National examination for medical residency admission: academic variables and performance among different schools

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Abstract

Objective. To identify medical school characteristics associated with performance in a medical residency admission test. **Materials and methods.** Performance and selection rates according to type of medical school (Student´s t-test, Chi-squared test), accreditation status (Student´s t-test) and geographic regions (Anova) were analyzed from a database comprising 153 654 physicians who took the residency admission test *Examen Nacional de Aspirantes a Residencias Médicas* (ENARM) in the period 2014-2018. **Results.** Performance was 62.5% for accredited programs and 61.4% for non-accredited programs ($p<0.001$); public schools reached 62.3% and private schools 62.2% ($p<0.001$). Northern regions performed above 63% while South-Southeast at 58.9% ($p<0.001$). Selection rate was 26.2% for accredited programs and 22.9% for non-accredited ($p<0.001$); 26.6% for public schools and 23.6% for private schools ($p<0.001$). North-East and North-West reached 31% while South-Southeast 20.7%. **Conclusions.** Type of school, accreditation status and geographic region may influence performance and selection rate.

Keywords: medical education; specialization; academic performance

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Resumen

Objetivo. Identificar características de las escuelas de medicina asociadas con desempeño en un examen de admisión a residencias. **Material y métodos.** Utilizando una base de datos con 153 654 registros de aspirantes entre 2014-2018 se analizaron el desempeño y selección en el Examen Nacional de Aspirantes a Residencias Médicas (ENARM) y su relación con tipo de escuela y estatus de acreditación, así como región geográfica. **Resultados.** El desempeño fue 62.5% para programas acreditados y 61.4% para no acreditados ($p<0.001$); 62.3% para escuelas públicas y 62.2% para privadas ($p<0.001$). Las regiones del norte alcanzaron 63% y Sur-Sureste 58.9% ($p<0.001$). La tasa de selección fue 26.2% para programas acreditados y 22.9% para no acreditados ($p<0.001$); 26.6% para escuelas públicas y 23.6% para privadas ($p<0.001$). Las regiones del norte alcanzaron 31% mientras Sur-Sureste 20.7%. **Conclusiones.** Las características de la escuela de medicina influencian el desempeño en el ENARM.

Palabras clave: educación médica; especialización; rendimiento académico

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Globally, the selection of physicians for medical residency courses involves many issues: applicants outnumber positions, applicants are applying to increasing numbers of programs, and the costs of the selection process are a burden to society.[1]

In Mexico, general practitioners have very few opportunities for medical practice. This is because there is a strong preference for people with specializations and a majority of job positions are filled by people who have completed a medical residency. Thus, the great majority of medical school graduates hope to be trained as specialists.[2-4]

Medical specialization refers to the training that physicians receive after obtaining a medical degree. A specialization expands and deepens their knowledge and skills in a specific medical field. This training helps them develop sound clinical judgment and performance skills that can be used to solve complex medical problems with high professional competence.[4,5]

Other countries have variations in admission policies to residency training: United States and Canada use a matching program which purpose is to allow applicants and specialty training programs to know each other and make their selections. In Australia, the United Kingdom, Germany and the Netherlands admission is through an open selection. There are further issues, for example, in Australia, candidates must show some clinical experience prior to application.[5]

In Mexico, to take a medical specialty training course, one must have a medical degree and pass the *Examen Nacional de Aspirantes a Residencias Medicas* (ENARM), a national examination for medical residency admission. Subsequently, candidates are admitted to the specialty training course based on their score and chosen specialty.[6] This test is conducted by the Interinstitutional Commission for Human Resources Formation in Health (*Comisión Interinstitucional para la Formación de Recursos Humanos para la Salud*, CIFRHS). The number of selected candidates corresponds to the number of positions offered for each discipline in the hospitals that provide training; i.e., it is a norm-referenced test. Annually, a little more than 35 000 candidates take the test for about 7 000 resident positions. Thus, a large number of candidates are excluded; for example, in 2016, only 22% of applicants were selected for residency training.[7] The majority of candidates, therefore, remain as general practitioners. Furthermore, some reports estimate that around 14% of all physicians are unemployed.[8]

The ENARM is taken for any direct entry specialty (not requiring previous specialty training) applicant.[9] It is structured in a different version for every day of application with a format of multiple choice questions.[10] ENARM explores examinees' knowledge of general medical practice in different areas. It is a high-stakes summative test with determinant results. It defines, in a way, the professional future of thousands of physicians. In this regard, although multiple choice questions have limitations, it has been demonstrated that well-structured multiple-choice questions can explore not only the recall of facts, but higher levels in the cognitive taxonomy of Bloom (e.g. application or synthesis).[11,12]

An analysis of this test helps identify some aspects of academic performance, as indicated by the number of correct answers, and assesses the amount of knowledge that the candidates possess in order to get into a medical residency course. It also identifies the strengths and weaknesses of the candidates.[5]

Academic performance does not depend exclusively on personal effort but also on variables such as academic background, learning strategies for the test, as well as socioeconomic, psychological, and vocational factors.[13-15] Type of medical school has been investigated in other contexts: at least one research paper has showed a greater possibility of matching into a family medicine residency if the candidate was from a public institution.[16]

In this context, research papers identifying academic variables that influence performance in ENARM are scarce. This kind of research allows feedback to candidates and gathers relevant information for design and implementation of education related interventions that strengthen educational plans and enhance quality. In Mexico, quality of medical care is usually associated with accreditation status considering that medical education accreditation processes can encourage institutional self-review and improvement, and in consequence ensure that medical students receive high-quality education experiences based on established standards.[17] An accredited medical school is one which complies with the requirements of the Mexican Council for the Accreditation of Medical Education (*Consejo Mexicano para la Acreditación de la Educación Médica*, COMAEM); that is getting a minimum of 80% on the assessment instrument. Another probable determinant of quality would be the geographic region where the medical school is located or to where the examinee belongs; this, related to the available resources: economic and academical. A recently published paper[18] demonstrated differences in performance and selection rates related to geographical and socioeconomical factors; the authors based their research on historical data (annual public report of the ENARM for 17 years from 2001 to 2017) and concluded a better ENARM performance in the northwestern region and for private schools. In our opinion, the method of socioeconomic segmentation according to levels and their geographic

allocation process, although sophisticated and made through specialized software, is not as easy to understand for the general medical community. A useful geographic segmentation process is that proposed by the National Association of Universities and Higher Education Institutions (*Asociación Nacional de Universidades e Instituciones de Educación Superior*, ANUIES), a non-government organization that comprises 191 of the most renowned public and private institutions in our country. These institutions are spread across 32 Mexican states and together represent almost 60% of higher education students and perform 90% of scientific research.[19] In agreement with the aforementioned organization, regions of Mexico are Northwest, Northeast, Center-West, Metropolitan area (Mexico City and surroundings), Center-South and South-Southeast; they could constitute a geographic predictor of performance. Table I shows the Mexican states grouped by these criteria.

Thus, we aimed to determine any difference in ENARM performance and selection rate between candidates from accredited medical schools and non-accredited medical schools and between public (government sponsored) and private schools. In the same way our study tried to demonstrate these differences between candidates from different regions of the country.

Materials and methods

Between July 2019 and March 2020, a retrospective analysis was executed.

Research design

Two stages; first stage: observational non-experimental study; second stage: analytical inferential study.

Setting

Our setting was the ENARM, a national examination for medical residency admission in Mexico; candidates are admitted to the specialty training course based on their score and chosen specialty.

Time frame and data source

The Interinstitutional Commission for Human Resources Formation in Health (*Comisión Interinstitucional para la Formación de Recursos Humanos para la Salud*, CIFRHS) provided data on ENARM from 2014-2018. A specific set of data indicated the number of correct answers in the test.

Table I
Mexican states grouped by geographical region. Number of ENARM candidates by region during 2014-2018. Mexico City, Mexico, 2020

Region	*n (%)*
Mexico City and metropolitan area	37 885 (24.8)
Center-South	22 701 (14.9)
Puebla	10 550 (6.9)
Hidalgo	3 100 (2.0)
Guerrero	2 897 (1.9)
Tlaxcala	1 750 (1.1)
Morelos	1 590 (1.0)
Querétaro	1 455 (1.0)
Estado de México	1 359 (0.9)
Center-West	32 656 (21.4)
Jalisco	17 192 (11.3)
Michoacán	9 575 (6.3)
Guanajuato	1 928 (1.3)
Nayarit	1 862 (1.2)
Aguascalientes	1 188 (0.8)
Colima	911 (0.6)
North-West	14 164 (9.3)
Sinaloa	5 102 (3.3)
Baja California	4 827 (3.2)
Chihuahua	3 018 (2.0)
Sonora	1 217 (0.8)
North-East	22 248 (14.6)
Nuevo León	8 178 (5.4)
Tamaulipas	6 047 (4.0)
Durango	2 972 (1.9)
Zacatecas	2 510 (1.6)
Coahuila	1 425 (0.9)
San Luis Potosí	1 116 (0.7)
South-Southeast	22 854 (15.0)
Veracruz	6 779 (4.4)
Oaxaca	5 076 (3.3)
Chiapas	4 267 (2.8)
Tabasco	3 662 (2.4)
Yucatán	1 879 (1.2)
Campeche	927 (0.6)
Quintana Roo	264 (0.2)
Total	152 508 (100.0)

Modified from reference 17
ENARM: *Examen Nacional de Aspirantes a Residencias Médicas*

Instrument

ENARM is a common test for any direct entry specialty (not requiring previous specialty training) applicant. It is structured in a different version for every day of application.[9, 10] ENARM explores examinees' knowledge of general medical practice in different areas. Since 2014, ENARM has been conformed by 450 items, arranged in clinical cases with one to three questions each case in a multiple choice question format (one correct answer, three distractors). From the total, 405 questions (clinical cases) are in spanish and 45 in english. Application is with use of a computer terminal providing about one minute per question.[20] For aspects pertaining to the structure and format of the test, please see the related documents.[10, 20,21]

Statistical analysis

We performed central tendency and dispersion measurements for each year and for the whole sample. We used the Student's t-test to identify differences between two means and performed an Analysis of variance (Anova) to examine the differences in more than two means with Bonferroni's post-test analysis. For categorical variables we used the Chi-squared (X^2) test.

Ethical aspects

The study protocol was approved by the Ethics Committee of the Postgraduate Program of Medical Sciences, National Autonomous University of Mexico (*Universidad Nacional Autónoma de México*, UNAM). Anonymity and confidentiality were preserved.

Financial aspects and conflict of interest

Resources were provided solely by the researchers with no identified conflict of interest.

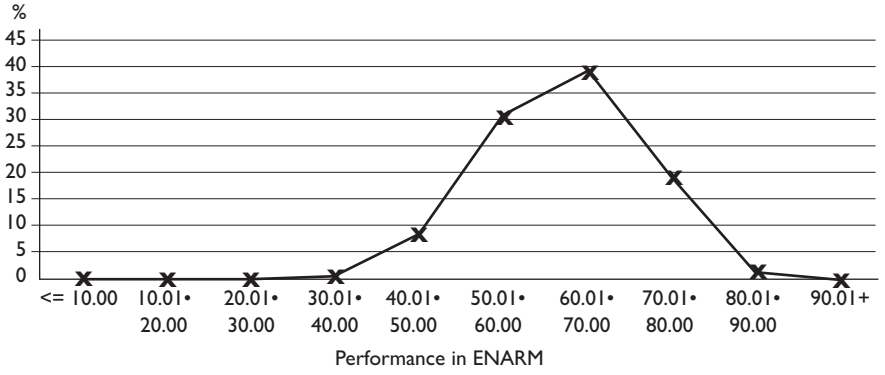
Results

Our study analyzed the data of 153 654 examinees of the ENARM test from 2014 to 2018. Of these, 51.2% were women and 49.7% were men.

Figure 1 shows a frequencies polygon with results obtained in ENARM. Data allows us to see a performance mean for the whole group of 62.3 (standard deviation 8.9) ranking from 1.11 to 91.11; median (50th percentile) was located at 62.4 and mode at 60.9 indicating an asymmetrical and unimodal distribution. The great majority of candidates performed in the range between 60 and 70, and 50.8% of the whole sample performed above the mean; the 75th percentile was located above 68.9. For a proper interpretation of the results, we must underscore that candidates know the exam content beforehand and usually spend a considerable amount of time in preparation for this high stakes test.[9]

Accreditation status of the medical schools and ENARM performance

In a further analysis, we grouped the examinees in relation to the criteria used by COMAEM: accredited



Frequencies polygon indicating performance in ENARM for the whole sample during the period from 2014 to 2018.
ENARM: *Examen Nacional de Aspirantes a Residencias Médicas*
n= 153 654.
X axis= ENARM performance. Y axis = % of candidates.
Note: 450 multiple choice questions. Mean performance for the whole group= 62.3.

FIGURE 1. PERFORMANCE IN ENARM: FREQUENCIES POLYGON. MEXICO CITY, MEXICO, 2020

and non-accredited school programs. In table II,[17] "Accreditation Status" shows that most examinees (n=137 272, 89%) belong to accredited programs, obtaining an ENARM performance mean of 62.5 compared to examinees belonging to non-accredited programs who, as a group, obtained an ENARM performance mean of 61.4. This difference was statistically significant after applying Student's t-test (p<0.001). Selection rate was 26.2% for accredited programs and 22.9% for non-accredited programs; the Chi-squared test was significant for this difference (p<0.001). Effect sizes were 0.12 (Cohen´s d) for performance and 1.14 (Odds ratio) for selection rate.

Type of school and ENARM performance

All of the examinees of our five year database were grouped dichotomously according to the medical school from which they graduated. In table II, "Type of Medical School" shows that most examinees (n=1 158 80, 75%) attended public medical schools, showing a higher ENARM performance mean as compared to those who attended private medical schools. Selection rate was 26.6% for public schools and 23.6% for private schools; these differences were statistically significant (p< 0.001) after Chi-squared test. Effect sizes were 0.01 (Cohen´s d) for performance and 1.13 (Odds ratio) for selection rate.

Table II
Type of medical school of ENARM examinees during period 2014-2018. Performance and selection according to accreditation status and type of medical school are shown. Mexico City, Mexico 2020

Variable	*n*	*ENARM*	*Selection**
		$\bar{x}$ ± *SD*	%
a) Accreditation status			
Accredited program‡	137 272	62.5 ± 8.9	26.2
Non-accredited program	15 236	61.4 ± 8.9	22.9
Total	152 508	62.3 ± 8.9	26.0
b) Type of medical school			
Public	115 880	62.3 ± 8.8	26.6
Private	36 628	62.2 ± 9.1	23.6
Total	152 508	62.3 ± 8.9	26.0

* p< 0.001 after χ^2 test
‡ p< 0.001 after T test
Data lost: 1 146.
Cohen´s d (accredited vs. non-accredited) = 0.1236
Cohen´s d (public vs. private) = 0.0112
ENARM: *Examen Nacional de Aspirantes a Residencias Médicas*

Geographic region and ENARM performance

In table III, under "Geographic Region," we can see how different geographic regions showed different and statistically significant performance means. Nevertheless, some cross comparisons, e.g., Metropolitan compared to Center-South and Center-West, or North-west compared to North-east, demonstrated very similar means. The geographic region with the lowest performance was South-Southeast.

Selection rate showed some differences: North-East and North-West reached 31%, contrasting with South-Southeast obtaining 20.7%; p< 0.001 after Chi-squared test (figure 2).

Discussion

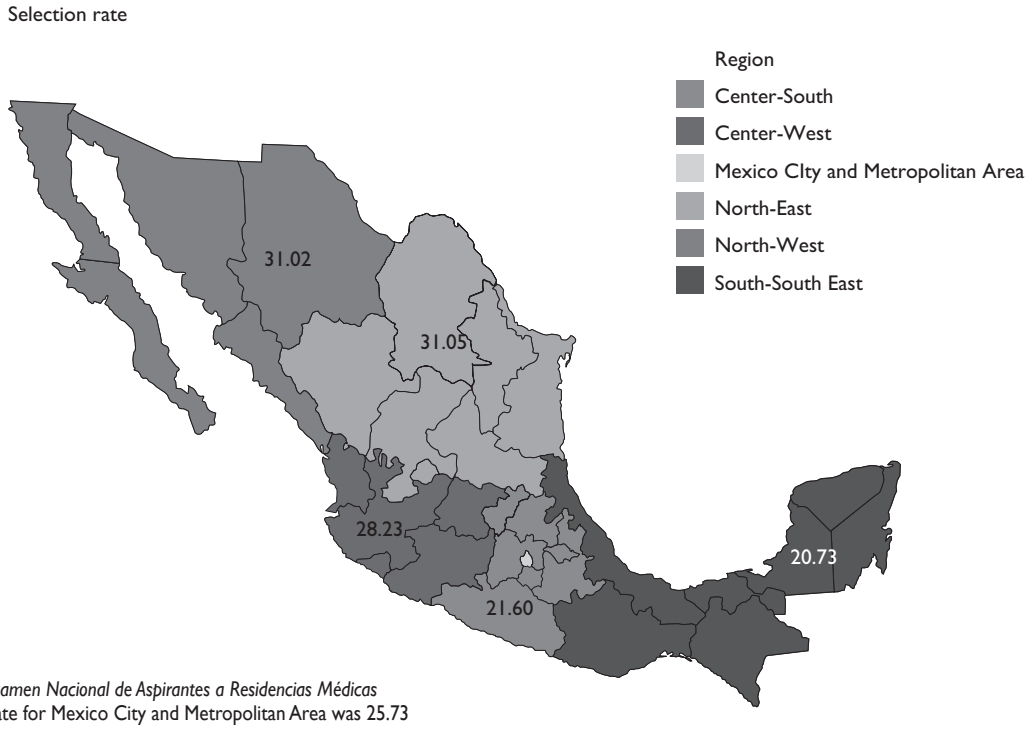
Our study aimed to identify the medical school characteristics associated with performance in a selection test (ENARM) among general physicians who want to be trained in a medical specialty.

Our results show that heterogeneous ENARM performance can be related to certain variables: accredita-

Table III
ENARM performance for different geographic regions in the period 2014-2018. Number of candidates per region and performance means are shown. Mexico City, Mexico 2020

Geographic region	*n*	*ENARM*
		$\bar{x}$ ± *SD*
Metropolitan*	37 885	62.6 ± 8.3
Center-South	22 701	61.2 ± 8.8
Center-West*	32 656	62.8 ± 9.3
North-West‡	14 164	63.3 ± 8.9
North-East‡	22 248	63.8 ± 9.0
South-Southwest	22 854	58.9 ± 8.2
Total	152 508	62.3 ± 8.9

Analysis of variance p< 0.001
*,‡ Compared groups with no difference after post-Hoc Bonferroni test
Data lost: 1 146
ENARM: *Examen Nacional de Aspirantes a Residencias Médicas*



ENARM: *Examen Nacional de Aspirantes a Residencias Médicas*
Selection rate for Mexico City and Metropolitan Area was 25.73

Figure 2. Geographic regions and ENARM selection rate, Mexico, 2020

tion status of the medical school, type of medical school (public or private), and geographic region.

We consider these findings as a form of validation of the ENARM and provide evidence of the test in relation to other variables.[22,23] This last assumption must be emphasized since other researchers have pointed out the lack of validity evidence regarding the ENARM.[24] Our study provides validity evidence considering terms of sample size and statistical analysis that proves our hypotheses. We expected statistically significant *p*-values because of the population size; nevertheless although effect sizes can be considered small, important information can be obtained in relation to the studied variables. For example, in a real scenario, differences in selection rates around 4% may signify hundreds of candidates in or out of the residency system.

Upon examining accreditation status in relation to ENARM performance, our findings are similar to those encountered by Vázquez-Martínez and colleagues[25] in the ENARM test of 2016. They found a greater selection rate (without statistical significance) for accredited medical schools; however, they did not examine performance (average number of correct answers). In our analysis, examinees belonging to accredited medical schools performed better on ENARM and had a higher selection rate compared to non-accredited medical schools ($p<0.001$); nevertheless, we must acknowledge that these differences (62.5 vs. 61.4 in performance) are marginal and thus must be interpreted properly. Difference in selection rate was somewhat greater (26.2 vs. 22.9%); this specific aspect can be of interest for stakeholders.

In relation to type of medical school (public vs. private), even though differences were not great from a numerical standpoint, examinees belonging to public schools performed better, which augments their probability of being selected for medical residency ($p<0.001$). Although differences were statistically significant, effect sizes were small. We could say that public and private medical schools are at least equivalent in terms of performance and selection rate in ENARM with a tendency of public schools to get better results.

This finding can have several meanings: a) supportive or corrective measures related to assessment and accreditation processes can improve education quality in medical schools; b) the inherent struggle for students to transcend their possible financial constraints by becoming better prepared professionals as a way to accomplish social mobility is enhanced;[26] c) although the number of private medical schools is almost double than that of public ones, because of the probably more lax requirements for the establishment of private institutions and the marked growth in their absolute numbers (e.g. there are over 3 000

medical schools in the world, twice as many as there were 20 years ago),[27] structural and academical limitations may predominate in this group. A similar phenomenon can be seen in other Latin-American countries.[28-30] Our results contrast with those of Hernández-Gálvez;[18] a possible explanation for this is that by having access to raw data we could determine in a more precise way the distinct characteristics of applicants, their performance and selection rates; i.e. means and proportions.

Geographical regions also impact ENARM performance; in our study, based in raw performance data, Northeast and Northwest regions show a better test performance, Center-West, Metropolitan, and Center-South areas are located midway, while South-Southeast areas are placed at the bottom. This reflects the unequal rate of socioeconomic development among regions of the country as well as a heterogeneous distribution of monetary and educational resources (e. g. more resources for Metropolitan areas); the number of applicants by region can give a hint, and an analysis of this situation may enable a thoughtful consideration of inequalities for students.

In our interpretation, general physicians who take the ENARM test are exposed to varied and heterogeneous medical school educational programs, as is the case in other parts of the world;[31] this may be one of the main determinants for varied ENARM performance. This heterogeneity has been demonstrated, and it is rather obvious; some researchers have aimed at identifying medical schools as better or worse, or assigning them places in a competition.[32] The quid of the matter is to know why this difference happens.

In a constructive way, ENARM has recently been more and more criticized in relation to issues of validity and equity;[23,33] for example, internal structure of the test has not been assessed publicly and the use of established psychometric theories, such as classical test theory or item response theory for creation and item analysis in this test is unknown;[33] we believe that our study can shed a light in the issue of validity.

Finally, when using ENARM to make inferences about medical school performances, we must not forget that this is a norm-referenced test; the number of "winners" depends directly on the number of available spots. Moreover, as we do ignore difficulty and discrimination indices at the moment, classifying candidates as underprepared based only on selection rates or means of performance is at least risky. Conversely, although ENARM is not intended to certify medical knowledge or academic quality of medical schools, in our opinion its inherent value lies in being the only test taken from graduates of every medical school in the country. A cautionary note has to be pointed out since the evidence obtained in this aspect is indirect: in terms of validity in education what we see is evidence in relation to other variables and evidence regarding consequences of testing.[22] As figure 1 shows, the performance means of candidates (e.g. 75th percentile above 68.9) indicate that as a whole they are prepared to continue with training as medical residents and somehow point to the quality level of medical education in our country as being adequate; once more, this estimation is indirect.

Previous studies have indicated that in order to align scarce healthcare resources we have to make efforts to know more about "how medical students are trained, who are the students who graduate, and the economic, political, and social factors that foster or hinder the establishment and operation of medical schools".[34,35] Thus, analysis of high-stakes tests like ENARM are valuable and strongly related to these topics.

Conclusion

There is a difference in ENARM performance in examinees from medical schools located in different geographic regions.

Accreditation status can have some impact on performance in ENARM; selection rate shows a little more influence. Nevertheless, because effect sizes are small, this finding has to be interpreted accordingly.

Public and private schools are at least equivalent with respect to performance and selection rate in ENARM.

To the best of our knowledge there have not been analyses of raw data pertaining to ENARM; we consider that this kind of approach allows a more direct and clear interpretation of the related phenomena.

Lastly, at the moment, our analyses is not exhaustive; it is part of a greater research project seeking to identify the most significant variables related to better performance in medical school as well as in summative assessments. This would, in turn, lead to the development and implementation of educational policies that enhance the quality of medical training in our country.

Declaration of conflict of interests. The authors declare that they have no conflict of interests.

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