.66
Intergroup ANOVA p-value		0.003**		0.111		<0.001**

Notes: *In the Iranian solar calendar. **Significant differences between groups (entry semesters).

Table 5 Age, GPA, and CBSE Score by Gender and Nationality

Variable	Group	N	GPA (Mean±SD)	N	CBSE Score (Mean±SD)	N	Age (Mean±SD)
Gender	Female	668	16.31±1.84	515	121.06±27.51	593	21.29±2.33
	Male	1011	16.42±1.73	850	124.95±27.32	917	20.78±1.79
P-value			0.219		0.011*		<0.001*
Nationality	Iranian	1332	16.78±1.54	1088	131.4±23.96	1233	20.8±1.69
	Non-Iranian	347	14.81±1.72	277	92.38±15.63	277	21.8±3.01
P-value			<0.001*		<0.001*		<0.001*

Notes: *Significant between-groups differences (female vs male; Iranian vs non-Iranian).

Multivariable Analysis of Academic Performance Predictors

The entry year consistently emerged as an independent correlate of academic performance across all final models in different courses and overall GPA, with variable results. The admission route was independently associated with performance across the majority of models, with students admitted via less competitive pathways having greater odds of unfavorable academic outcomes (grades B and C), and students admitted via competitive routes, such as Olympiad, had higher adjusted odds of achieving superior performance (grades A).

The variables of age at CBSE and CBSE attempt number were included in only a few models, and when included, their impacts were minimal. Notably, repeated CBSE attempts were independently associated with substantially higher odds of lower overall GPA (OR: 4.31, P = 0.009). Older age and multiple attempts at the CBSE were typically associated with lower academic performance (grades B and C). Gender was included in several course-specific models, though effect sizes were generally modest and inconsistent across outcomes. The comprehensive details and ORs for the variables included in the final models for overall GPA and each course are presented in detail in Table 6.

Table 6 Multivariate Logistic Regression, Indicating the Odds Ratio of Grades B and C in Comparison to Grades A

Courses	Predictors	Groups	OR (Grades B and C)	SE	P-value
Physiology	Entry year	1398	0.600	0.289	0.077
		1399	2.784	0.287	<0.001*
		1400	3.313	0.304	<0.001*
	Admission route	Special	2.261	0.191	<0.001*
		Semi-special/International	1.078	0.444	0.865
		Olympiad	0.733	0.330	0.346
Biochemistry	Entry year	1398	0.555	0.211	0.005*
		1399	0.266	0.212	<0.001*
		1400	0.920	0.237	0.724
	Admission route	Special entrants	2.816	0.182	<0.001*
		Semi-special/International	1.691	0.386	0.174
		Olympiad	1.103	0.288	0.733
Microbiology	Entry year	1398	0.485	0.261	0.006*
		1399	0.391	0.258	<0.001*
		1400	2.038	0.370	0.054
	Admission route	Special entrants	1.734	0.221	0.013*
		Semi-special/International	2.609	0.626	0.126
		Olympiad	1.090	0.339	0.799

(*Continued*)

Table 6 (Continued).

Courses	Predictors	Groups	OR (Grades B and C)	SE	P-value
Parasitology	Entry year	1398 1399 1400	0.816 2.915 1.379	0.203 0.205 0.218	0.318 <0.001* 0.141
	Admission route	Special entrants Semi-special/International Olympiad	2.237 1.201 0.914	0.169 0.362 0.295	<0.001* 0.613 0.762
	Age	Per 1-year increase	1.125	0.057	0.039*
Anatomy	Entry year	1398 1399 1400	0.398 1.159 1.777	0.207 0.204 0.231	<0.001* 0.469 0.013*
	Admission route	Special entrants Semi-special/International Olympiad	3.431 1.629 1.025	0.183 0.374 0.294	<0.001* 0.193 0.933
	Gender	Male	1.490	0.163	0.015*
	Age	Per 1-year increase	1.131	0.057	0.031*
Virology	Entry year	1398 1399 1400	0.323 0.271 0.997	0.235 0.236 0.284	<0.001* <0.001* 0.990
	Admission route	Special entrants Semi-special/International Olympiad	1.825 3.735 1.239	0.186 0.554 0.301	0.001* 0.017* 0.478
	CBSE attempt	>1 attempt	0.400	0.474	0.053
English	Entry year	1398 1399 1400	0.160 0.081 1.837	0.278 1.167 0.228	<0.001* 0.031* 0.008*
	Admission route	Special entrants Semi-special/International Olympiad	2.783 0.813 0.807	0.228 0.484 0.475	<0.001* 0.668 0.652
	Gender	Male	2.269	0.231	<0.001*
	Age	Per 1-year increase	1.291	0.088	0.004
Principles of Health Services	Entry year	1398 1399 1400	0.588 0.951 0.401	0.205 0.200 0.238	0.010* 0.802 <0.001*
	Admission route	Special entrants Semi-special/International Olympiad	1.892 0.695 0.711	0.166 0.405 0.325	<0.001 0.370 0.295
Epidemiology	Entry year	1398 1399 1400	1.281 2.459 4.040	0.240 0.273 0.359	0.301 0.001* <0.001*

(*Continued*)

Table 6 (Continued).

Courses	Predictors	Groups	OR (Grades B and C)	SE	P-value
Islamic Studies	Entry year	1398 1399 1400	3.636 1.048 3.582	0.415 0.479 0.428	0.002* 0.922 0.003*
	Admission route	Special entrants Semi-special/International Olympiad	2.172 3.071 1.140	0.267 0.541 0.506	0.004* 0.038* 0.796
	Gender	Male	1.793	0.295	0.047*
Mycology	Entry year	1398 1399 1400	0.553 1.813 3.558	0.290 0.246 0.253	0.041* 0.016* <0.001*
Overall GPA	Entry year	1398 1399 1400	0.621 1.037 2.945	0.215 0.208 0.232	0.027* 0.863 <0.001*
	Admission route	Special entrants Semi-special/International Olympiad	3.099 2.058 0.701	0.175 0.369 0.323	<0.001* 0.051 0.271
	Gender	Male	1.616	0.168	0.004*
	Age	Per 1-year increase	1.262	0.061	<0.001*
	CBSE attempt	>1 attempt	4.313	0.562	0.009*

Notes: *Significant in the final multivariable model for each course and the overall GPA. Values are odds ratios (OR) obtained from multivariable logistic regression analyses using forward stepwise selection. Only predictors retained in the final adjusted model for each course are presented. Reference categories were entry year 1397, Konkur entrant admission route, female sex, and first CBSE attempt. Age was modeled as a continuous variable (per 1-year increase). SE denotes standard error. P-values <0.05 were considered statistically significant.

Discussion

This study presents a retrospective descriptive analysis of the relationships between admission and demographic variables and academic outcomes, specifically cumulative basic-sciences GPA and CBSE scores, among MD students at Tehran University of Medical Sciences. The dataset comprised 1,727 student records, with GPA available for 1,679 students and CBSE scores for 1,365 students. Associations were evaluated through univariate and multivariate methods. Our findings offer essential insights into the complex interactions among various determinants, including demographic factors and educational pathways, and their respective impacts on student academic performance.

Univariate analyses indicated that students who repeated the CBSE had significantly lower mean GPAs and CBSE scores than first-time examinees. Students with repeat attempts were also older on average (mean age rose across attempt categories; $P < 0.001$), consistent with delayed progression. These results describe strong bivariate associations but do not establish that attempt number is an independent predictor after adjustment for other factors; nonetheless, the pattern supports prioritizing early identification and remedial support for students who fail or repeat high-stakes examinations.[35] In this regard, our results contradict studies suggesting that retaking an exam can improve scores.[25,35–37]

The admission route was associated with significant differences in mean GPA and CBSE in univariate comparisons ($P < 0.001$). These results show substantial heterogeneity across admission routes, plausibly reflecting differences in prior academic preparation and selection rigor, and suggest the potential value of admission route-specific academic support. Additionally, multivariable analysis confirmed these differences, independent of confounders. These findings highlight the need for tailored academic support to ensure equitable outcomes across all admission pathways. This pattern aligns with reports that more competitive admission routes are associated with later performance advantages and mirrors cross-context disparities reported internationally.[19,29]

Statistical analysis revealed a significant variation in mean basic sciences GPA across entry semesters (P = 0.003). However, CBSE scores did not show a significant difference across entry semesters in the updated dataset (P = 0.111). Given the inconsistency between GPA and CBSE across entries and the lack of adjusted analyses, temporal explanations (for instance, pandemic-related instructional changes, such as shifts to virtual instruction and examinations, which led to a decline in teaching quality and an excessive increase in academic rigor) remain speculative and should be interpreted cautiously. Entry effects arising from COVID-19 disruptions to instruction and assessment conditions may therefore partly account for between-entry GPA differences despite broadly stable CBSE scores.

Age showed notable bivariate associations with some outcomes in the dataset: older students were more likely to have repeated CBSE attempts, with mean age rising across attempt categories (P < 0.001), which corresponds with lower mean GPAs and CBSE scores in those groups. The observed pattern nevertheless suggests that age is correlated with delayed progression and poorer unadjusted outcomes. Future adjusted analyses should examine whether age itself or correlated factors explain these associations. The findings challenge the assumption that age uniformly influences all academic outcomes, suggesting that age-related performance differences are context-dependent.[10,38,39] Educational policies should avoid overgeneralizing age as a risk factor and investigate its interactions with other academic and psychosocial variables.

Although gender differences in academic outcomes have been inconsistently reported in the literature, our analysis found that male students scored slightly higher on the CBSE than females, while the mean basic-sciences GPA was essentially equivalent between genders.[28,38,40,41] Although the CBSE difference is statistically significant, its absolute magnitude is modest (3.9 points on a 0–200 scale), whereas GPA differences are negligible (0.11 points), suggesting limited practical impact on overall academic standing. These findings indicate that, in this study, gender-related variation is more apparent on the high-stakes standardized CBSE than on routine course assessments; this pattern merits closer inspection of factors (for example, test format familiarity, exam preparation strategies, or subdomain performance) that might explain the CBSE gap and guide targeted support where needed.

The extent of these differences indicates a significant performance disparity between Iranian and non-Iranian students. The findings indicate the potential impact of factors such as language proficiency, variations in prior educational backgrounds, and differing levels of academic or social support. This highlights the need for targeted strategies to enhance non-Iranian students' adaptation to the MD curriculum.[19,20,42,43] Nevertheless, qualitative research may be needed to explore whether non-Iranian students experience unique challenges, such as language barriers, cultural adjustment, or selection metrics, that are not captured through quantitative performance metrics alone.[44–47] Because many non-Iranian students enter via the international admission route, nationality-based disparities may intersect with admission pathways, warranting admission route-by-nationality monitoring and tailored transition support.[19,20]

These findings emphasize the need for reform of the admissions process from a policy perspective. The notable performance disparities across admission routes underscore the need for a comprehensive reevaluation of selection criteria and academic standards, especially in essential disciplines such as medicine.[8,48] In parallel, the pronounced performance drop associated with repeated CBSE attempts underscores the urgency of early academic intervention and remediation, ideally before or immediately after the first failed attempt. Practical implications include language and transition support for non-Iranian entrants, early monitoring and mentoring pathways for repeat examinees, and admission route-specific bridging modules to level foundational preparation.

Consistent with previous studies that emphasize the influence of gender, nationality, and age, our results indicate that these demographic variables affect academic performance.[49–51] In our present unadjusted analyses, gender and nationality were associated with CBSE and both GPA/CBSE, respectively, and age and admission route showed strong univariate relationships with outcomes. These unadjusted patterns underscore the plausibility that demographic and admission factors are important correlates of performance, but they do not establish independent causal roles. Structured mentorship, targeted academic counseling, and continuous formative assessments may reduce the downstream effects of these risk factors.[35]

Our findings align with the existing literature, which highlights the multifactorial nature of academic success in medical education.[8,49] Unlike studies focusing solely on cognitive metrics or demographic traits, this study confirms that academic achievement is an integrated outcome of admission stringency, examination trajectory, and contextual variables, all of which must be considered to optimize educational outcomes.

Study Limitations and Future Directions

This study draws on a multi-semester institutional dataset with broad coverage of MD basic sciences records. However, several limitations should be emphasized in light of the updated methods and results. First, outcome availability varied by variable (GPA available for 1,679/1,727 records; CBSE score available for 1,365/1,727 records), and missing data were not imputed. Analyses were conducted using available cases for each comparison. This differential completeness creates potential for selection bias and limits the generalizability of unadjusted findings. Second, the retrospective, single-institution design remains a limitation. Finally, the absence of direct measures such as socio-economic status, prior academic preparation, language proficiency (for non-Iranian students), and academic integrity metrics constrains the interpretation of observed group differences. Future multi-center, longitudinal, and adjusted analyses, ideally combining quantitative multivariable models with qualitative inquiry, are needed to determine independent predictors and mechanisms, as well as to test interventions such as randomized comparisons of assessment modalities or targeted remediation programs.

Conclusion

This study identified associations in academic performance among MD students at TUMS with CBSE attempt number, admission route, nationality, gender, and entry semester in univariate analyses. Entry-related factors during pandemic-era instruction and assessment may have influenced grading conditions, so between-entry differences should be interpreted cautiously. Students repeating the CBSE and those admitted through international routes demonstrated notably lower mean GPAs and CBSE scores, while Olympiad and Konkur entrants tended to achieve higher results in this study. Male students scored slightly higher on the CBSE than females, although GPA differences were minimal. Older age was associated with repeated examination attempts, suggesting delayed progression rather than an isolated performance effect. Overall, these findings highlight the influence of admission route and examination repetition on early medical education outcomes and underscore the importance of tailored academic support, particularly for repeat examinees and non-Iranian students, including early monitoring for repeat examinees, language and transition support for non-Iranian entrants, and admission route-aware bridging modules, to promote equitable academic performance across the student body.

Disclosure

The authors report no conflicts of interest in this work.

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