RESEARCH ARTICLE

Iran's Orthopaedic Landscape: Distribution, Per-capita Ratios, Female Inclusion, and Academic Standing among Residents and Surgeons

Amir Human Hoveidaei, MD, MSc, Health MBA; Mohammad Amin Khadembashiri, MD; Mohammad Reza Ramezanpour, MD; Omid Bahrami, MD; Reza Niakan, MD; Fatemeh Rashidi, MD; Sina Esmaeili, MD

Research performed at Rubin Institute for Advanced Orthopedics, Sinai Hospital of Baltimore, Baltimore, Maryland, USA

Received: 27 September 2024 *Accepted: 22 January 2025*

Abstract

Objectives: Iran's orthopaedic surgery care is facing significant challenges due to an aging population and the increasing prevalence of chronic medical conditions such as osteoarthritis, fractures, and trauma. These challenges underscore the pressing need for a more equitable distribution of the orthopaedic workforce. This study aimed to assess the per capita ratios and geographical distribution of orthopaedic surgeons (OSs) in Iran, as well as their distribution in academic and non-academic settings. Additionally, the involvement and scientific productivity of women in orthopaedic s were examined.

Methods: This study investigated the distribution, per-capita ratios, and academic status of OSs and trainees in Iran, and compared these parameters with those in Turkey and the UK. This study used data from the Islamic Republic of Iran Medical Council, the Iranian Scientometrics Information Database, and the population census to indicate an uneven distribution of OSs across Iran.

Results: The per capita ratio of OSs in Iran (3.13) is lower than in Turkey (4.00) and the United Kingdom (8.00), highlighting disparities in healthcare infrastructure and economic resources in low-income countries. Notably, 33.6% of Iranian OSs reside in Tehran, contributing to unequal access to care. Furthermore, female representation in orthopaedic s remains limited, with only 3.5% of OSs being women. These academic surgeons have a median H-index of 4, which is lower than that of their counterparts in Canada and the United States.

Conclusion: The study emphasized the significance of governmental reforms and incentives in promoting equitable distribution, gender diversity, and academic progress within Iran's orthopaedic workforce. Financial incentives, advanced facilities, and career advancement opportunities could enhance academic involvement and diversity. Improving the distribution of surgeons, increasing support for women in orthopaedic, and fostering academic interests are essential steps toward achieving equitable healthcare and boosting scientific output in Iran.

Level of evidence: IV

Keywords: Gender disparity, Orthopaedic surgeon, Orthopaedic workforce distribution, Orthopaedics

Introduction

The landscape of orthopaedic surgical care is constantly evolving due to the aging population and the prevalence of chronic medical conditions, such as osteoarthritis, fractures, and trauma.[1-3] The equitable distribution of the orthopaedic workforce is of significant importance within the healthcare sector, particularly as the demand for these professionals is projected to rise with the aging population.[4,5] Several factors, including societal and economic disparities, the structure of medical education, and financial incentives,[6] have been shown in previous

Corresponding Author: Amir Human Hoveidaei, International Center for Limb Lengthening, Rubin Institute for Advanced Orthopedics, Sinai Hospital of Baltimore, Baltimore, Maryland, USA

Email: hoveidaei.a.h@gmail.com

THE ONLINE VERSION OF THIS ARTICLE ABJS.MUMS.AC.IR

studies to contribute to the global inequality and lack of fairness in the distribution of orthopaedic surgeons (OSs).[7,8] Iran, with a population exceeding 80 million, exhibits an uneven geographical distribution of orthopaedic services across its provinces.[9,10]

The workforce is adaptable to working in both academic and non-academic environments. Faculty members in the field of orthopaedic surgery and related areas who work in academic settings are more likely to advance in their careers. They tend to be more productive, utilizing their specialized knowledge, authoritative positions, and influential capabilities to strategically guide the allocation of resources aimed at workplace innovation and resident training proficiency.[11-15]

One of the benefits of academic practice is the increase in diversity within the field of orthopaedic surgery.[16] It is well documented that orthopaedic surgery societies worldwide lack diversity.[17,18] The underrepresentation of women in orthopaedic surgery and the negative impact of city size on the representation of underrepresented minorities in orthopaedic surgery have been highlighted in several previous studies.[19-21] In some countries, such as the United States, the presence of women in medicine, particularly in orthopaedic surgery, has led to significant positive improvements.[22,23] However, this is not the case in other parts of the world, and there is limited information regarding the presence of women in orthopaedic surgery in developing countries or the underrepresentation of women in this field.[24] Women working in orthopaedic surgery in developed countries have demonstrated higher productivity and H-index compared to those in other countries.[25,26]

Considering that none of the information related to the orthopaedic workforce exists in Iran, this study aims to answer the following questions:

1- What are the Per Capita Ratios and geographical Distribution of OSs in Iran? And its comparison with per capita in Turkey due to its similar geographical, cultural, and incidence of musculoskeletal disorders (MSDs), proximity to Iran[27-29] and the United Kingdom (UK) due to its prominent status as one of the world's largest healthcare systems and the success rate of conservative treatment for MSDs.[30,31]

2- How is the orthopaedic workforce distributed in non-academic and academic environments?

3- How is the presence of women in orthopaedics in non-academic and academic environments, and their scientific productivity in the academic environment?

Materials and Methods

Overview and Ethical Approval

This cross-sectional study was conducted using publicly accessible data sources; therefore, ethical approval was deemed exempt. All data for this study were collected on May 15, 2024.

Data Source

We utilized the membership database of the Islamic Republic of Iran Medical Council (IRIMC),[32] the most significant data source in Iran, which contains information on all Iranian doctors. Data on academic surgeons was obtained from the Iranian Scientometrics Information Database (ISID).[33] The national residency program booklets published by Iran's Medical Education Assessment Center (Sanjesh)[34] were reviewed in 2020–2023. Population data were gathered from census information provided by the Statistical Center of Iran,[35] the most recent survey conducted by national authorities. A study by Madanat et al. in 2017[36] reviewed the number of OSs and orthopaedic trainees (OTs) in Turkey and the UK. Additionally, surgeon H-indices were collected from Scopus.

Variables

The province of employment and sex were evaluated for each surgeon. In addition, academic rank (assistant professor, associate professor, and professor), affiliated university, and H-index were extracted for academic surgeons. The number of first-year to last-year orthopaedic residents (ORs) in each province was obtained. Population data for each of Iran's 31 provinces were collected. Also, the number of OSs and OTs in Turkey and the UK was extracted.

Statistical analysis

Surgeons working in multiple practice locations were considered based on their primary province of employment, with no surgeons having various practice locations. Only OSs with active practice licenses were included. Retired academic surgeons and those without a Scopus profile were excluded. The per capita ratio of OSs and ORs for each province was calculated and reported per 100,000 population. This analysis was conducted separately based on gender and academic activation status. The Mann-Whitney U test was used to compare the H-indices of male and female surgeons, given the variable skewness. The mean H-index of academic surgeons in each province was calculated. Pearson correlation tests were used to determine the associations between the mean H-index and three variables: the number of ORs, the percentage of female academics, and the percentage of both academic and non-academic active surgeons. Additionally, the Pearson correlation test was used to examine the association between the number of OSs per capita and the presence of OR training programs in each province. The significance level was set at a P-value of 0.05. All statistical analyses were performed using IBM SPSS V27.0.1 (IBM, Armonk, New York, USA). The geographic heat map was generated using Microsoft Excel 2016 (Microsoft Corp, Redmond, Washington, USA).

Results

Per Capita Ratios and Geographical Distribution of OSs and Trainees in Iran and Their Comparison with Per Capita in Turkey and the UK

A total of 2,504 OSs with active practice licenses were extracted from the membership database of IRIMC, which included 88 (3.5%) female surgeons and 2,416 (96.5%) male surgeons. The analysis of these 2,504 surgeons revealed that the four provinces with the highest number of surgeons—Tehran (33.6%), Razavi Khorasan (7.9%), Fars (7.6%), and Isfahan (6.9%)—account for more than half of the total number of surgeons in Iran. When adjusted for population, the total per capita ratio of OSs across all provinces was 3.13 [Table 1, Figure 1]. This ratio ranged from 0.97 to 6.33 across provinces.

Through the published booklets by Sanjesh, 641 ORs (ORs) were identified, including 170 first-year, 161 second-year, 147 third-year, and 163 fourth-year residents. The overall per capita ratio of ORs was 0.80, with Tehran having the highest ratio at 1.90. Orthopaedic residency training programs were not identified in a significant number of provinces (41.9%).

The per capita ratio of OSs in Iran was 3.13, while Turkey and the UK reported higher ratios of 4.00 and 8.00, respectively [Table 2]. Both Turkey and the UK also had a higher number of OTs and a greater per capita ratio of OTs compared to Iran. A statistical difference could not be established due to the unavailability of raw data.

Table 1. Orthopaedic Surgeons (OSs) and Residents (ORs) Per Province.

Province	OS / 100000 of the population	Female OS / Total OS	Non-Academic OS / 100000 of the population	Academic OS / 100000 of the population	Male OS / 100000 of the population	Female OS / 100000 of the population	OR / 100000of the population	Academic OS / OR
East Azerbaijan	3.20	0.06	3.17	0.49	3.02	0.18	1.00	0.49
West Azerbaijan	1.93	0.08	1.93	0.21	1.78	0.15	0.61	0.35
Ardabil	1.73	0.00	1.73	0.16	1.73	0.00	1.02	0.15
Isfahan	3.38	0.04	3.34	0.25	3.24	0.14	0.84	0.30
Alborz	2.21	0.07	2.18	0.15	2.06	0.15	0.44	0.33
Ilam	2.07	0.17	1.90	0.17	1.72	0.34	0.00	
Bushehr	2.49	0.07	2.49	0.09	2.32	0.17	0.00	
Tehran	6.33	0.03	6.32	0.78	6.15	0.18	1.90	0.41
Chaharmahal and Bakhtiari	1.79	0.00	1.79	0.21	1.79	0.00	0.00	
South Khorasan	2.47	0.00	2.47	0.00	2.47	0.00	0.00	
Razavi Khorasan	3.06	0.03	3.05	0.37	2.97	0.09	0.51	0.73
North Khorasan	1.51	0.00	1.51	0.23	1.51	0.00	0.00	
Lorestan	1.65	0.03	1.65	0.00	1.59	0.06	0.00	
Khuzestan	2.31	0.06	2.31	0.21	2.17	0.15	0.62	0.34
Zanjan	1.61	0.00	1.61	0.38	1.61	0.00	0.85	0.44
Semnan	3.13	0.00	3.13	0.14	3.13	0.00	0.00	
Sistan and Baluchestan	0.97	0.07	0.97	0.00	0.90	0.07	0.00	
Fars	3.94	0.03	3.90	0.31	3.83	0.10	0.78	0.39
Qazvin	1.33	0.00	1.33	0.08	1.33	0.00	0.00	
Qom	2.24	0.00	2.24	0.08	2.24	0.00	0.00	
Kurdistan	2.00	0.03	2.00	0.12	1.93	0.06	0.00	
Kerman	1.99	0.02	1.99	0.28	1.96	0.03	0.76	0.38
Kermanshah	1.64	0.03	1.64	0.20	1.59	0.05	0.82	0.25
Kohgiluyeh and Boyer-Ahmad	2.24	0.00	2.10	0.14	2.24	0.00	0.00	
Golestan	2.62	0.04	2.62	0.27	2.51	0.11	0.80	0.33
Gilan	2.77	0.03	2.77	0.24	2.69	0.08	0.63	0.38
Mazandaran	2.95	0.03	2.89	0.24	2.86	0.09	0.91	0.27
Markazi	2.10	0.07	2.10	0.21	1.96	0.14	1.33	0.16
Hormozgan	1.46	0.04	1.46	0.23	1.41	0.06	0.00	
Hamedan	2.01	0.09	1.96	0.40	1.84	0.17	0.98	0.41
Yazd	3.78	0.00	3.78	0.61	3.78	0.00	1.41	0.44
Total	**3.13**	**0.04**	**3.12**	**0.33**	**3.02**	**0.11**	**0.80**	**0.41**

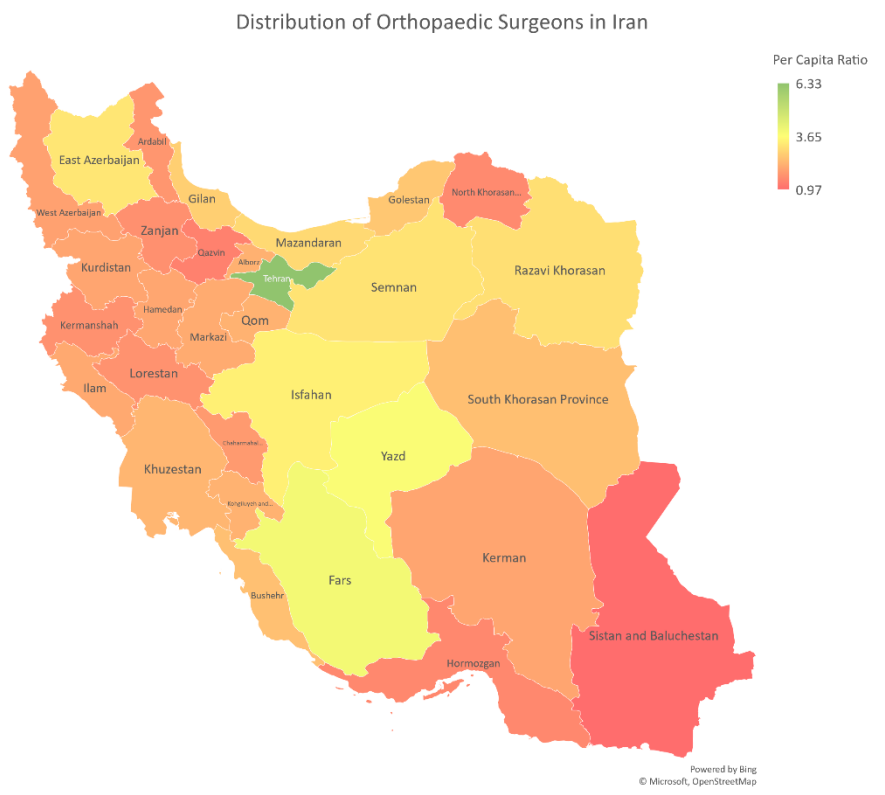

Figure 1. Distribution of Orthopaedic Surgeons in Iran per capita ratio in 100000 population

Table 2. Orthopaedic Surgeons (OSs) and Trainees (OTs) of Iran, Turkey, and United Kingdom

	No. of OS (% female)	OS / 100000 of the population	No. of OT (% female)	OT / 100000 of the population
Iran	2504 (3.51%)	3.13	641 (NA)	0.8
Turkey	3117 (NA)	4.00	976 (NA)	1.2
United Kingdom	5071 (4.2%)	8.00	976 (19%)	1.6

Distribution of the Orthopaedic Workforce in Non-academic and Academic Environments

ISID provided a list of 266 academic OSs, including 147 (55.3%) assistant professors, 73 (27.4%) associate professors, and 46 (17.3%) professors, of whom 260 (97.7%) were male. The overall per capita ratio of academic and non-academic OSs in Iran was 0.33 and 3.13, respectively. These ratios ranged from 0.00 to 0.78 for academic surgeons and from 0.97 to 6.32 for non-academic surgeons. Three provinces had no academic surgeons and lacked orthopaedic residency training programs. A significant weak positive correlation was identified between the per capita ratio of OSs and the availability of orthopaedic residency training programs in each province ($r = 0.395$, $p = 0.028$) [Table 3]. Razavi Khorasan demonstrated the highest proportion of academic OSs per resident in that province (0.73).

Table 3. Association between Orthopaedic Surgeon Per Capita and Presence of Orthopaedic Resident Training in each Province

r	P-value
0.395	0.028

The presence of Women in Orthopaedics in non-academic and academic environments and their Scientific Productivity

As previously mentioned, women make up a smaller proportion of the orthopaedic workforce compared to men. The total per capita ratio for female surgeons was 0.11. Notably, in 31 provinces of Iran, several provinces (32.3%) had a per capita ratio of 0.00 for female surgeons. The percentage of female surgeons in the UK (4.2%) was higher than that in Iran (3.51%).

Both male and female academic surgeons had a median H-index of 4, with interquartile ranges (IQR) of 2–8 and 1–9, respectively [Table 4]. There was no significant difference between the median H-indices of academic surgeons (p = 0.827), regardless of their academic ranks. None of the female academic OSs held the rank of professor, and only two were associate professors; therefore, statistical differences could not be determined. The associations between the mean H-index of OSs and various variables across different academic ranks in each province were explored [Table 5]. None of the correlations were statistically significant (p > 0.05).

Table 4. Difference between Male and Female Orthopaedic Surgeon (OS) H-index

	No. of Male OS (%)	No. of Female OS (%)	Male OS H-index (Median (Q1-Q3))	Female OS H-index (Median (Q1-Q3))	P-value*
Academic	260 (97.7%)	6 (2.3%)	4 (2-8)	4 (1-9)	0.827
Assistant Professor	143 (97.3%)	4 (2.7%)	2 (1-3)	2 (1-7.5)	0.840
Associate Professor	71 (97.3%)	2 (2.7%)	6 (4-8)	7	
Professor	46 (100%)	0 (0%)	10 (8-11.25)		

* Mann-Whitney U Test

Table 5. Association between Mean H-index and other Variables in each Province

	Assistant Professor OS		Associate Professor OS		Professor OS	
	r	*P-value*	r	*P-value*	r	*P-value*
Count of OR	0.147	0.560	0.016	0.963	0.178	0.580
Percentage of Academic Female	-0.887	0.306				
Percentage of Both Academic and Non-Academic Actives	-0.100	0.627	-0.585	0.059	-0.152	0.619

Abbreviations OS: Orthopaedic Surgeon, OR: Orthopaedic Resident

Discussion

The orthopaedic surgical care landscape is evolving due to an aging population and the increasing prevalence of chronic conditions such as osteoarthritis, fractures, and trauma.[37,38] The influence of societal and economic disparities, medical education structures, and financial incentives for equitable distribution of the orthopaedic workforce has led to significant global inequalities in the distribution of OSs.[8,39] In Iran, with a population of over 80 million, there are unbalanced geographical patterns in orthopaedic services.[10] Academic practice in orthopaedics offers benefits such as career advancement and increased diversity; however, orthopaedic societies globally still lack diverse representation.[12,15] The underrepresentation of women and minorities in orthopaedics, particularly outside developed countries, remains a significant issue. In developed nations, women in orthopaedics tend to exhibit higher productivity and H-index, highlighting disparities that need to be addressed in other regions.[23,40]

Geographical distribution of the orthopaedic workforce in Iran and comparing its per capita with Turkey and the UK

The per capita distribution of orthopaedic care in Iran is 3.13, which is lower than that of Turkey (4) and the UK (8). The lower per capita ratio in developing countries, including Iran, can be attributed to factors such as limited financial resources for healthcare infrastructure, workforce shortages, geographic barriers, lack of health insurance and income, and possibly the influence of cultural beliefs or traditional healing practices that prioritize alternative medicine in smaller cities.[41-44] According to health policies in developing countries such as Bangladesh, India, Indonesia, and Thailand, there appear to be incentives to work in less developed areas. These incentives include increased material compensation based on the country's actual inflation rate, alignment of work and workload with income, reforms in medical education and healthcare delivery systems, installation of necessary facilities to support a sustainable lifestyle, and attention to the political and cultural issues specific to each region. Additionally, familiarizing the workforce with the way of life in less developed regions can help increase the per capita ratio in these areas.[45-51] These experiences can be used to move towards a fairer distribution of orthopaedic care in Iran. The per capita distribution of OSs was higher in larger cities and lower in smaller and border cities. Factors such as the lack of suitable living accommodations, inadequate salaries, and the province's specific geographical conditions appear to be the main contributors.[52] In larger cities like Tehran, better accommodations and a more developed private healthcare sector are more readily available, driven by the growing demand for medical services and the ease of physician recruitment. As a result, this may reduce the per capita allocation of healthcare resources within the public healthcare system.[53]

Distribution of the orthopaedic workforce in non-academic and academic environments

The proportion of OSs engaged in academic settings compared to the total number of OSs is 10%, accounting for 266 individuals out of a total of 2,504. This proportion is slightly lower than that in the United States, which stands at approximately 12.7% (2,915 out of 22,965 OSs).[54] The median h-index for academic individuals is 4, with an IQR of 2 to 8. This value is lower than that in developed countries such as Canada, as indicated by Yousif-Atwan et al. (median: 8, IQR: 3–16.5),[55] and the United States, as reported by Andrew K. Ence et al. (median: 5, IQR: 1–12).[56] This discrepancy may be attributed to the more advanced financial support and facilities in these countries, which attract a larger workforce to the academic environment.[56] There is a direct relationship between progress in the academic environment, individuals' scientific rank, and their H-index, as expected by previous studies.[57-59] According to these studies, the availability of funding from the health system or public organizations, as well as the privileges afforded to individuals in this field, can encourage greater participation in academic settings.[60-62]

Presence of women in orthopaedics in non-academic and academic environments and comparison of their scientific productivity in the academic environment

Our study showed that, among 2,504 OSs in Iran, 88 (3.5%) are women. Currently, only six women are part of the academic community, with a median H-index of 4 (IQR: 1–9). The small sample size limits the ability to make a precise comparison. In developed countries like the United States, studies show a low ratio of women to men in orthopaedics (one woman for every 20 men, equivalent to 5%),[63] highlighting the disparity in the representation of women and men in the field of orthopaedics. This trend is consistent across both developing and developed nations.[64] Studies have demonstrated that the most critical factors encouraging the presence of women in orthopaedics include personal interactions with residents, the reputation of the orthopaedic surgery program, camaraderie among residents, residents' overall happiness, and geographic location. However, there was no evidence suggesting that female mentorship, family, pregnancy, significant others, or physical attributes contributed to their participation in the field of orthopaedics.[65,66]

Limitations

There were several limitations in our study, including the following: First, the accuracy of the H-index calculation may be compromised for individuals with the same name. To ensure the reliability of the review, the scientometric system's profile, endorsed by the individuals themselves rather than the main Scopus website, was utilized. Second, it is essential to note that not all scientific indicators can be examined, and the H-index is only one limited measure among many. Other factors influencing the determination of residency capacity and faculty recruitment, such as disease burden and financial resources, were not explored. This highlights the need for future studies in this area.

Conclusion

The distribution of OSs in developing countries, such as Iran, is skewed toward larger cities, with factors including financial incentives, legal considerations, and lifestyle amenities contributing to this imbalance. Incentives are essential for promoting a more equitable distribution of these professionals. The distribution of academic OSs mirrors that of the general workforce, with a higher concentration in urban areas. This can be attributed to the larger number of residents and the increased number of universities offering advanced educational and research facilities in metropolitan areas. There is a direct relationship between progress in the academic environment, individuals' scientific rank, and their H-index. Fair distribution is characterized by diversity, including gender equality in the workforce. The underrepresentation of women in orthopaedics highlights the need for incentives to encourage their entry into the field.

Acknowledgement

N/A

Authors Contribution: Authors who conceived and designed the analysis: Amir Human Hoveidaei/ Authors who collected the data: Mohammad Amin Khadembashiri, Reza Niakan/Authors who contributed data or analysis tools: Mohammad Amin Khadembashiri/Authors who performed the analysis: Mohammad Reza Ramezanpour/Authors who wrote the paper: Mohammad Reza Ramezanpour, Omid Bahrami/Other contribution: The other authors actively contributed to all stages of the project, and the final version of the submitted paper has been reviewed and approved by all authors.

Declaration of Conflict of Interest: The author(s) do NOT have any potential conflicts of interest for this manuscript.

Declaration of Funding: The author(s) received NO financial support for the preparation, research, authorship, and publication of this manuscript.

Declaration of Ethical Approval for Study: This cross-sectional study was conducted using publicly accessible data sources; therefore, ethical approval was exempted.

Declaration of Informed Consent: There is no identifiable information in the submitted manuscript.

Amir Human Hoveidaei, MD, MSc, Health MBA [1]
Mohammad Amin Khadembashiri MD [2,3]
Mohammad Reza Ramezanpour MD [2]
Omid Bahrami MD [2]
Reza Niakan MD [4]
Fatemeh Rashidi MD [2]
Sina Esmaeili MD [5]

1 International Center for Limb Lengthening, Rubin Institute for Advanced Orthopaedic s, Sinai Hospital of Baltimore, Baltimore, Maryland, USA

2 School of Medicine, Tehran University of Medical Sciences, Tehran, Iran

3 Neuromusculoskeletal Research Center, Iran University of Medical Sciences, Tehran, Iran

4 Student Research Committee, School of Medicine, Shiraz University of Medical Sciences, Shiraz, Iran

5 Sina University Hospital, Tehran University of Medical Sciences, Tehran, Iran

References

1. Hogan MV, Ahn J, Egol KA, Mittwede PN. Research During Orthopaedic Training. J Am Acad Orthop Surg. 2022;30(4):e461-e469. doi:10.5435/jaaos-d-21-00455.
2. Vail TP. What's Important: A Musculoskeletal Moonshot: Accelerating Orthopaedic Innovation. J Bone Joint Surg Am. 2018;100(7):627-628. doi:10.2106/jbjs.17.01486..
3. Poacher AT, Bhachoo H, Weston J, Shergill K, Poacher G, Froud J. Undergraduate education of trauma and orthopaedic surgery in the UK : a systematic review. Bone Jt Open. 2022;3(7):549-556. doi:10.1302/2633-1462.37.Bjo-2022-0044.R1.
4. Rohrer F, Farokhnia A, Nötzli H, et al. Profit-Influencing Factors in Orthopaedic Surgery: An Analysis of Costs and Reimbursements. Int J Environ Res Public Health. 2022;19(7). doi:10.3390/ijerph19074325.
5. Yu S, Zuckerman JD. Orthopaedic s in US Health Care. Am J Orthop (Belle Mead NJ). 2015;44(12):538-41.
6. Wibulpolprasert S, Pengpaibon P. Integrated strategies to tackle the inequitable distribution of doctors in Thailand: four decades of experience. Hum Resour Health. 2003;1(1):12. doi:10.1186/1478-4491-1-12.
7. Okike K, Utuk ME, White AA. Racial and ethnic diversity in orthopaedic surgery residency programs. J Bone Joint Surg Am. 2011;93(18):e107. doi:10.2106/jbjs.K.00108.
8. Day MA, Owens JM, Caldwell LS. Breaking Barriers: A Brief Overview of Diversity in Orthopaedic Surgery. Iowa Orthop J. 2019;39(1):1-5.
9. Amiresmaili M, nekoeimoghadam M, Goudarzi R, Yazdi-Feyzabadi V, Karimi Mobarakeh M, Jahad Sarvestani A. Epidemiological study of Total Knee Arthroplasty in Iran. Health Management & Information Science. 2021;8(3):210-216. doi:10.30476/jhmi.2022.92476.1096.
10. Aslani H, Nourbakhsh ST, Lahiji FA, et al. Iranian Joint Registry (Iranian National Hip and Knee Arthroplasty Registry). Arch Bone Jt Surg. 2016;4(2):192-6.
11. Bastian S, Ippolito JA, Lopez SA, Eloy JA, Beebe KS. The Use of the h-Index in Academic Orthopaedic Surgery. J Bone Joint Surg Am. 2017;99(4):e14. doi:10.2106/jbjs.15.01354.
12. Casciato DJ, Cravey KS, Barron IM. Scholarly Productivity Among Academic Foot and Ankle Surgeons Affiliated With US Podiatric Medicine and Surgery Residency and Fellowship Training Programs. J Foot Ankle Surg. 2021;60(6):1222-1226. doi:10.1053/j.jfas.2021.04.017.
13. Appelbaum NP, Lee N, Amendola M, Dodson K, Kaplan B. Surgical Resident Burnout and Job Satisfaction: The Role of Workplace Climate and Perceived Support. J Surg Res. 2019:234:20-25. doi: 10.1016/j.jss.2018.08.035.
14. Lases LSS, Arah OA, Busch ORC, Heineman MJ, Lombarts K. Learning climate positively influences residents' work-related well-being. Adv Health Sci Educ Theory Pract. 2019;24(2):317-330. doi:10.1007/s10459-018-9868-4.
15. Christmas C, Durso SC, Kravet SJ, Wright SM. Advantages and challenges of working as a clinician in an academic department of medicine: academic clinicians' perspectives. J Grad Med Educ. 2010;2(3):478-84. doi:10.4300/jgme-d-10-00100.1.
16. Chen RE, Kuhns BD, Kaupp S, Voloshin I, Mannava S. Diversity among academic orthopaedic shoulder and elbow surgery faculty in the United States. J Shoulder Elbow Surg. 2020;29(4):655-659. doi:10.1016/j.jse.2019.11.035.
17. Onuoha AC, Meadows AM, Faraj MT, Skinner MM, Day C, Ravi K. Comparative analysis of racial and gender diversity in orthopaedic surgery applicants and residents from 2007 and 2019. Journal of Orthopaedic Experience & Innovation. 2022;3(1).
18. Lum ZC, Dennison S, Le HV, Bayne CO, Lee CA. Trends in Orthopaedic Surgery Workforce Diversity: Analyzing Changes Over Time. J Am Acad Orthop Surg Glob Res Rev. 2024;8(4)doi:10.5435/JAAOSGlobal-D-24-00038.
19. Van Heest AE, Fishman F, Agel J. A 5-Year Update on the Uneven Distribution of Women in Orthopaedic Surgery Residency Training Programs in the United States. J Bone Joint Surg Am. 2016;98(15):e64. doi:10.2106/jbjs.15.00962.
20. Van Heest AE, Agel J. The uneven distribution of women in orthopaedic surgery resident training programs in the United States. J Bone Joint Surg Am. 2012;94(2):e9. doi:10.2106/jbjs.J.01583.
21. Klyce W, Nhan DT, Dunham AM, El Dafrawy MH, Shannon C, LaPorte DM. The Times, They Are A-Changing: Women Entering Academic Orthopaedic s Today Are Choosing Nonpediatric Fellowships at a Growing Rate. J Surg Educ. 2020;77(3):564-571. doi:10.1016/j.jsurg.2019.12.007.
22. Van Heest AE, Agel J, Samora JB. A 15-Year Report on the Uneven Distribution of Women in Orthopaedic Surgery Residency Training Programs in the United States. JB JS Open Access. 2021;6(2)doi:10.2106/jbjs.Oa.20.00157.
23. Rohde RS, Wolf JM, Adams JE. Where Are the Women in Orthopaedic Surgery? Clin Orthop Relat Res. 2016;474(9):1950-6. doi:10.1007/s11999-016-4827-y.
24. Alomar AZ, Almonaie S, Nagshabandi KN, AlGhufaili D, Alomar M. Representation of women in orthopaedic surgery: perception of barriers among undergraduate medical students in Saudi Arabia. J Orthop Surg Res. 2023;18(1):19. doi:10.1186/s13018-022-03487-6.
25. Agaronnik N, Xiong GX, Uzosike A, et al. The role of gender in academic productivity, impact, and leadership among academic spine surgeons. Spine J. 2022;22(5):716-722. doi: 10.1016/j.spinee.2021.1
26. Hoof MA, Sommi C, Meyer LE, et al. Gender-related Differences in Research Productivity, Position, and Advancement Among Academic Orthopaedic Faculty Within the United States. J Am

Acad Orthop Surg. 2020;28(21):893-899. doi: 10.5435/JAAOS-D-19-00408.
27. Parhizkari K, Kuehnel S. Comparing Modernization in Iran and Turkey. International Journal of Social Sciences and Humanity Studies. 2011;3(1):207-15.
28. Liu S, Wang B, Fan S, Wang Y, Zhan Y, Ye D. Global burden of musculoskeletal disorders and attributable factors in 204 countries and territories: a secondary analysis of the Global Burden of Disease 2019 study. BMJ Open. 2022;12(6):e062183. doi:10.1136/bmjopen-2022-062183.
29. Al-Ajlouni YA, Al Ta'ani O, Mushasha R, et al. The burden of musculoskeletal disorders in the Middle East and North Africa (MENA) region: a longitudinal analysis from the global burden of disease dataset 1990-2019. BMC Musculoskelet Disord. 2023;24(1):439. doi:10.1186/s12891-023-06556-x.
30. Grosios K, Gahan PB, Burbidge J. Overview of healthcare in the UK. EPMA J. 2010;1(4):529-34. doi:10.1007/s13167-010-0050-1.
31. Adams R, Branthwaite H, Chockalingam N. Prevalence of musculoskeletal injury and pain of UK-based podiatrists and the impact of enforced altered working practices. J Foot Ankle Res. 2021;14(1):53. doi:10.1186/s13047-021-00491-7.
32. IRIMC. Islamic Republic of Iran Medical Council, Membersearch. Available at: https://membersearch.irimc.org/. Accessed May 15, 2024.
33. ISID. Iranian Scientometrics Information Database. Available at: https://isid.research.ac.ir/Index.php. Accessed May 15, 2024.
34. Sanjesh. Iran's Medical Education Assessment Center Accessed. Available at: https://sanjeshp.ir/Content.aspx?click=12. Accessed May 15, 2024.
35. Statistical Center of Iran. Available at: https://amar.org.ir/. Accessed May 15, 2024.
36. Madanat R, Mäkinen TJ, Ryan D, Huri G, Paschos N, Vide J. The current state of orthopaedic residency in 18 European countries. Int Orthop. 2017;41(4):681-687. doi:10.1007/s00264-017-3427-0.
37. Peterson BE, Jiwanlal A, Della Rocca GJ, Crist BD. Orthopaedic Trauma and Aging: It Isn't Just About Mortality. Geriatr Orthop Surg Rehabil. 2015;6(1):33-6. doi:10.1177/2151458514565663.
38. Alqarni MM, Alaskari AA, Al Zomia AS, et al. Epidemiology and Pattern of Orthopaedic Trauma in Children and Adolescents: Implications for Injury Prevention. Cureus. 2023;15(5):e39482. doi:10.7759/cureus.39482.
39. Chalupa RL, Hooker RS. The education, role, distribution, and compensation of physician assistants in orthopaedic surgery. JAAPA. 2016;29(5):1-7. doi:10.1097/01.JAA.0000482318.38700.d1.
40. Agaronnik N, Xiong GX, Uzosike A, et al. The role of gender in academic productivity, impact, and leadership among academic spine surgeons. Spine J. 2022;22(5):716-722. doi:10.1016/j.spinee.2021.12.003.
41. Mock C, Cherian M, Juillard C, et al. Developing priorities for addressing surgical conditions globally: furthering the link between surgery and public health policy. World J Surg. 2010;34(3):381-5. doi:10.1007/s00268-009-0263-4.
42. Ozgediz D, Jamison D, Cherian M, McQueen K. The burden of surgical conditions and access to surgical care in low- and middle-income countries. Bull World Health Organ. 2008;86(8):646-7. doi:10.2471/blt.07.050435.
43. Marks IH, Thomas H, Bakhet M, Fitzgerald E. Medical equipment donation in low-resource settings: a review of the literature and guidelines for surgery and anaesthesia in low-income and middle-income countries. BMJ Glob Health. 2019;4(5):e001785. doi:10.1136/bmjgh-2019-001785.
44. Grimes CE, Henry JA, Maraka J, Mkandawire NC, Cotton M. Cost-effectiveness of surgery in low- and middle-income countries: a systematic review. World J Surg. 2014;38(1):252-63. doi:10.1007/s00268-013-2243-y.
45. Meliala A, Hort K, Trisnantoro L. Addressing the unequal geographic distribution of specialist doctors in indonesia: the role of the private sector and effectiveness of current regulations. Soc Sci Med. 2013;82:30-4. doi:10.1016/j.socscimed.2013.01.029.
46. Nair A, Jawale Y, Dubey SR, Dharmadhikari S, Zadey S. Workforce problems at rural public health-centres in India: a WISN retrospective analysis and national-level modelling study. Hum Resour Health. 2022;19(Suppl 1):147. doi:10.1186/s12960-021-00687-9.
47. Rawal LB, Joarder T, Islam SM, Uddin A, Ahmed SM. Developing effective policy strategies to retain health workers in rural Bangladesh: a policy analysis. Hum Resour Health. 2015;13:36. doi:10.1186/s12960-015-0030-6.
48. Sriram V, Hariyani S, Lalani U, Buddhiraju RT, Pandey P, Bennett S. Stakeholder perspectives on proposed policies to improve distribution and retention of doctors in rural areas of Uttar Pradesh, India. BMC Health Serv Res. 2021;21(1):1027. doi:10.1186/s12913-021-06765-x.
49. Thoresen SH, Fielding A. Inequitable distribution of human resources for health: perceptions among Thai healthcare professionals. Qual Prim Care. 2010;18(1):49-56.
50. Dell AJ, Gray S, Fraser R, Held M, Dunn R. Orthopaedic Surgeon Density in South Africa. World J Surg. 2018;42(12):3849-3855. doi:10.1007/s00268-018-4709-4.
51. Brouillette MA, Kaiser SP, Konadu P, Kumah-Ametepey RA, Aidoo AJ, Coughlin RC. Orthopaedic surgery in the developing world: workforce and operative volumes in Ghana compared to those in the United States. World J Surg. 2014;38(4):849-57. doi:10.1007/s00268-013-2314-0.
52. Moradi R, Olyaeemanesh A, Mosadeghrad AM, Harirchi I, Larijni B. Measuring Equity of Geographical Distribution of Specialist Physicians in Iran's Health System. Int J Prev Med. 2023;14:60. doi:10.4103/ijpvm.ijpvm_542_21.
53. Rabbanikhah F, Moradi R, Mazaheri E, Shahbazi S, Barzegar L, Karyani AK. Trends of geographic distribution of general practitioners in the public health sector of Iran. J Educ Health Promot. 2018;7:89. doi:10.4103/jehp.jehp_14_18.
54. Weintraub M, Ahn D, Herzog I, et al. Retainment of U.S. OSs in Academia from 2016 to 2022. JB JS Open Access. 2024;9(1). doi:10.2106/jbjs.Oa.23.00111.
55. Atwan Y, Charron BP, Sidhu S, Cavanagh J, Degen R. Publication Productivity Among Academic OSs in Canada. Cureus. 2020;12(6):e8441. doi:10.7759/cureus.8441.
56. Ence AK, Cope SR, Holliday EB, Somerson JS. Publication Productivity and Experience: Factors Associated with Academic Rank Among Orthopaedic Surgery Faculty in the

United States. J Bone Joint Surg Am. 2016;98(10):e41. doi:10.2106/jbjs.15.00757.
57. Ashfaq A, Kalagara R, Wasif N. H-index and academic rank in general surgery and surgical specialties in the United States. J Surg Res. 2018;229:108-113. doi:10.1016/j.jss.2018.03.059.
58. Lopez J, Susarla SM, Swanson EW, Calotta N, Lifchez SD. The Association of the H-Index and Academic Rank Among Full-Time Academic Hand Surgeons Affiliated With Fellowship Programs. J Hand Surg Am. 2015;40(7):1434-41. doi:10.1016/j.jhsa.2015.03.026.
59. Kuhns B, Haws BE, Kaupp S, Maloney MD, Carmody EE, Mannava S. Academic Orthopaedics As a Driver of Gender Diversity in the Orthopaedic Workforce: A Review of 4,519 Orthopaedic Faculty Members. J Am Acad Orthop Surg Glob Res Rev. 2022;6(2). doi:10.5435/JAAOSGlobal-D-21-00028.
60. Flanagan CD, Schmidt CM, Amin MJ, et al. Academic productivity metrics correlate positively with industry funding amongst orthopaedic shoulder and elbow surgeons. JSES Int. 2023;7(3):372-375. doi:10.1016/j.jseint.2023.02.011.
61. Flanagan CD, Walson FT, Schmidt CM, Frankle MA, Mir HR. The Association Between Orthopaedic Surgeon Academic Productivity Metrics and Compensation from Medical Industry. J Am Acad Orthop Surg. 2023;31(3):141-147. doi:10.5435/jaaos-d-22-00453.
62. Haislup BD, Trent S, Sequeira S, Murthi AM, Wright MA. The relationship between academic influence, NIH funding, and industry payments among academic shoulder and elbow surgeons. J Shoulder Elbow Surg. 2022;31(11):2431-2436. doi:10.1016/j.jse.2022.06.019.
63. Rodgers BM, Moore ML, Mead-Harvey C, et al. How Does Orthopaedic Surgeon Gender Representation Vary by Career Stage, Regional Distribution, and Practice Size? A Large-Database Medicare Study. Clin Orthop Relat Res. 2023;481(2):359-366. doi:10.1097/corr.0000000000002176.
64. Kocjan K, Safavi KS, Flaherty B, et al. Current Gender Diversity and Geographic Trends Among Orthopaedic Sports Medicine Surgeons in the United States. Orthop J Sports Med. 2022;10(11):23259671221134091. doi:10.1177/23259671221134091.
65. Kroin E, Garbarski D, Shimomura A, Romano J, Schiff A, Wu K. Gender Differences in Program Factors Important to Applicants When Evaluating Orthopaedic Surgery Residency Programs. J Grad Med Educ. 2019;11(5):565-569. doi:10.4300/jgme-d-18-01078.1.
66. Jurenovich KM, Cannada LK. Women in Orthopaedic s and their Fellowship Choice: What Influenced their Specialty Choice? Iowa Orthop J. 2020;40(1):13-17.