



Original Article

Discrimination of residents during neurosurgical training in Mexico: Results of a survey prior to SARS-CoV-2

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ABSTRACT

Background: Recent severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic represents an important negative impact on global training of neurosurgery residents. Even before the pandemic, discrimination is a challenge that neurosurgical residents have consistently faced. In the present study, we evaluated discriminatory conditions experienced by residents during their neurosurgical training in Mexico before the SARS-CoV-2 pandemic.

Methods: An electronic survey of 18 questions was sent among residents registered in the Mexican Society of Neurological Surgery (MSNS), between October 2019 and July 2020. Statistical analysis was made in IBM SPSS Statistics 25. The survey focused on demographic characteristics, discrimination, personal satisfaction, and expectations of residents.

Results: A response rate of 50% (132 of 264 residents' members of MSNS) was obtained and considered for analysis. Median age was 30.06 ± 2.48 years, 5.3% ($n = 7$) were female and 16.7% ($n = 22$) were foreigners undergoing neurosurgical training in Mexico. Approximately 27% of respondents suffered any form of discrimination, mainly by place of origin (9.1%), by gender (8.3%) or by physical appearance (6.1%). About 42.9% ($n = 3$) of female residents were discriminated by gender versus 6.4% ($n = 8$) of male residents ($P = 0.001$); while foreign residents mentioned having suffered 10 times more an event of discrimination by place of origin compared to native Mexican residents (36.4% vs. 3.6%, $P < 0.001$).

Conclusion: This manuscript represents the first approximation to determine the impact of discrimination suffered by residents undergoing neurosurgical training in Mexico before the SARS-CoV-2 pandemic.

Keywords: Discrimination, Mexico, Neurosurgery, Resident, Women

INTRODUCTION

Over the past two decades, progress has been observed for gender equality in neurosurgery. An increase in the number of women in neurosurgical training has been expanding in North American programs including the American Board of Neurological Surgery (ABNS)^[20] and the Accreditation Council for Graduate Medical Education (ACGME).^[1,2] In Mexico, the Mexican Society of Neurological Surgery (MSNS)^[14] database reported between 2019 and 2020 that 14.5% of the residents in training were women. Despite a legitimate effort to balance opportunities, gender discrimination rates suffered by women in neurosurgery (WINS) continue to be high with an estimation of 31–77% in published surveys.^[7,10,11,18]

A genuine intention for gender equality with better training opportunities and facilities has been reflected by an increased number of foreign countries residents receiving international neurosurgical training. The United States represents one of the main countries selected by residents to perform neurosurgery, and this has been reflected on published rates of up to 8.9% of foreigner doctors graduated in neurosurgery.^[3,4] Mexico represents the most important destination for Latin America.

Foreign residents usually have a solid research background with greater number of publications and a higher H-index compared to residents of the United States. Even though, their average match rate represents <50% for postgraduate studies in the United States.^[3,4] Discrimination by place of origin represents a substantial disadvantage for foreign residents that have been underestimated and not yet been extensively studied.

In Mexico, there is no history of publications evaluating the impact of discrimination suffered by residents during neurosurgical training before the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic. In this study, we applied for the 1st time a survey to evaluate the discriminatory conditions experienced by residents during their neurosurgical training in Mexico to identify areas of opportunity to improve educational conditions in our country.

MATERIALS AND METHODS

Data were collected from an original online survey created using Google Forms Survey. This survey was sent by email to 264 native and foreigners' residents during neuro-surgical training in Mexico registered in the MSNS between October 2019 and July 2020. The survey consisted of 18 questions and three sections and was answered anonymously [Supplemental Appendix 1]. All results were collected in a Google forms database.

Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics 25. Descriptive analysis was made, and bivariate analysis was

carried out with a Pearson's Chi-square test. The impact of discrimination suffered by women and foreigners' residents during neurosurgical training in Mexico was analyzed. In addition, academic and technological resources, specialty and surgical resources, number of operating rooms, monthly admissions, and number of major surgeries were analyzed to observe the impact on the degree of academic and training satisfaction, as well as current and future expectations.

RESULTS

Survey responses: Demographic information

The survey was sent to 264 Mexican residents in training through email and we obtained a response rate of 51.14% ($n = 135$). Three surveys were eliminated due to incomplete fulfilling of all the fields required. A total of 132 responses were considered for the analysis. Median age was 30.06 ± 2.48 years, 5.3% ($n = 7$) were female, and 16.7% ($n = 22$) were foreigners. About 74.2% ($n = 98$) of the responders were junior residents (PGY 1-3) [Table 1].

Gender: Female and male

About 42.9% ($n = 3$) of female residents were discriminated by gender against 6.4% ($n = 8$) of male residents ($P = 0.001$) [Figure 1]. However, 85.7% of female residents mentioned high expectations of having a formal job at the end of their residency, compared to 75.2% of male residents ($P = 0.040$) [Figure 2]. Additional variables were not statistically significant [Table 2]. Only seven women answered the survey, two were foreigners. About 84% ($n = 105$) of the male residents were Mexican while 16% ($n = 20$) were foreigners. A higher response rate of junior residents was observed regardless of gender (85.7% of women [$n = 6$] and 73.6% of men [$n = 92$] were junior residents).

Table 1: Socio-demographic information.

Age (years)	30.06 SD±2.48 (Range 25–38)
Gender (%)	
Male	125 (94.7)
Female	7 (5.3)
PGY (%)	
1	51 (38.6)
2	26 (19.7)
3	21 (15.9)
4	18 (13.6)
5	16 (12.1)
Place of origin	
Mexican	110 (83.3)
Foreign	22 (16.7)

Table 2: Results by gender.

Variable	Female n (%)	Male n (%)	P-value
Place of origin			
Foreign	2 (28.6)	20 (16)	0.385
Mexican	5 (71.3)	105 (84)	
Degree of satisfaction			
Satisfied with the academic program of your center	5 (71.4)	98 (78.4)	0.665
Satisfied with your professors	5 (71.4)	92 (73.6)	0.899
Balance between workload and training	5 (71.4)	85 (68)	0.850
Does your training center fulfill your expectations at arrival	5 (71.4)	97 (77.6)	0.705
Do you agree with the sanctions applied to residents for indiscipline	7 (100)	112 (89.6)	0.369
Discrimination			
Gender	3 (42.9)	8 (6.4)	0.001*
Race	0 (0)	2 (1.6)	0.736
Social status	0 (0)	4 (3.2)	0.631
Economic status	0 (0)	5 (4)	0.590
Place of origin	1 (14.3)	11 (8.8)	0.623
Sexual orientation	0 (0)	1 (0.8)	0.812
Physical appearance	0 (0)	8 (6.4)	0.490
Age	0 (0)	2 (1.6)	0.736
Resident training year	0 (0)	2 (1.6)	0.736
Expectations			
Your current expectations will be fulfilled during your residency	6 (87.5)	107 (85.6)	0.993
Expectations of a formal job after completing residency training			
Uncertain	0 (0)	29 (23.2)	0.040*
Low	1 (14.3)	2 (1.6)	
High	6 (85.7)	94 (75.2)	
Expectations after residency			
Work at a public institution	3 (42.9)	64 (51.2)	0.667
Work at a private institution	2 (28.6)	78 (62.4)	0.075
Subspecialty/Fellowship	6 (85.7)	99 (79.2)	0.678
Teaching	1 (14.3)	35 (28)	0.428
Investigation (Master's Degree or Doctorate)	2 (28.6)	33 (26.4)	0.899
Is neurosurgery at a hospital level ii facility adequate for a neurosurgical practice	1 (14.3)	30 (24)	0.555

P-value obtained by Pearson's χ^2

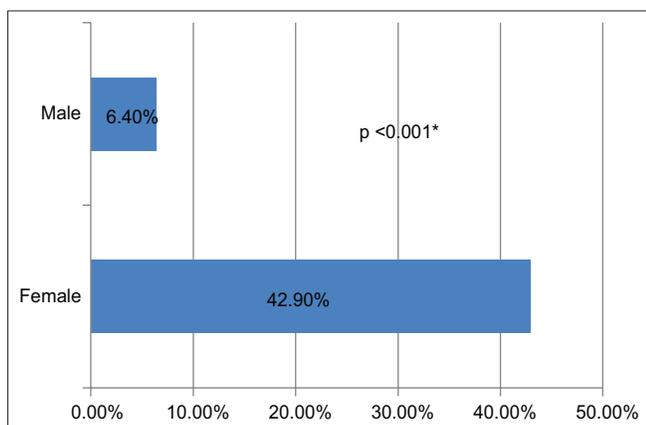


Figure 1: Gender discrimination. *Statistically significant variables ($P < 0.05$), P-value obtained by Pearson's χ^2 .

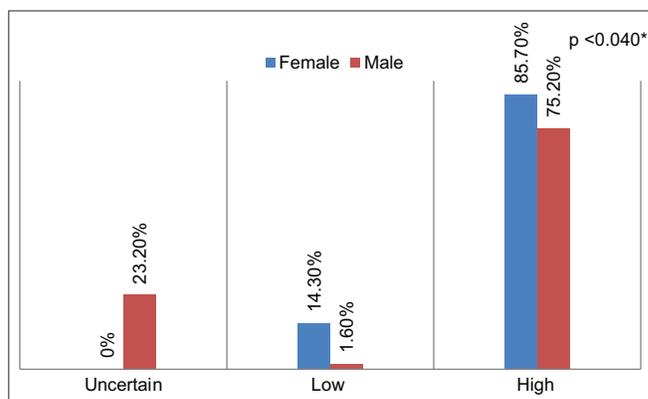


Figure 2: Analysis by gender of the expectations of getting a formal job at the end of the residence. *Statistically significant variables ($P < 0.05$), P-value obtained by Pearson's χ^2 .

Place of origin: Foreign and Mexican resident trainers

More than three-quarters of Mexican residents reported being satisfied with the tutoring of their professors compared to 54% of foreign residents ($P = 0.027$). Foreign residents mentioned having suffered 10 times more an event of discrimination by place of origin compared to Mexican residents (36.4% vs. 3.6%, $P < 0.001$) [Figure 3]. Mexican residents prefer to work in private institutions at the end of their training (64.5% vs. 40.9%, $P = 0.038$). However, most foreign residents wanted to take a subspecialty or fellowship course (81.8% vs. 79.1, $P = 0.772$). About 45.5% of foreign residents mentioned that the second level is adequate for the development of neurosurgical practice compared to 19.1% of Mexican residents ($P = 0.008$) [Table 3].

Junior and senior residents

Most of the survey respondents were junior residents (74.2%). Junior residents answered that they had a predilection for

taking a sub-specialty or fellowship course after completing their residency (86.7% vs. 58.8%, $P = 0.001$) [Figure 4], while most senior residents wanted to work in a private institution

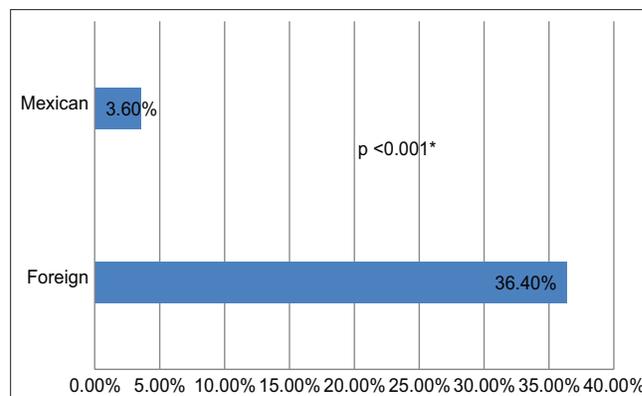


Figure 3: Discrimination of residents by place of origin. *Statistically significant variables ($P < 0.05$), P -value obtained by Pearson's χ^2 .

Table 3: Results by place of origin.

Variable	Foreign n (%)	Mexican n (%)	P-value
Satisfaction with the program of your campus	15 (68.2)	88 (80)	0.222
Satisfaction with your professors' teachings	12 (54.5)	85 (77.3)	0.027*
Balance between workload and training	13 (59.1)	77 (70)	0.316
Does your training center fulfill your expectations at arrival	15 (68.2)	87 (79.1)	0.265
Do you agree with the sanctions applied to residents for indiscipline	20 (90.9)	99 (90)	0.896
Discrimination			
Gender	1 (4.5)	10 (9.1)	0.481
Race	0 (0)	2 (1.8)	0.524
Social Status	1 (4.5)	3 (2.7)	0.650
Economic Status	1 (4.5)	4 (3.6)	0.838
Place of origin	8 (36.4)	4 (3.6)	<0.001*
Sexual Orientation	0 (0)	1 (0.9)	0.653
Physical appearance	2 (9.1)	6 (5.5)	0.514
Age	0 (0)	2 (1.8)	0.524
Resident training year	0 (0)	2 (1.8)	0.524
Expectations			
Your current expectations will be fulfilled during your residency	20 (90.9)	93 (84.5)	0.438
Expectations of a formal job after completing residency training			
Uncertain	4 (18.2)	25 (22.7)	0.637
Low	0 (0)	3 (2.7)	
High	18 (81.8)	82 (74.5)	
Expectations after residency			
Work at a public institution	7 (31.8)	60 (54.5)	0.052
Work at a private institution	9 (40.9)	71 (64.5)	0.038*
Subspecialty/Fellowship	18 (81.8)	87 (79.1)	0.772
Teaching	3 (13.6)	33 (30)	0.116
Investigation (Master's Degree or Doctorate)	5 (22.7)	30 (27.3)	0.659
Is neurosurgery at a second level facility adequate for a neurosurgical practice	10 (45.5)	21 (19.1)	0.008*

P-value obtained by Pearson's χ^2

(67.6 vs. 58.2%, $P = 0.329$). The rest of the variables were not statistically significant.

Discrimination

The main causes of discrimination were discrimination by place of origin, followed by discrimination by gender and discrimination by physical appearance [Figure 5]. However, more than 70% of those surveyed mentioned not being discriminated against. Women presented higher rates of discrimination compared to men (57.1% vs. 25.6%, $P = 0.68$), mainly discrimination by gender (42.9% vs. 6.4%, $P < 0.001$). Mexicans presented the lower discrimination rates compared to foreign residents with neurosurgical training in Mexico (45.5% vs. 23.6%, $P = 0.036$). The year of neurosurgical training did not present differences for discrimination. The residents who did not suffer discrimination presented higher rates of academic satisfaction, mainly in the teaching given by their teachers (77.3% vs. 22.7%, $P = 0.049$), a greater balance between workload and training (78.9% vs. 21.1%, $P = 0.020$), and contradictorily the residents who did not

suffer from discrimination agreed with the sanctions applied to the residents for indiscipline (76.5% vs. 23.5%, $P = 0.003$). Discriminated residents had the lowest rates of expectations of getting a job at the end of their residency (100% vs. 0%, $P = 0.013$), while almost three-quarters of residents who did not suffer from discrimination had high expectations of getting a formal job at the end of their residency ($P = 0.013$), mainly in a public institution (80.6%, $P = 0.039$) [Table 4].

Characteristics of neurosurgical training centers

Respondents mentioned an average number of operating rooms per hospital of 2.7 SD \pm 1.23 (Range 1–4), a mean of monthly admissions of 105.48 SD \pm 90.5 (Range 54–200), and a mean of major surgeries performed monthly of 63.73 SD \pm 33.2 (Range 21–136). We observed that centers with four operating rooms had larger educational resources, more subspecialties facilities, and a greater amount of technological resources [Figure 6 and Appendix 2]. However, it was not observed that the volume of surgeries and hospital admissions reflected in the number of operating rooms influenced the discrimination rates suffered by residents with neurosurgical training in Mexico (results are not shown because they were not statistically significant).

DISCUSSION

Discrimination is a problem of global impact in surgical residencies. A recent study carried out in Latin America by the AO Spine Latin America association reported that only 12.11% of the members are women ($n = 27$). Gender discrimination is an important topic and approximately 67% of the women reported having been discriminated against by gender (66.67% vs. 1.02%) and 81% of the women mentioned being discouraged from becoming spinal surgeons or neurosurgeons (81.48% vs. 0.51%) in this study.^[8] In turn, women reported higher rates of sexual harassment (44.44% vs. 7.65%) and more often felt fewer job opportunities (55.56% vs. 2.55%).^[8] In Mexico, gender discrimination has been previously mentioned in an historical context.^[13] However, no studies have been published evaluating discrimination and its impact on women and foreigners who carry out their residency in Mexico.

Conventionally, in medical literature, neurosurgical centers have been classified into low and high volume; by the amount of patients, annual admissions, number of major surgeries performed, subspecialties or technological resources, and the number of subarachnoid hemorrhages admitted per year.^[15,25] However, an association between the size of the center and the impact on the degree of discrimination suffered by residents has not been investigated. In our results, it was not observed that the volume of surgeries and hospital admissions reflected in the number of operating rooms

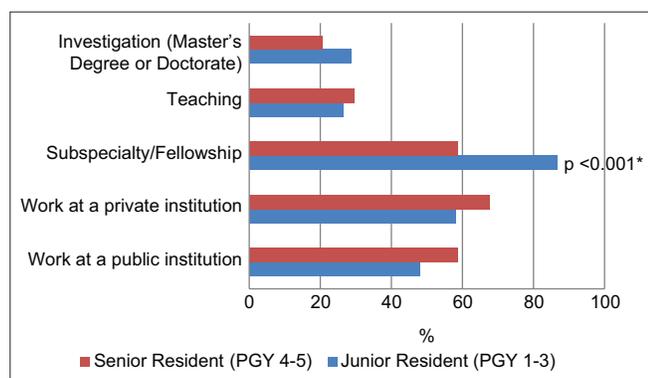


Figure 4: Analysis by year of neurosurgical training and work plans at the end of the residency. *Statistically significant variables ($P < 0.05$), P -value obtained by Pearson's χ^2 .

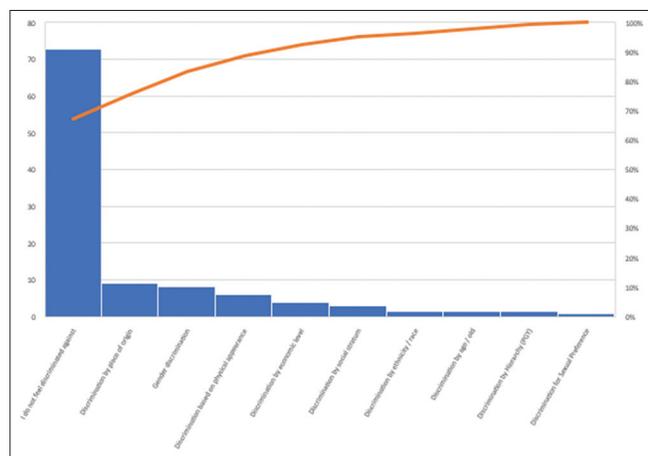


Figure 5: Main causes of discrimination.

Table 4: Results by discrimination.

Variable	Did you suffer from discrimination?		P-value
	Yes n (%)	No n (%)	
Gender			
Woman	4 (57.1)	3 (42.9)	0.068
Male	32 (25.6)	93 (74.4)	
Place of origin			
Foreign	10 (45.5)	12 (54.5)	0.036*
Mexican	26 (23.6)	84 (76.4)	
Resident Junior (PGY 1–3)	24 (24.5)	74 (75.5)	0.223
Resident Senior (PGY 4–6)	12 (35.3)	22 (64.7)	
Degree of satisfaction			
Satisfied with the academic program of your center	27 (26.7)	76 (73.8)	0.607
Satisfied with your professors	22 (22.7)	75 (77.3)	0.049*
Balance between workload and training	19 (21.1)	71 (78.9)	0.020*
Does your training center fulfill your expectations at arrival	26 (25.5)	76 (74.5)	0.396
Do you agree with the sanctions applied to residents for indiscipline	28 (23.5)	91 (76.5)	0.003*
Expectations			
Your current expectations will be fulfilled during your residency	30 (26.5)	83 (73.5)	0.649
Expectations of a formal job after completing residency training			
Uncertain	6 (20.7)	23 (79.3)	0.013*
Low	3 (100)	0 (0)	
High	27 (27)	73 (73)	
Expectations after residency			
Work at a public institution	13 (19.4)	54 (80.6)	0.039*
Work at a private institution	19 (23.8)	61 (76.3)	0.260
Subspecialty/Fellowship	29 (27.6)	76 (72.4)	0.860
Teaching	7 (19.4)	29 (80.6)	0.216
Investigation (Master's Degree or Doctorate)	6 (17.1)	29 (82.9)	0.116

P-value obtained by Pearson's χ^2

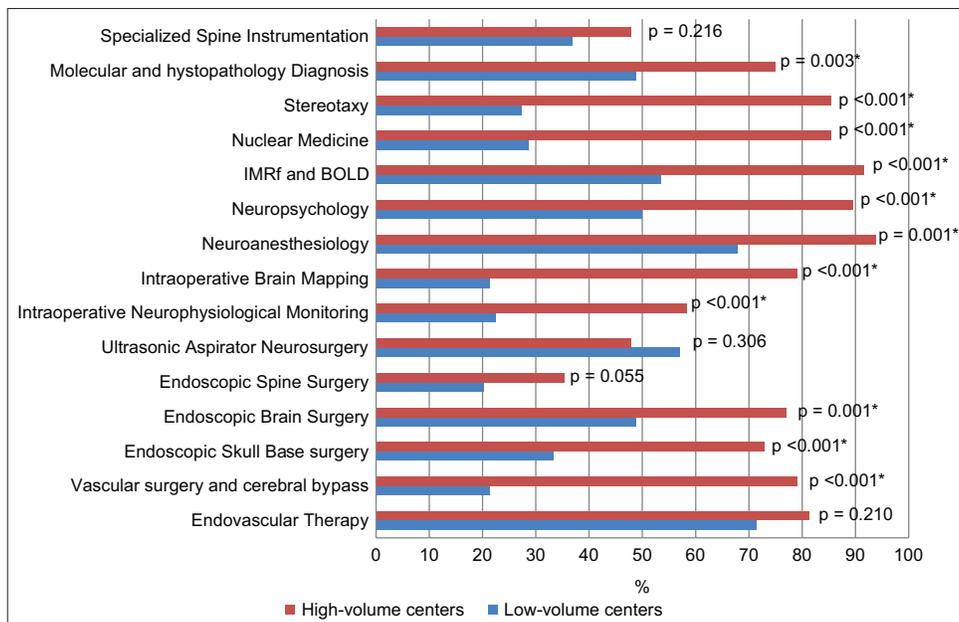


Figure 6: Hospital characteristics: Technological and multidisciplinary resources. *Statistically significant variables ($P < 0.05$), P-value obtained by Pearson's χ^2 .

influenced discrimination rates suffered by residents with neurosurgical training in Mexico.

WINS training

The ABNS reports that 66 female neurosurgeons were trained between the years 2011–2016 (an average of 11 neurosurgeons per year). Before this data, the ABNS mentions an annual rate of 7.58 neurosurgeon women trained between the years 1964 and 2013.^[20] The ACGME mentions an increase from 11% in 2008^[1] to 19.3% in 2020^[2] of female neurosurgery residents in the last 12 years. The aforementioned data support the increase in the number of women and their growing impact on neurosurgery today representing an advance in gender equality within medicine. The MSNS reported that 14.5% of neurosurgery residents are women in 2020.^[14] Nevertheless, in our survey, only seven women responded, two women were foreigners, and five were natives of Mexico, which prevents us from knowing the real impact that women experience in our country. This report makes us aware of the persistence around this taboo due to the low response of women to the survey (this is partly because cultural practices may be implicated). Despite advances obtained in the past two decades with an increase in the number of WINS, it is important to highlight that female population within neurosurgery is still <20% even on first world countries.^[11]

Foreigner in training in neurosurgery

In our study, 16.7% of the participants were foreigners who are undergoing their neurosurgery residency in Mexico. In contrast, <9% of graduated neurosurgeons in the United States are foreigners.^[4,12,22] We consider that Mexico represents one of the most important destinations for neurosurgical training for the rest of the Latin American countries. The results of the survey identify a clear perception of discrimination concerning the place of origin among foreign residents compared to native Mexican residents. About 37% of foreign residents reported feeling discrimination at some point during the training compared to 4% of Mexican residents ($P < 0.001$). Gadjraj *et al.* published that ethnic minorities presented a 3.8 times risk of being victims of discrimination (odds ratio [OR] 3.8, 95% confidence interval [CI] 2.3–6.2).^[10] There is no previous report in Latin America about the subject.

Discrimination in neurosurgery training

Despite recent advances that report an increase in the presence of WINS^[1,2,20] and the fight for equal opportunities for foreigners,^[4,12,22] achieving gender and race equality is an unavoidable challenge for Mexico as an inclusive society and for Neurosurgery at a global level. Nowadays, discrimination

is an undeniable problem.^[5,7,9-11,19,24] The survey identified that women presented higher rates of discrimination compared to men (57.1% vs. 25.6%, $P = 0.68$), mainly discrimination by gender (42.9% vs. 6.4%, $P < 0.001$). Mexicans presented lower discrimination indices compared to foreign residents with neurosurgical training in Mexico (45.5% vs. 23.6%, $P = 0.036$).

The previous studies have reported that men surpass academic and occupational productivity compared to women. We consider that these results may be biased by a gender-based discrimination and reduced presence of women in these reports.^[16,23] Other authors have published that racial and gender diversity has been associated with better patient outcomes and quality of care.^[11,17,21,26] Although this was not an objective in our study, we consider that our results constitute areas of opportunity to be considered in subsequent studies. Our study provides initial information to analyze in a further research the causes related to the association between discrimination and academic productivity affected by gender or ethnicity.

Several authors have documented support against discrimination experienced by WINS.^[5,7,9,11,19,24] Our results show that approximately 7 times more women suffer gender discrimination than men (42.9% vs. 6.4%, $P < 0.001$). Recently, an analysis of women in academic departments of surgery, indicates that women were up to 10 times more likely than men to notice gender discrimination.^[5,11]

Gender discrimination experienced by WINS has been evaluated globally. Gupta *et al.* (2020)^[11] describes a discrimination perception rate from 31% to 77% ($n = 126$) by WINS. It is disappointing that 77% of women who are planning to have children are concerned about being segregate by their colleagues. Although we did not explore the origin of discrimination in our survey, this is an important issue because the majority of neurosurgery residents are traditionally male, and perhaps this resumes a tendency to assume conventional sexist attitudes in the specialty.

In Mexico, the MSNS^[14] database reported a presence of WINS of 14.5% between 2019 and 2020. The response rate of women in our survey did not meet our expectations and was only 2.6% ($n = 7$). Even though, the rate of perception of gender discrimination among women in our survey was significantly higher compared to men (42.9% vs. 6.4%, $P < 0.001$). Another study from India describes a total of 69 women registered in neurosurgery practice, of which 34.54% ($n = 19$) were residents and 40% of those who answered the survey mentioned being discriminated by gender ($n = 22$).^[18] A conducted survey distributed among members of the congress of neurological surgeons (CNS) showed that 61.4% of respondents were victims of abusive behavior and 47.9% suffered any form of discrimination. Women surveyed were 2.5 times more likely to be victims of abuse (OR 2.5;

95% CI: 1.4–4.6) and 19.8 times more likely to be victims of discrimination (OR 19, 8, 95% CI: 8.9–43.9); followed by ethnic minorities who had 3.8 times the risk of being victims of discrimination. (OR 3.8, 95% CI 2.3–6.2).^[10] In addition, they observed that victims of abuse presented approximately 2 times the risk of presenting burnout (OR 1.7, 95% CI 1.1–2.6).^[10] We must emphasize that this was not a topic evaluated in our survey.

A perception of disadvantage for being women compared to men is clear. Factors such as a paucity of women mentors in neurosurgery, lack of work-life balance, absence of support in academic fields, perception of a reduced access to professional opportunities due to gender, and a sense of having to work harder than men for the same prestige^[7,8] coupled with the high rates of gender discrimination, abuse, and sexual harassment are some of the problems that have been detected in most of the responses obtained in the multiple surveys applied internationally.^[7,8,10,11,18] This information has inspired the creation of several women's advocacy associations, such as the Women's Committee in AO Spine.^[8] Although the organization WINS was established 30 years ago to promote the inclusion and advancement of women in the field, only in 2014 was it recognized as a joint chapter of the American Association of Neurological Surgeons and the CNS.^[11] This reflects a reluctant recognition of the important role of WINS and the current challenge facing gender discrimination.

Strengths and limitations of the study

In another study (De la Cerda-Vargas *et al.*, 2021), we evaluated the impact of COVID on neurosurgery residents in Latin America and Spain.^[6] 67% of residents reported that COVID negatively impacted their residence while 54% mentioned that their physical and mental health were compromised. However, the impact of discrimination suffered by residents was not identified. The results of the present survey obtained before SARS-CoV-2 pandemic identifies alternative areas such as discrimination which negatively impact neurosurgical training and have been present for decades. In Mexico, there is no history of publications evaluating the impact of discrimination suffered by residents during neurosurgical training before the SARS-CoV-2 pandemic.

Due to the restricted number of women and foreigners undergoing neurosurgical training in Mexico who responded to the survey, our results do not allow us to enunciate strong conclusions. Nevertheless, this study represents an initial assessment of the problem which requires a greater number of respondents to calculate the real impact in Mexico or even in Latin America. We did not evaluate the burden of discrimination on the burnout rates suffered by residents,^[10] abuse, mistreatment, or sexual harassment.^[10]

CONCLUSION

Our results determine the situational diagnosis that neurosurgery residents experienced in Mexico before the SARS-CoV-2 pandemic. We believe that identifying issues that our residents face on a day-to-day basis is essential to upgrade educational and social relationships. This study pretends to recognize areas of opportunity to reduce the rate of discrimination suffered by residents who receive neurosurgical training in Mexico. Specific strategies targeted to our neurosurgical community aimed at improving a balance of opportunities among residents are a priority to reduce discrimination by gender and place of origin. Our study represents the first approach to determine the impact of discrimination suffered by women and foreign residents with neurosurgical training in Mexico before the SARS-CoV-2 pandemic.

Acknowledgments

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Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Declaration of patient consent

Patient's consent not required as patients identity is not disclosed or compromised.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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APPENDIX

Appendix 1: Survey.

National Survey of Neurosurgery Residents in Training

Neurosurgical training center:

PGY:

Age:

Gender:

Country of Origin:

Situational diagnostic:

1. Has your neurosurgical training center its own academic program?
Yes () Not ()
 2. Is the practice in your neurosurgical training center tutorial? (Topics or cases are supervised by associate professors)
Yes () Not ()
 3. Choose the educational methodology of your neurosurgical training center:
Monographic lectures given by a resident. Yes () Not ()
Monographic classes given by a teacher. Yes () Not ()
Discussion of morbimortality cases. Yes () Not ()
Discussion of cases with related specialties. Yes () Not ()
Internal rotations. YES () Not ()
External rotations. Yes () Not ()
Foreign rotations. Yes () Not ()
 4. Technological resources essential for neurosurgical training.
Basic neurosurgical instruments. Yes () Not ()
Basic spine surgery instruments. Yes () Not ()
Drilling tools. Yes () Not ()
Microscope. Yes () Not ()
Fluoroscope. Yes () Not ()
Neuronavigation. Yes () Not ()
Microscope with fluorescein filter. Yes () Not ()
 5. Sub-specialties technological resources
Endovascular therapy. Yes () Not ()
Vascular surgery and cerebral bypass. Yes () Not ()
Endoscopic skull base surgery. Yes () Not ()
Endoscopic brain surgery. Yes () Not ()
Endoscopic spine surgery. Yes () Not ()
Ultrasonic aspirator neurosurgery. Yes () Not ()
Intraoperative neurophysiological monitoring. Yes () Not ()
Intraoperative brain mapping. Yes () Not ()
Neuroanesthesiology. Yes () Not ()
Neuropsychology. Yes () Not ()
IMRF and BOLD. Yes () Not ()
Nuclear medicine. Yes () Not ()
Stereotaxy. Yes () Not ()
Molecular and histopathology diagnosis. Yes () Not ()
Specialized spine instrumentation. Yes () Not ()
 6. How many operating rooms does your hospital have?
-

7. How many admissions per month does your training center have?

8. How many major surgeries per month are performed in your hospital?

Satisfaction diagnosis:

9. Are you satisfied with the academic program of your center?

Yes () Not ()

10. Are you satisfied with the instruction and tutoring of your professors?

Yes () Not ()

11. Has the relationship between practice and learning an adequate balance for your learning in your center?

Yes () Not ()

12. Does your neurosurgical training meet the expectations that you had before your admittance to residency?

Yes () Not ()

13. Do you agree that failure to comply with obligations as a resident in training should be punished?

Yes () Not ()

14. Mention if you consider yourself discriminated for any of these reasons:

Gender _____

Social stratum _____

Race _____

Birthplace _____

Sexual preference _____

Physical Appearance _____

Age _____

Other (Mention the reason) _____

I Do not feel discriminated _____

Diagnosis of Expectations:

15. Do you consider that your current expectations will be fulfilled during the course of your residence?

Yes () Not ()

16. At the end of your residence you plan for your practice is:

Working in a public institution _____

Working in a private institution _____

Subspecialty/fellowship _____

Teaching activity _____

Research activity (Includes master/doctorate) _____

17. Your expectations of obtaining formal job at the end of your residence are:

High _____

Uncertain _____

Low _____

18. Do you consider that the medicine in a second level hospital in Mexico allows an adequate development of the practice of neurosurgery?

Yes () Not ()

Appendix 2: Results by hospital group.			
Variable	<4 operating rooms	4 or more operating rooms	P-value
Gender			
Female	6 (7.1)	1 (2.1)	0.212
Male	78 (92.9)	47 (97.9)	
Place of origin			
Foreign	18 (21.4)	4 (8.3)	0.052
Mexican	66 (78.6)	44 (91.7)	
Level of satisfaction			
Satisfaction with the program of your campus	58 (69)	45 (93.8)	0.001*
Satisfaction with your professors' teachings	56 (66.7)	41 (85.4)	0.019*
Balance between workload and training	53 (63.1)	37 (77.1)	0.097
Does your training center fulfill your expectations at arrival	58 (69)	44 (91.7)	0.003*
Do you agree with the sanctions applied to residents for indiscipline	74 (88.1)	45 (93.8)	0.294
Discrimination			
Gender	7 (8.3)	4 (8.3)	1.000
Race	0 (0)	2 (4.2)	0.059
Social Status	1 (1.2)	3 (6.3)	0.103
Economic Status	2 (2.4)	3 (6.3)	0.263
Place of origin	8 (9.5)	4 (8.3)	0.819
Sexual orientation	0 (0)	1 (2.1)	0.184
Physical appearance	3 (3.6)	5 (10.4)	0.113
Age	1 (1.2)	1 (2.1)	0.686
Academic year	1 (1.2)	1 (2.1)	0.686
Expectations			
Your current expectations will be fulfilled during your residency	71 (84.5)	42 (87.5)	0.639
Expectations of a formal job after completing residency training			
Uncertain	17 (20.2)	12 (25)	0.361
Low	3 (3.6)	0 (0)	
High	64 (76.2)	36 (75)	
Expectations after residency			
Work at a public institution	42 (50)	25 (52.1)	0.818
Work at a private institution	53 (63.1)	27 (56.3)	0.439
Subspecialty/Fellowship	65 (77.4)	40 (83.3)	0.415
Teaching	18 (21.4)	18 (37.5)	0.046*
Investigation (Master's Degree or Doctorate)	13 (15.5)	22 (45.8)	<0.001*
Is neurosurgery at a hospital level II facility adequate for a neurosurgical practice	23 (27.4)	8 (16.7)	0.162
Academic resources of the hospital			
Hospital's own academic program	82 (97.6)	48 (100)	0.281
Tutorial teaching	63 (75)	44 (91.7)	0.019*
Classes by residents	83 (98.8)	43 (89.6)	0.014*
Classes by professors	23 (27.4)	37 (77.1)	<0.001*
Discussion sessions	55 (65.5)	45 (93.8)	<0.001*
General sessions	59 (70.2)	44 (91.7)	0.004*
Internal rotations	52 (61.9)	44 (91.7)	<0.001*
External rotations	69 (82.1)	44 (91.7)	0.134
Foreign rotations	52 (61.9)	44 (91.7)	<0.001*
Technological and subspecialty resources			
Endovascular therapy	60 (71.4)	39 (81.3)	0.210
Vascular surgery and cerebral bypass	18 (21.4)	38 (79.2)	<0.001*

(Contd...)

Appendix 2: (Continued).

Variable	<4 operating rooms	4 or more operating rooms	P-value
Endoscopic skull base surgery	28 (33.3)	35 (72.9)	<0.001*
Endoscopic brain surgery	41 (48.8)	37 (77.1)	0.001
Endoscopic spine surgery	17 (20.2)	17 (35.4)	0.055
Ultrasonic aspirator neurosurgery	48 (57.1)	23 (47.9)	0.306
Intraoperative neurophysiological monitoring	19 (22.6)	28 (58.3)	<0.001*
Intraoperative brain mapping	18 (21.4)	38 (79.2)	<0.001*
Neuroanesthesiology	57 (67.9)	45 (93.8)	0.001*
Neuropsychology	42 (50)	43 (89.6)	<0.001*
IMRf and BOLD	45 (53.6)	44 (91.7)	<0.001*
Nuclear medicine	24 (28.6)	41 (85.4)	<0.001*
Stereotaxy	23 (27.4)	41 (85.4)	<0.001*
Molecular and histopathology diagnosis	41 (48.8)	36 (75)	0.003*
Specialized spine instrumentation	31 (36.9)	23 (47.9)	0.216
Transoperative resources			
Basic neurosurgical instruments	83 (98.8)	48 (100)	0.448
Basic spine surgery instruments	77 (91.7)	47 (97.9)	0.148
Drilling tools	62 (73.8)	46 (95.8)	0.002*
Microscope	81 (96.4)	48 (100)	0.185
Fluoroscope	64 (76.2)	43 (89.6)	0.059
Neuronavigation	26 (31)	38 (79.2)	<0.001*
Microscope with fluorescein filter	9 (10.7)	29 (60.4)	<0.001*
Number of operating rooms by center			
≥4	0 (0)	100 (40)	<0.001*
<4	100 (84)	0 (0)	
Admissions by month			
≥125	0 (0)	100 (40)	<0.001*
<125	100 (84)	0 (0)	
Major surgeries by month			
≥84	0 (0)	100 (40)	<0.001*
<84	100 (84)	0 (0)	

P-value obtained by Pearson's χ^2 , IMRf: Functional magnetic resonance imaging, BOLD: Blood oxygenation level-dependent imaging