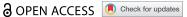


RESEARCH ARTICLE



International students in United States allopathic medical education: a mixed-methods analysis of institutional policies

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International medical students (IMS; non-U.S. citizens/permanent residents) greatly enhance the diversity of U.S. medical schools and serve in areas of greatest healthcare needs. Despite 15% of the US population being foreign born, international students represent < 2% of US-MD matriculants. Factors that contribute to this underrepresentation of IMS remain unknown. In this study, we analyzed the accessibility, quality, and inclusivity of publicly available admissions and financial aid policies at all US-MD schools, with the goal of evaluating potential institutional and informational barriers faced by IMS. Institutional webpages and American Association of Medical College (AAMC) databases were searched from May-July 2023 to gather IMS-specific admissions and financial aid information from 153 accredited US-MD schools. Two-tailed t-test or chi-square analysis was used to examine differences. An inductive thematic approach was used to qualitatively categorize institutional webpage friendliness. While 45% (69/153) of U.S.-MD schools reported accepting IMS, only 18% (27/153) admitted students without restrictions (e.g., Canadians only, state/religious preference). Further, 38% (26/69) of the schools that accept IMS did not provide financial aid information, while nearly two-thirds of the remaining schools required proof of personal financial ability with no institutional/federal support. International students also entered schools with a higher average Medical College Admission Test (MCAT) score and Grade Point Average (GPA). In the national AAMC databases, 19 additional programs were listed as accepting IMS although the institutional webpages stated otherwise; the databases also lacked details on specific restrictions posed by the majority of institutions. Of all 153 webpages, only 14% were deemed 'international friendly.' Restrictive admissions and financial aid policies as well as the poor quality and access to information are major barriers that affect IMS. Strategies that aim to overcome these challenges can greatly help advance diversity, equity, and inclusion in medical education.

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International students; F1 visa: medical education: admissions; diversity; inclusion

Introduction

International students (i.e., non-U.S. citizens and non-permanent residents) contribute significantly to the cultural diversity of medical schools and pursue career paths that serve some of the U.S. healthcare's greatest areas of need [1-4]. Medical students report that having a diverse class enhances their education by increasing discussions of alternative viewpoints, improving understanding of medical conditions/ treatments, and increasing their understanding of and concern for equity in healthcare [5]. Evidence suggests that care provided by physicians who share similar backgrounds with their patients - whether in terms of race, ethnicity, socioeconomic status, or language - improves patient trust, satisfaction, and

treatment adherence [6]. Despite these well-described benefits of having a diverse workforce, international students are largely underrepresented in medical schools and comprise less than 2% of all U.S. medical school matriculants [1,2] although foreign-born immigrants in the U.S. comprise nearly 15% of the total population. The U.S. also lags the 7.5% of international students at United Kingdom medical schools [7], 15% at German medical schools, and 16% at Australian medical schools [8].

Over 50,000 students apply to U.S MD schools each year, and among them, only 1300 are international students. Among the international student applicants, <20% are accepted compared to the approximately 40% of citizens and permanent residents who are accepted

and matriculate into U.S. medical schools [1,9]. This disparity has remained unchanged for the past 10 years [1], underscoring the importance of addressing barriers faced by international premedical students. Prior work reported that difficulty with acquiring necessary immigration and financial support [3], limited access to extracurricular opportunities due to visa restrictions, and challenges finding knowledgeable mentors [1,2,10] are some of the primary barriers faced by international premedical students [11]. These barriers are amplified by challenges with finding reliable and consistent information on admissions criteria, financial aid processes, and organizational or immigration support for students [1,2,9]. In fact, 8 of 10 international premedical students report challenges finding institutions that accept international students [1].

However, these studies are greatly limited in sample size and often are based on subjective opinions of a limited cohort of international students. To date, no studies have evaluated institutional factors that may limit international students' matriculation into medical schools. As such, in this study we comprehensively evaluated publicly available institutional policies/information regarding international students across all 153 accredited U.S. allopathic medical (US-MD) schools in 2023, with the ultimate goal of understanding whether current institutional policies and information accessibility contribute to the underrepresentation of international medical students. To address this question, we first evaluated the accessibility, quality, and inclusivity of both admissions and financial aid policies. We also assessed the academic profile of institutions that accept international students and the institutional differences in the proportion of international students who are offered interviews and who subsequently matriculate. Finally, based on our findings, we offer guidelines for standardized, equitable promotion of information on medical school websites.

Methods

Study design

We performed an environmental scan of the current state of policies and practices that affect international medical students across U.S. MD schools. This involved comprehensive data collection from both standardized databases and institutional websites, as well as structured analysis of quantitative metrics and qualitative content. Our approach (detailed below) included three components: analysis of publicly available database information, review of public institutional websites, and thematic analysis of website content.

Source of data

We reviewed admissions and financial aid policies for international students in 153 allopathic medical

schools located in the United States using information from the American Association of Medical College's comprehensive 2023-2024 Medical School Admissions Requirement (MSAR) as well as publicly available information from each school's website from May 2023 to July 2023. We acquired additional institutional information using the MSAR data from the October 2022 AAMC Data Warehouse's Applicant Matriculant File; this included information about private vs public schools, average Medical College Admission Test score (MCAT) and Grade Point Average (GPA) for international vs noninternational students, and the number of noninternational and international students who applied and matriculated into the school. All data used were from publicly available MSAR data, and institutional admissions, financial aid, or related pages (i.e., web pages for the international students' office, a global health office, diversity office). As such, this study was not deemed human subject research and exempt from institutional review board approval. Complete data is available upon request.

Inclusion and exclusion criteria

We defined international students as anyone without U.S. citizenship or permanent residency regardless of the location of their undergraduate education. This consists of students on immigrant visas (i.e., F1, J1, or H1b/dependent H4 visas) and excludes students with DACA, refugee, or asylum status.

Public database analysis

To identify institutions that accepted international students, we filtered data from MSAR for accepting 'International,' 'International (case-by-case),' 'Canadian,' or 'Canadian (case-by-case)' students. We then cross-validated this information with each institution's website. When there were discrepancies between the AAMC data and institutional webpages, we assumed that the institutional webpage was more updated and utilized that information. Using school-specific data reported by each institution to the AAMC, we calculated the number of international and non-international students who interviewed and matriculated.

Public institutional website review

We gauged admissions and financial aid information for international students from each institution's international student page, admissions page, or financial aid webpage. We developed our data extraction framework through an iterative process. Initially, two authors (GSK and AVM) reviewed five medical school websites to identify key information relevant to international students as well as the primary sources of this information within webpages: general admissions/financial aid pages for medical schools, frequently asked Q&A pages, as well as dedicated international student pages/sections. The authors then established a standardized data extraction template in Google Sheets to identify language about admission and financial aid as it applies to international medical students. This included information about public/private status, location, admission policies, financial aid policies, information about visas, and any metrics about previous international students. The template was utilized for five additional webpages and refined based on discussion between authors. Once finalized, data for all 153 schools was manually extracted in a standardized manner within a 1-week time-frame by AVM. All data was recorded with a link to the original source, which was used for cross-validation by other authors.

We then used an inductive thematic approach to determine if the language on each school's webpage was 'international friendly.' We used an inductive approach to identify common themes regarding the quality and completeness of information, language used to describe consideration of students for admission, access to/showcasing of previous international students, and clear definition of financial aid/scholarship opportunities. We next summarized these qualitative themes into six broad criteria and categorized them into 'international friendly' versus 'non-friendly.' Two independent reviewers (AVM and GSK) assessed and validated these themes, and any discrepancies were resolved through discussion and consensus. Three theoretical frameworks informed our evaluation criteria for website friendliness. First, the information accessibility theory was applied to examine how easily students can find and understand institutional information when deciding to apply to and attend medical school [12]. We also utilized the international student mobility theory and the push-pull model of decision making to consider factors, particularly information availability and institutional support, that may further influence international students' decisions during medical school applications [13].

Statistical analysis

A two-tailed t-test or chi-square analysis and Cohen d statistics were used to examine differences between groups, with a significance level of p = 0.1. The alpha level was selected during the study design phase. Given the exploratory nature of our analysis, and the fact that this is the first study to evaluate systemic/ institutional factors that influence a highly underrepresented student population, we prioritized minimizing the risk of missing potential differences (Type 2 error), accepting a higher risk of Type 1 error. Homogeneity of variance was tested using the Levene test. All statistical analyses were conducted using Prism GraphPad Version 9.5.0 and R Studio Version 2024.12.0 + 467.

Results

Landscape admissions to U.S. allopathic medical schools for international students

The breakdown of institutions that accept versus do not accept international students are detailed in Figure 1. The majority (55%, n = 84/153) of US-MD schools require their applicants to be U.S. citizens or permanent residents. Of the remaining 69 schools, 61% (n = 42/69) of schools only consider international students on a restricted, case-by-case basis. A majority of these restrictions are specific to international students (57%, n = 24/42) while some are state or religious preferences that apply to all applicants (43%, n = 18/42). Specifically, 14% (n = 6/42) of schools that state they accept international students only accept Canadian students, 5% (n = 2/42) only admit U.S. nationals, 12% (n = 5/42) only admit international students to their MSTP programs, and 12%

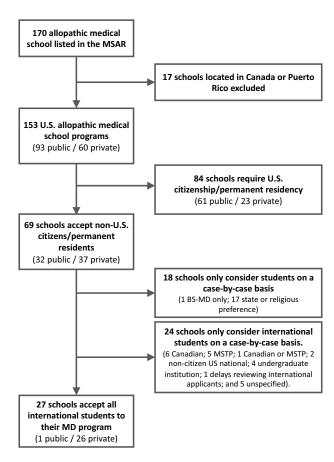


Figure 1. Characterizing international student admissions policies in U.S. allopathic medical schools. MSAR = medical school admissions requirements (online database). U.S. = United States. BS-MD = Bachelor of science - Doctor of medicine. MSTP = Medical scientist training program. MD = Doctor of medicine.

(n = 5/42) do not specify what constitutes a case-by -case basis. In addition, 10% (n = 4/42) of schools are restricted to international students who graduated from the institution's undergraduate institution, and one school only reviews international students after U.S. permanent residents/citizens. Thus, only 18% (n = 27/153) of U.S. allopathic medical institutions equally consider all international students for admission to their MD program. Of these institutions, 96% (n = 26/27) are private schools.

Characterizing schools based on international student admissions policy

Comparison of MCAT scores, GPA, interview invitation rates, and matriculation rates across U.S MD institutions are summarized in Table 1. The average MCAT score among schools that admit international students is 515.16 (SD = 4.427; n = 68) compared to 511.76 (SD = 3.198; n = 82; p < 0.001) for schools that do not; a score of 515 falls within ~ 91st percentile while 511 is ~ 82nd percentile. The average GPA score of admitted students at schools that admit international students is 3.840 (SD = 0.085; n = 68) compared to 3.818 (SD = 0.069; n = 82; p = 0.089) among schools that do not.

Of the institutions accepting international students, 94% (64/68) of the schools extended interview invitations to a greater proportion of noninternational applicants compared to international applicants (Figure 2). On average, 10.90% (SD = 4.58, n = 68) of non-international applicants were invited to interview across institutions while only 3.84%

Table 1. (a) Comparison of MCAT scores and GPA across U.S MD institutions that do and do not admit international students. (b) Comparison of interview invitation rates and matriculation rates across international and non-international applicants. Significant values are bolded while nonsignificant values are indicated by (ns), with alpha of 0.1.

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A	Institutions that admit international students	Institutions that do not admit international students	T-test results
Average MCAT Score	515.16 (SD=4.427; <i>n</i> =68)	511.76 (SD=3.198; <i>n</i> =82)	t(119) = 5.29, p < .001 , d = 0.89
Average GPA	3.840 (SD=0.085; <i>n</i> =68)	3.818 (SD=0.069; <i>n</i> =82)	t(128) = 1.72, p = .089 , d = 0.29
В			•
	International applicants	Non-international applicants	
% Interview invitations across institutions	3.84% (SD=3.41, <i>n</i> =68)	10.90% (SD=4.58, <i>n</i> =68)	t(124) = -10.20, p < .001 , d = -1.75
% Matriculated across institutions after receiving an interview invite	31.23% (SD=27.51; <i>n</i> =57)	24.82% (SD=11.81; <i>n</i> =69)	t(73) = 1.64, p = .106(ns), d = 0.31

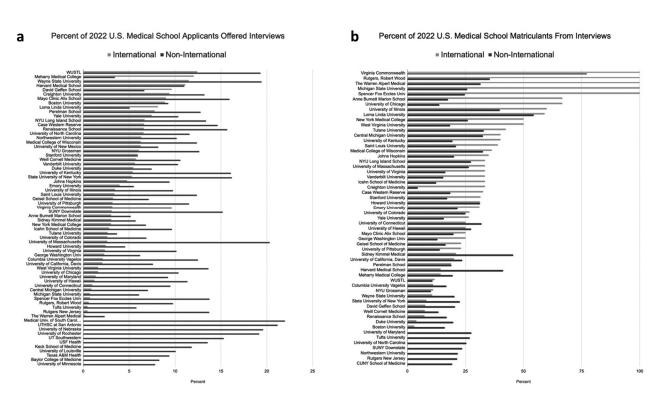


Figure 2. (a) Percent of interview invitations for international students vs. non international students in US-MD schools. (B) Percent of post-interview matriculation among international students vs. non international students in US-MD schools. Light grey = international students, dark grey = non-international students.

(SD = 3.41, n = 68; p < 0.001) of international applicants were invited to interview (Figure 2a). Further, 16% (n = 11/69) of schools that accept international students did not invite any international students to interview. Once invited for an interview, 31.23% (SD = 27.51; n = 57) of international students matriculated into the school while only 24.82% (SD = 11.81; n = 69; p= 0.106) of non-international students did (Figure 2b). There were two errors (more matriculants than interviewees and missing data), which we omitted in these and subsequent calculations.

Financial aid policies for international students

Breakdown of financial aid policies for international students are detailed in Figure 3. No information about financial aid is available on the website for 38% (n = 26/69) of the schools that admit international students. Of the schools that do offer information, 63% (n = 27/43) do not offer any institutional aid to international students and 63% (n = 27/43) specify that students must be able to finance their own education. Specifically, 14% (n = 6/43) of institutions require 1-2 years of funding to be shown in a bank/escrow account, while 21% (n = 9/43) require financial documentation for 4 years. One institution requires that 4 years of fees are paid in advance. Fees include costs required for tuition, health insurance, and living/incidental expenses; institutions specify that admissions can often be withdrawn if students do not demonstrate sufficient financial holdings. These requirements can extend to the application phase, with one institution requesting plans for funding in secondary applications and another requesting students to note their personal and family financial resources prior to offering them an interview. Ultimately, 23% (n = 16/69) of the schools that accept

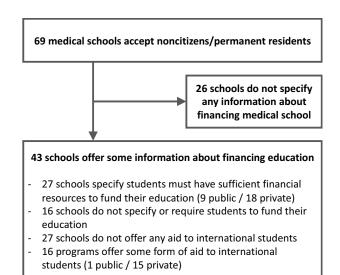


Figure 3. Breakdown of financial aid policies for international students at US-MD schools.

international students mention that they can offer some form of institutional aid to them. Most schools that offer financial aid are private institutions (94%; n = 15/16).

The quality of information available for international students: defining 'international'

While cross-referencing with institutional websites showed that 69 institutions considered applications from international students, even if on a case-by-case basis, the MSAR listed that 88 schools consider international applicants. Of these, 22% (n = 19/88) actually required applicants to hold U.S. citizenship/permanent residency or DACA/refugee/asylee status. Among the remaining institutions (n = 69), there were discrepancies about eligibility for MSTP programs between the information in the MSAR and the institutional websites. Of the schools that the MSAR noted as accepting international students, 3% (n = 2/69) did not admit international students to their MSTP program. Additionally, 6% of schools (n = 4/69) schools only admitted international students to their MSTP programs.

There is significant variation in the definition of 'international' across institutions, the AAMC, and the MSAR based on birth country, country of graduation, country of citizenship, and additional legal statuses. Unlike the MSAR, AAMC does not disaggregate Canadian students from other international students and classifies DACA/refugee/asylee students as international (under the non-U.S. citizen/permanent resident umbrella category). However, students with these immigration statuses are considered alongside domestic students by many individual schools. Some consider international students as those who reside or were educated outside America, but still require them to hold U.S. citizenship. Others consider international students as anyone without legal residency or citizenship, regardless of residence or being seniors from U.S. undergraduate colleges.

Due to such variations, the MSAR's homepage might state that international students are ineligible to apply, but the AAMC data will list international applicants (presumably DACA students). Similarly, the AAMC might list international matriculants even when there were 0 interviewees because interview data are taken from individual schools (n = 5cases, omitted when applicable in our analysis). In addition, 7% of schools (n = 5/69) that accept international students state that they do so on a case-bycase basis in the MSAR, but only 40% (n = 2/5) confirm this by specifying the case-by-case criterion on their website. Some schools state that the admissions office is unable to answer specific questions about student visas, immigration-related concerns, or international student financial aid.



The 'friendliness' of institutional information and listed policies

While 69 schools state that they accepted international students, the 'friendliness' of the language used to describe admissions policies varied. We characterized the friendliness of each institution analyzing direct language from medical school webpages and using six inductively derived categories as illustrated in Table 2. In total, 29% (n = 20/69) schools that admit international students and 2% (n = 2/84) of schools that do not admit international students were 'international friendly.' These together reflect only 14% (n =22/153) of all U.S.-MD schools. Among the international friendly schools, 82% of schools (n = 18/22) were private and 18% (n = 4/22) were public.

We found that most schools (86% or n = 131/153) did not have friendly language. For example, they doubted international students' ability to succeed in future jobs and competitive residency programs; shared stringent financial requirements that served to scare, rather than inform (i.e., stating students are 'unqualified' for aid and should be prepared to 'absorb high costs' given 'rapidly diminishing' funds); or highlighted exceptional admissions requirements (Table 2).

Interview, matriculation, and financial aid policy differences between international friendly and nonfriendly/neutral schools are compared in Table 3. Of the schools that currently accept international students, we found that international students comprised 6.25% (SD = 2.15; n = 20) of applicants to international friendly schools, compared to 4.59% (SD = 3.14; n = 48; p = 0.015) to international nonfriendly/neutral schools. The difference between the proportion of non-international and international applicants invited to interview was -4.57% (SD = 3.16; n = 20) for international friendly schools compared to -8.09% (SD = 6.07, n = 48; p = 0.003) for others. There was no difference between the proportion of non-international and international applicants invited to matriculate based on international friendliness (5.45%, SD = 12.92; n = 20 for international friendly schools; 0.233%, SD = 30.16, n = 48; p =0.003 for others; p = 0.332). Of the international students, 24.10% (SD = 15.11, n = 20) of interviewees matriculated into international friendly schools and 35.09% (SD = 31.84, n = 37; p = 0.083) matriculated into non-friendly/neutral schools. Of the noninternational students, 18.50% (SD = 7.52, n = 20) of interviewees matriculated into international friendly

Table 2. 'Friendliness' of language used on medical school webpages. Direct quotes from various institutional pages are included as examples but are not cited to maintain institutional anonymity.

International Friendly Language International Non-friendly/Neutral Language Schools **Encourages admissions Emphasizes difficulties** 'welcomes international applicants' Accepting 'application process is complex' International 'in the spirit of diversity' 'admissions is competitive' 'each student has a right to obtain an education ... a student's 'limited options in terms of post-graduate training, both Students citizenship status should not be a reason to prevent him or her geographically and within specialties' from achieving **Establishes equality** Imposes special requirements 'considered in the same pool as U.S. citizens' 'all else being equal, priority will be given to candidates who 'full review of file under identical criteria' are US citizens or permanent residents' 'no difference in admissions process' 'extraordinary qualifications' 'without regard to country of origin' 'strong record of research achievement' 'no additional requirements' 'admitted under unique or compelling circumstances' Characterizes previous international students Highlights lack of international students 'no cap on the number of admitted international students' 'do admit international students, but relatively few' 'our student body has approximately 15% of international 'applications for international students are reviewed after USA students, which is above the national average citizens and permanent residents. The entering class has been 'includes students from Canada, China, Ireland, South Korea, filled before the review of any international students for the last twenty-three years' 'shortage of U.S. physicians' Offers opportunities for institutional aid Emphasizes lack of financial resources 'eligible for need-based financial aid international students are not qualified for traditional 'eligible for our Full-Tuition scholarship' funding' 'evaluated for financial aid in the same need-based manner as 'rapidly diminishing sources of financial assistance' U.S. citizens (with the one exception of loan sources)' 'financial aid is limited and difficult to obtain' 'considered for merit scholarships with the rest of the 'school cannot co-sign any loans' accepted students' Requires demonstrated financial ability Suggests alternate funding opportunities

Schools

Not Accepting International Students

Recognition of international students

'Private loans are available

'Regretfully, [the school] does not accept international 'At this time, [the school] does not accept international ... the policy may change in the future'

'Unfortunately [financial aid is not available] ... recommend

possible sponsoring agencies, scholarship programs' 'Office will work with you [to obtain funds/visa]'

that you check a site called eduPASS, which may lead you to

Doubt of international students

sufficient funds?

'must be able to absorb high cost'

'[International students are not admitted] given uneven advanced training opportunities for non-citizen/non-green card holders'

'admissions will be withdrawn [if unable to demonstrate

required to pay four years of tuition in advance'

'[We admit students] guaranteed to complete the full four years of the curriculum based on citizenship or permanent

Table 3. Interview, matriculation, and financial aid policy statistics among international friendly versus non-friendly/neutral schools. Significant values are bolded while nonsignificant values are indicated by (ns), with alpha of 0.1. *T-test, #chi-square

	International Friendly	International non-friendly/neutral	T-test*/chi-square analysis results#
% of international applicants to schools	6.25% (SD = 2.15; $n = 20$)	4.59% (SD = 3.14; n = 48)	t(51) = 2.51, p = .015 , d = 0.57*
Difference in interview invitation rates (% non-international minus international)	-4.57% (SD = 3.16; <i>n</i> = 20)	-8.09% (SD = 6.07; $n = 48$)	t(63) = 3.13, $p = .003$, $d = 0.65*$
Difference in post-interview matriculation rates (% non-international minus international)	5.45% (SD = 12.92; <i>n</i> = 20)	0.233% (SD = 30.16, <i>n</i> = 48)	t(66) = 1.00, p = .322(ns), d = 0.20*
% of international interviewees who matriculated	24.10% (SD = 15.11, n = 20)	35.09% (SD = 31.84, <i>n</i> = 37)	t(54) = -1.76, p = .083 , d = -0.40 *
% of non-international interviewees who matriculated	18.50% (SD = 7.52, $n = 20$)	27.39% (SD = 12.31, <i>n</i> = 49)	t(56) = -3.65, p = 0.004 , d = -0.8 *
% of schools offering aid	13/20 (65%)	3/49 (6%)	p < 0.0001 [#]
% of schools requiring demonstration of financial resources	5/20 (25%)	22/49 (45%)	$p = 0.124(ns)^{\#}$

schools and 27.39% (SD = 12.31, n = 49; p = 0.004) matriculated into non-friendly/neutral schools.

The international friendly schools also were more likely to offer aid (65%, 13/20) compared to international neutral/non-friendly schools (6%, 3/49; p < 0.0001). A lower, but non-significant proportion of international friendly schools require demonstration of financial resources (25%, n = 5/20) compared to international non-friendly/neutral schools (45%, n = 22/49; p = 0.124).

Discussion

The number of medical students has consistently increased over the last 25 years, due to both the establishment of new medical schools as well as increases in class sizes. However, the proportion of international students in U.S. medical schools has remained unchanged over the past decade (<2%) [1], and the current percentage of medical students identifying as racial and ethnic minorities remains well below their corresponding percentages in the U.S. population [14]. Ample research shows that health outcomes, medication compliance, and patient satisfaction are all greatly improved among minority patients when doctors and their patients share similar backgrounds [6,15,16]. A diverse medical school class also helps enhance the cultural competency of physicians, preparing them to serve the highly diverse population of the U.S. Minority students also commonly practice in hospitals that serve patients from low socioeconomic or minority backgrounds [15]. Given that international students represent a wide range of cultures, backgrounds, and perspectives, increasing their representation within US-MD schools can greatly enhance the diversity of institutions and help address crucial needs of our health system.

International students in the U.S. also greatly benefit from pursuing their medical education in the U.S., as it allows students to continue their education/work in the same country as their immigrant

parents or families. American medical education is also highly rigorous and prestigious, and it is well known to increase career prospects for students throughout the world. Furthermore, immigrants are a largely understudied population in the U.S. leading to poor access to evidence-based medicine [17], and students from immigrant backgrounds are uniquely positioned to better understand and address heathcare needs of our foreign born population [18]. As such, increasing the representation of international students in M.D. programs can provide bidirectional benefits to students and our health system.

Prior studies document that medical education is one of the least accessible fields for international students in the U.S., and students self-report that the lack of reliable information on admissions and financial aid criteria can be major barriers to pursuing medicine [2,3]. In this study, we used both national and institutional level data to understand whether admissions and financial aid policies across all 153 U.S. medical schools as well as their accessibility/quality may contribute to the current underrepresentation of international students in US-MD schools. The major findings of our work are fivefold: 1) international students are only eligible for admissions at 18% of U.S. medical schools without any restriction; 2) when compared to noninternational students, a smaller proportion of international students received interview invitations, although most of the international matriculants attended institutions with higher average MCAT and GPA; 3) a majority of institutions that accept international students require proof of financial ability to pay for medical school; 4) there is conflicting and limited information about admissions policies and financial aid across institutional and national web pages; 5) we qualitatively defined 'internationalfriendly' institutional webpages that provide sufficient information and utilize inclusive language, and these represent only 14% of current US-MD institutions.



Limitations in the current admissions policies as well as the poor quality of information and resources available for international medical students are actionable areas for future work.

Non-equal consideration of international students for admissions

Our work suggests that international students have limited opportunities for matriculating into U.S. medical schools, as <20% of all U.S. medical schools accept international students without restrictions; on average, schools interviewed a smaller percent of international applicants than their U.S. citizen or permanent resident peers. Moreover, 16% of schools that stated they accepted international students did not interview any international applicants. Interestingly, prior work showed that the average GPA and MCAT scores for international matriculants have been higher than those of noninternational students for the past 10 years [1]. In line with these findings, our results show that institutions that accept international students have significantly higher GPA and MCAT averages. While these findings shed light on the competitiveness of international students matriculating into the U.S. medical system, they also highlight the non-equal consideration of international students for admission.

Public institutions often cannot accept international students because of state-mandated policies. However, the reasons for non-equal consideration of international students for admission by private institutions remain poorly defined. From our evaluation of 'non-friendly' or neutral institutional webpage language, we deducted that concerns about students' residency MATCH success, potential complications with travel or work eligibility, and funding requirements (given that international students are not eligible for federal aid), all might dissuade institutions from equally considering students that require a visa. While some logistical considerations are justified and require the use of additional institutional resources, concerns about international students' career prospects or low confidence in their ability to succeed in the future are not based on any objective metrics. The current data available for MATCH success only differentiates international medical graduates (those who attend or have graduated from an international medical school) from US-medical graduates. The increased competitiveness of international students who matriculate into U.S. medical schools suggests they are likely to remain competitive candidates for residency, but there is currently no available data assessing their outcomes after matriculating from U.S. medical schools. Such studies are critically needed to better understand and guide medical school admission policies.

Persistent barriers to admission: lack of information and financial requirements

Our analyses used a standardized definition of 'international' based on a student's non-citizen and nonpermanent resident visa status; however, resolving discrepancies between definitions of 'international' based on visa, residence, legal status, and education was challenging since many schools were erroneously designated as accepting international students in the national databases when their institutional website specified that they actually required students to have a permanent residency or citizenship. Specific information about admissions policies were also not always accessible online. While prior literature documents this lack of information [1], we characterize the extent of difficulty required to acquire it; organizing our results required considerable research and cross-checking across websites - an added time barrier for applicants or pre-medical advising staff, who already in prior studies expressed lower confidence in guiding non-US citizens/permanent residents [10].

Furthermore, US medical education is significantly more expensive than other countries, and most students rely on loans/grants/scholarships to fund their education. The eligibility for these financial aid opportunities varies based on visa status. Yet, no information about financial aid is available on institutional websites for 38% of the schools which admit international students, compounding the ambiguity of admissions criteria. Concerningly, of the schools that do offer financial aid information, the majority (63%) do not offer any institutional aid to international students and the majority also specify that students must be able to finance their own education. Past work has identified the 'prohibitively expensive' costs of applying to medical school [19] and documented the significant costs and debts accrued while attending medical school [20]; international premedical students cite both as barrier to their applications [1]. International students recently became eligible for the AAMC's Fee Assistance Program that supports costs of MCAT resources and medical school admissions. This is an important first step towards increasing access to medical education for this community. However, students on visas remain ineligible for any federal funding or loans and need a US-based co-signer for private loans; these are the primary source of financing for over half of all medical students [21]. The requirements for international students to demonstrate or pay up to four years of tuition in advance may contribute to the current overrepresentation of medical school students from high-income backgrounds [21,22]. A recent study in fact highlighted that higher childhood income of medical school applicants

was associated with increased likelihood of being accepted [23]. Improving admissions and financial aid policies for international students may target both the lack of socioeconomic and cultural diversity in medical school, and improve the inclusivity and representation within the healthcare workforce.

Another common information barrier affecting international students, is the lack of clear distinction within medical education research and medical school/residency websites regarding policies that specifically apply to international students attending medical schools in the U.S versus international medical graduates (IMGs) - students who graduate from medical schools outside the U.S, and apply for residencies in the U.S. Aside from the location of their medical education, there are many other unique distinctions between the two groups. The international medical students - the population this study focuses on - are commonly children of legal immigrants in the U.S. As such, these students likely have completed their undergraduate and often part of their K12 education in the U.S. and are well integrated with the culture of American education and health systems. Their educational pathway parallels U.S. citizens/permanent residents, and they are subject to the same application requirements for medical education and residency - aside from visa requirements. These students are also less likely to leave their families or support systems behind in the U.S to pursue an education/residency/jobs outside of the U.S. In comparision, IMGs have unique requirements when applying for residencies in the U.S, which often includes exams showing proof of language competency as well as externships or elective rotations and research years in the U.S. IMGs also vary widely in whether they continue to practice in the U.S. or other countries after graduation, and have added cultural barriers when acclimating to the U.S. health system [24]. Most research to-date has focused on the IMG population, and the challenges faced by this group vary widely from those faced by international medical students [25]. Therefore, in order to better serve both groups, it is important that medical education and residency resources as well as research studies provide clear deliniation between these groups.

Recommendations for improving 'international friendliness' of institutional webpages

While some of the barriers described above require national policy changes, institutions can first improve the accessibility, quality, and inclusivity of information provided to international pre-medical students. Websites are one of the largest platforms for sharing information with the applicants and are often a student's source of 'contact' with a school. As such, they also serve as a public-facing expression of the institution's commitment to diversity and inclusivity. Using the friendly language from 20 schools' websites as examples, we suggest that every institutional website should include information about 1) their admissions policies, including any admissions preferences or restrictions for international medical students, with explanations (i.e., funding restrictions, potential for the policy to change) and 2) their criteria for evaluating international students (i.e., are they more stringent than non-international students, and if so, why?). We also encourage website updates to transparently share the number of students in the entering class who are international students as well as the countries that are represented by these students.

Institutional websites should clearly discuss whether international students are eligible for any merit or needbased aid, as well as the average amounts disbursed. Even when international students are not eligible for any institutional funding, we encourage the website to list additional opportunities for funding such as private scholarships or loans that must be co-signed by a U.S. citizen or permanent resident to inform, rather than scare applicants. Often, funding is required for students who wish to gain an F-1 visa, the most common international medical student visa; in such cases, the steps and timeline to fill out immigration paperwork should be outlined on the medical school's website. Finally, contact information for any sources of support (peer groups, institutional offices, etc.) that these students can rely on should also be listed on the institutional webpage.

We found that schools with friendlier language on their websites had a statistically significant increase in the number of international applicants, interviewees, and matriculants compared to schools with neutral/nonfriendly language. Thus, our recommendations may help increase international student representation in medical schools.

Limitations

Our analyses were limited by the variable definitions of 'international' among our data sources. The AAMC data used to calculate the number of international applicants and matriculants included all non-U.S. citizen/ permanent residents, however interview data and our definition of international student was restricted to non-DACA/refugee/asylee internationals. As such, we may have overestimated the number of 'international' applicants and matriculants by including DACA students; however, the impact of this is likely minimal given that DACA students only comprise an estimated



200 medical students/residents over the last eight years [26]. We also recognize the imperfect overlap between labels like 'immigrant,' 'foreign-born,' and 'international' in our argument for provider-population concordance since even non-international medical school students can be foreign-born or immigrants. While we focused on GPA/MCAT metrics to comment on international students' qualifications and a school's competitiveness, we recognize that many other factors are involved in holistic admissions and as such warrant future study [27]. We also did not have information on the frequency of updates made to institutional webpages, and admissions officers across schools may have differing responsibilities and levels of access to make timely changes. As such, our analysis only represents a single point in time and may not reflect the most up-to -date information based on each institution's website updating schedule.

Conclusion

To our knowledge, this is the first study to comprehensively evaluate publicly available admissions and financial aid policies for international students across all 153 accredited U.S. medical schools (US-MD) schools. Our findings reveal significant barriers in U.S. medical school admissions for international students, as <20% of medical schools accept international applicants without restrictions. International students have lower interview invitation rates overall, although they tend to matriculate into more competitive schools. Most institutions also require proof of financial capability, adding another layer of complexity to the application process. The landscape of medical admissions for international students is further complicated by inconsistent and often insufficient information across institutional and national platforms regarding admissions policies and financial aid. In fact, only <15% of US-MD institutions maintain what we term 'international-friendly' webpages - i.e., those providing comprehensive information with inclusive language. These identified limitations in both admissions/ financial aid policy implementation and information accessibility present clear opportunities for institutional improvement. As a starting point, we provide in this manuscript a set of best practices for medical school webpages to provide standardized, reliable, and inclusive information. Ultimately, we hope our findings support further research in this field in order to mitigate challenges encountered by international students pursuing medical education.

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No research involving Human Participants and/or Animals was conducted.

Data available statement

The data that support the findings of this study are all publically available and can also be gathered from the corresponding author (GSK) upon reasonable request.

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