DESIDOC Journal of Library & Information Technology, Vol. 45, No. 3, May 2025, pp. 217-223, DOI : 10.14429/djlit.20443

Examining the Correlation between Presence in the University Ranking Systems with Countries' Income and R&D Expenditure: A Study on Medical Sciences Universities

Romina Sepehr[#], Maryam Shekofteh[#,*], Azam Shahbodaghi[#], and Sara Jambarsang[$]

[#]*Department of Medical Library and Information Science, School of Allied Medical Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Iran*

[$]*Center for Healthcare Data Modeling, Departments of Biostatistics and Epidemiology, School of public health, Shahid Sadoughi University of Medical Sciences, Yazd, Iran*

[*]*E-mail: shekofteh_m@yahoo.com*

ABSTRACT

This study aims to examine the presence of various countries in international university ranking systems, specifically the Shanghai Academic Ranking of World Universities (ARWU), QS, and the Times Higher Education (THE) World University Rankings, focusing on medicine and related sciences. It also explores the relationship between the presence in the university ranking systems and country's income level and spending on Research and Development (R&D). Data was gathered from the websites of the three international university ranking systems, as well as from the Organisation for Economic Co-operation and Development (OECD) and the World Bank. Findings showed that 1191 universities from 100 countries are present in medical sciences sections of the three ranking systems. About half of these countries are classified as high-income, while fewer than five are classified as low-income. A significant correlation was found between a country's income level and the number of its universities appearing in the rankings. High-income countries have a noticeably higher number of universities in these rankings than other income levels (p-value ≥ 0.001). Additionally, the study found a significant relationship between a country's R&D spending and the presence of its universities in the rankings: THE (r = 0.33), QS (r = 0.24), and ARWU (r = 0.28). In conclusion, countries should consider increasing their investment in R&D to achieve higher positions in international university ranking systems.

Keywords: University ranking systems; Medical universities; Research and development expenditure

1. INTRODUCTION

International ranking systems play a significant role in evaluating the performance and promoting universities performance. Competition among universities in international ranking systems leads to their improved performance[1–5]. Hence, international university ranking systems have gained significant importance, prompting countries to enhance and elevate their research centers and institutions on a global scale[5–7]. The competition between countries and their universities has caused universities to try to be known and noticed as universities on a global scale[8]. International university ranking systems evaluate institutions from various countries, motivating them to enhance their academic standards. Simultaneously, these systems foster competition among universities vying for top rankings. Among the international ranking systems, the three most renowned are the Shanghai Academic Ranking of World Universities (ARWU), QS World University Rankings, and Times Higher Education (THE) rankings. These ranking systems, in addition to the general rankings of universities, include subject ranking divisions. Within these divisions, they assess and rank universities across various disciplines. However, these divisions are different in various university ranking systems.

Training skilled and capable human resources professionals in medicine and related fields is essential. Medical universities have a mission that goes beyond education and research. They perform tasks related to health, treatment, food security, and resource development and management in collaboration with other sectors of society. [2] Therefore, medical universities can use university ranking systems to plan their growth and development paths and effectively show their abilities[9].

Previous literature has shown that countries' income levels can influence scientific production[3,6,10], the number of citations received[4,6,11] and their expenditure on Research and Development (R&D)[6,12,13]. However, the relationship between countries' R&D expenditures and the ranking of their universities in the international ranking systems of world universities is unspecified. In addition, no previous studies have explored ranking

Received : 29 July 2024, Revised : 20 August 2024
Accepted : 02 April 2025, Online published : 09 May 2025

systems through the lens of subject areas, making the current research the first of its kind in this area. Hence, the current research addressed the presence of medical sciences universities of various countries in three international university ranking systems, including ARWU, QS, and THE. Additionally, the study examines the correlation between R&D expenditures and countries' income levels and their presence in medical university rankings.

This study aims to achieve several specific objectives:

- Determining the number of institutions and countries in QS, THE, and ARWU in medical sciences.
- Determining countries' income levels that house medical universities in the university ranking systems.
- Comparing the R&D expenditures across countries featured in medical university ranking systems.
- Exploring the correlation between a country's income level and the presence of their medical universities in the university ranking systems.
- Investigating the correlation between R&D expenditures and the position of countries within medical university rankings.

2. MATERIAL AND METHODS

In this correlational study, the statistical population includes countries with medical sciences universities in the three ranking systems of ARWU, QS, and THE in 2022. This research has no sampling, and all the countries and universities classified in the ranking systems in medical sciences divisions were reviewed. To collect relevant data, the authors visited the websites of three international university ranking systems: THE (https://www.timeshighereducation.com/wòrld-university-ránkings), ARWU (http://www.shanghairanking.com/), and QS (https://www.topuniversities.com/university-rankings), and extracted the relevant country and their rank in these three ranking systems in medical sciences university subject rankings section.

To check the amount of expenditure on R&D, the researchers searched the websites of the Organization for Economic Co-operation and Development (https://www.oecd.org/) and adjusted the time frame of the results from 2015 to 2021. Since, the 2022 report was not mentioned on the above website during data collection, the reports are up to 2021. Also, the average R&D expenditure using Million US Dollars and the percentage of Gross Domestic Product (% GDP) was extracted.

The income levels of various countries were determined through the World Bank's website (https://datahelpdesk.worldbank.org). Using the search term "countries income," the researchers utilised the classification of countries by income level for 2022-2023 as a reference for this research[14].

The results were entered into an Excel file and used for further analysis. Data analysis using descriptive statistics and Pearson's correlation coefficient was performed using SPSS.

3. RESULTS

3.1 The Number of Universities and Countries in QS, THE, and ARWU in Medical Sciences

Generally, universities from 100 countries were present in three ranking systems. The presence of different countries in the university ranking systems in medical sciences is depicted in Table 1, indicating that ARWU have six subcategories in medical sciences, while ARWU and QS have five and two, respectively.

Table 1. The number of universities and countries in QS, THE, and ARWU in medical sciences

University ranking system	Subject categories	Number of countries	Number of institutions
QS	Anatomy & physiology	29	140
	Dentistry	26	70
	Medicine	81	671
	Nursing	29	170
	Pharmacy & pharmacology	52	362
	Total*	81	728
THE	Medicine & dentistry	93	945
	Other health	93	1123
	Total	95	1191
ARWU	Clinical medicine	74	499
	Public health	70	500
	Dentistry & oral sciences	43	300
	Nursing	35	300
	Medical technology	42	400
	Pharmacy & pharmaceutical sciences	52	500
	Total	83	867

* In total, duplicate countries and universities in different subject categories have been removed

3.2 The Number and Percentage of Countries and Medical Universities in the Reviewed Ranking Systems based on Income Level

Based on this information of OECD, countries are divided into four income levels:

- **Income level code 1:** High-income countries ($13,205 or more)
- **Income level code 2:** Upper middle-income countries ($4,256 to $13,205)
- **Income level code 3:** Lower middle-income countries ($1,086 to $4,255)
- **Income level code 4:** Low-income countries ($1,085 or less)

Table 2 shows the number and percentage of countries and universities in the reviewed ranking systems based on income level in 2022. In all three university ranking systems under review, most ranked medical science universities belong to high-income countries (level 1), and the lowest amount belongs to low-income countries (level 4).

3.3 The Amount of R&D Expenditure in the Countries with Universities in QS, THE, and ARWU Ranking Systems

Table 3 shows that the United States of America (USA), with 578,189.23 million dollars, China, with 456,567.73 million dollars, and Japan, with 168,585.85 million dollars, spent the highest average R&D expenditures based on the index of million US dollars.

Table 4 shows that Israel, South Korea, and Sweden have the highest percentages of R&D expenditure, respectively, at 4.80 %, 4.36 %, and 3.33 %.

3.4 Comparing the Presence of Universities and their Income Levels in the ARWU, QS, and THE in Medical Sciences

Table 5, by comparing the presence of universities according to income level, demonstrates that the number of universities in income level 1 in all three international ranking systems was significantly higher than income levels 3 and 4 (p-value $\leq$ 0.001). From an analytical standpoint, level 1 countries boast a higher number of universities across all three ranking systems. Consequently, a significant correlation exists between a country's income level and the representation of its universities in the ARWU, QS, and THE rankings for medical sciences.

3.5 Comparing the Relationship between Countries' R&D Expenditure and their Presence in the Medical University Rankings

Table 6 presents the relationship between countries' R&D expenditure and their presence in the university ranking systems examined in medical sciences 2022. Using Pearson's correlation coefficient, the relationship between the number of universities and the average R&D expenditure based on US dollars and % GDP was investigated. The findings revealed a significant relationship between the variables (p-value$\leq$0.001), and the relationship between the average R&D expenditure and the number of universities is stronger than the relationship between the % GDP.

Table 2. Number and percentage of countries and universities of the reviewed ranking systems based on income

University ranking system	Income level code	Number of countries	Percentage of countries	Number of institution	Percentage of institution
QS	1	48	60	542	74.45
	2	16	20	121	16.62
	3	14	17.5	63	8.65
	4	2	2.5	2	0.27
	Total	**80***	**100%**	**728**	**100%**
THE	1	50	53.76	811	68.09
	2	22	23.65	238	19.98
	3	19	20.43	138	11.58
	4	2	2.15	2	0.16
	Total	**93****	**100%**	**1191**	**100%**
ARWU	1	45	54.87	655	75.54
	2	16	19.51	146	16.83
	3	17	20.73	56	6.45
	4	4	4.87	9	1.03
	Total	**82*****	**100%**	**867**	**100%**

*The total number of countries in the QS ranking is 81, but Venezuela is not included here because it is not ranked in the reports.
**The countries of Palestine and Venezuela are not ranked in the reports of this ranking and, therefore, are not counted in the total.
***The country of Cameroon is not ranked in the reports of this ranking and is not counted in total.

Table 3. Top 10 countries with the most average R&D expenditure and the number of medical universities in the QS, THE, and ARWU ranking systems

Ranking	Country	The total number of universities in different fields of medicine (the number of universities after removing duplicates in different fields)			The average R&D expenditure in millions of US dollars
		ARWU	THE	QS	
1	USA	160	167	130	578189.23
2	China	80	47	29	456567.73
3	Japan	34	84	32	168585.85
4	Germany	40	33	34	123523.92
5	South Korea	32	28	20	90494.38
6	France	29	23	17	62231.32
7	UK	60	91	54	48644.58
8	Taiwan	15	19	11	39054.18
9	Russia	3	-	8	38971.23
10	Italy	33	39	41	32031.13

Table 4. The Top 10 countries with the most percent of R&D expenditure based on GDP and the number of medical universities in the QS, THE, and ARWU ranking systems

Ranking	Country	The total number of universities in different fields of medicine			R&D expenditure %GDP
		QS	THE	ARWU	
1	Israel	6	6	5	4.80
2	South Korea	20	28	32	4.36
3	Sweden	8	9	23	3.33
4	Taiwan	11	19	15	3.29
5	Japan	32	84	34	3.20
6	Austria	8	6	7	3.11
7	Switzerland	8	8	9	3.07
8	Germany	34	33	40	3.05
9	USA	130	167	160	3.03
10	Denmark	5	6	5	2.98

Table 5. Comparing the presence of universities and their income levels in the ARWU, QS, and THE in medical sciences categories

Ranking system	Income level code	Number of institution	Percentage of institution	Chi-squared	P-value
QS	1	542	74.5	988.363a	≤ 0.001
	2	121	16.6		
	3	63	8.7		
	4	2	3		
THE	1	811	68.2	1278.327a	≤ 0.001
	2	238	20		
	3	138	11.6		
	4	2	0.2		
ARWU	1	655	75.6	1228.956a	≤ 0.001
	2	146	16.9		
	3	56	6.5		
	4	9	1		

Table 6. Comparing the relationship between countries' R&D expenditure and their presence in the university ranking systems examined in medical sciences

	Number of universities and the average R&D expenditure (US dollars)		Number of universities and %GDP	
Ranking system	**Correlation coefficient**	**p-value**	**Correlation coefficient**	**p-value**
QS	0.47	≤ 0.001	0.24	≤ 0.001
THE	0.52	≤ 0.001	0.33	≤ 0.001
ARWU	0.6	≤ 0.001	0.28	≤ 0.001

4. DISCUSSION

The research findings revealed that universities from 100 countries are present in the reviewed ranking systems in medical sciences. QS has five medical subcategories, THE has two , and ARWU has seven medical subcategories. Given the numerous subcategories within medical sciences, focusing the ranking systems on more subcategories could yield a more precise evaluation of universities. This refined ranking method might serve as a better guide for students pursuing different fields of study.

The findings showed that 81, 95, and 83 countries with 728, 1191, and 867 universities are present in the QS, THE, and ARWU ranking systems, respectively. Previous studies have shown that universities can enjoy a better position in international ranking systems by improving the quality and quantity of their research outputs[4–6,15-16]. Countries and universities engaged in medical sciences can enhance their global standing by focusing on the quality and quantity of their offerings, aligning with the metrics utilised in ranking evaluations. This strategic improvement can lead to greater international recognition through university ranking systems, drawing more students to these institutions[5-6].

Previous studies reveal that increasing university financial support and resources has significantly enhanced their performance and overall quality[5,6,10,16-18.] Van Raan indicated that income distribution affects the production of science and the number of citations[11]. The current study also highlights that university ranking systems predominantly feature countries and universities from high-income levels. Specifically, level 1 includes 48 countries and 542 universities, while level 4, representing low-income levels, includes only two countries with two universities. This trend continues in the THE and ARWU ranking systems. For THE, level 1 comprises 50 countries with 811 universities, and for ARWU, it includes 45 countries with 655 universities. Conversely, level 4 features the least representation: THE lists two countries with two universities, while ARWU lists four countries with nine universities.

Abraham Maslow's theory categorises human needs into five hierarchical levels, beginning with the most fundamental. His model suggests that fulfilling basic needs paves the way for individuals to pursue and attain higher levels of personal development and self-fulfillment[19]. Consequently, in low-income countries fixated on meeting their most fundamental needs, the likelihood of advancing to higher levels of self-actualization and scientific progress is significantly diminished, if attainable. Countries like the USA, the United Kingdom, Germany, and Canada, falling into higher income levels, often dominate global university rankings. In contrast, countries with lower income levels appear less frequently on these prestigious lists[5,6,10,16,20,21] .

The present research demonstrated that a country's income level significantly correlates to its ranking in international systems like QS, THE, and ARWU (p-value ≤0.001). In a world where 6 % of the population consumes 40 % of vital resources, and per capita income in wealthier nations far exceeds that in poorer ones, the prospect of achieving uniformly developed societies seems unattainable. Consequently, the gap between the rich and the poor continues to widen[5,6,10,16,21,22]. Inequality in class hierarchies and capitalist systems significantly impacts the information age, and the reason for this is the difference in income and assets of developed countries. Furthermore, financial capability has caused the difference between information poverty and richness[6,10,16,20,22] . Another consequence of this income inequality is the creation of a digital divide in different countries. Developed countries are superior to other countries in terms of economies and education. Free access to information resources and advanced communication facilities is the reason for this superiority[5,6,10,16,22]. Consequently, the information divide, digital divide, and lack of free flow of information in developing countries can have global repercussions[20].

This study explored the connection between a country's R&D expenditure and the number of universities featured in ranking systems. Findings revealed a significant positive correlation between the average R&D expenditure in US dollars and the presence of a country's universities on these rankings. These findings align with Norouzi and Madadi's 2014 study, indicating that countries investing heavily in R&D expenditures saw more extraordinary advances and climbed higher scientific rankings. Their research noted that high-income nations boasted numerous universities in global rankings, drew a higher number of academic degrees, and garnered more citations[12].

5. CONCLUSION

Countries with higher income levels consistently lead in major international university rankings. A clear, positive link exists between a nation's ranking presence and its income and R&D spending. To climb the ranks, countries should consider increasing their investment in R & D. Moreover, policymakers should enhance university quality and performance, investing in elevating them within the top tiers of the three leading international

ranking systems. Universities can climb higher in these rankings by focusing on the criteria these rankings use, such as funding to attract international students, encouraging graduates to pursue further education, and fostering global collaborations. Attention to additional metrics used by QS, THE, and ARWU will further assist in this advancement.

REFERENCES

1. Yaghtin, M. The criteria and indicators affecting the divergence between the Iranian national ranking system and global university ranking systems. *Sci. Res. J.*, 2024, **9**(2), 1-22. https://rsci.shahed.ac.ir/article_4072_en.html?lang=en (accessed on 14 Apr 2025) [In Persian]
2. Topilovich Mirzayev, A. Assessment of the impact of influencing factors in ensuring the competitiveness of graduates in higher education institutions. *World Sci. news Sci. Int. J.,* 2024, **2**(2), 79-102. https://worldofresearch.ru/index.php/wsjc/article/view/198 (accessed 15 Jan 2024)
3. Vasilevska, M. Towards development of a new higher education institution ranking model that establishes a meaningful linkage between higher education and economic development. *Knowl.International J.,* 2024, **62**(2), 205-10. https://ojs.ikm.mk/index.php/kij/article/view/6580 (accessed 15 Jan 2024)
4. Matlis, G.; Dimokas, N. & Karvelis, P. Unveiling university groupings: A clustering analysis for academic rankings. *Data,* 2024, **9**(5), 67. doi: 10.3390/data9050067
5. Ramezani, S.G. & Ursin, J. University rankings in Nordic higher education: A scoping review. *Scand J. Educ. Res.* 2024, **68**(1), 6-21. doi: 10.1080/00313831.2023.2263770
6. Moustafa, K. University rankings: Time to reconsider. *Bioimacts,* 2024, **14**(3), 1-6. https://bi.tbzmed.ac.ir/Article/bi-30290 (accessed 20 Feb 2024)
7. Rigi, A.; Azizi, N. & Pourghaz, AW. Critical analysis of extracurricular factors affecting the global ranking of Iranian universities. *Res. Educ. Syst.,* 2016, **14**(49), 91-109. http://www.jiera.ir/article_108275.html (accessed 15 Jan 2024) [In Persian]
8. Altakhaineh, A.R.M. & Zibin, A. A new perspective on university ranking methods worldwide and in the Arab region: Facts and suggestions. *Qual. High Educ.,* 2021, **27**(3), 282–305. doi: 10.1080/13538322.2021.1937819
9. Khanizad, R. & Montazer, G. A Comparative evaluation of world university ranking systems. *Sci. Technol. policy.,* 2017, **9**(3), 31-43. https://jstp.nrisp.ac.ir/article_12985_c42fa52b0af338442c9cbd3ccce38058.pdf (accessed 20 March 2023) [In Persian]
10. Riyad, A.S. & Baizhanov, S. Global university rankings and geopolitics of knowledge. In: Tierney, R.; Rizvi F.; Ercikan, K. & Smith, G., editors. *International Encyclopedia of Edu.*, 4th ed. Oxford, UK: Elsevier; 2023, 261-71. doi: 10.1016/B978-0-12-818630-5.08042-8
11. Van Raan, A.F.J. Two-step competition process leads to quasi power-law income distributions. *Phys. A.: Stat. Mech. its Appl.,* 2001, **298**(3–4), 530-6. doi: 10.1016/S0378-4371(01)00254-0
12. Norouzi Chakli, A. & Madadi, Z. Gross domestic expenditure on R&D indicators and scientific ranking: Do countries that better spend on research and development have better scientific rankings? *Res. Inf. Sci. Public Libr.,* 2015, **21**(1), 177-191. https://publij.ir/article-1-1172-en.html (accessed 2 Aug 2023) [In Persian]
13. Fred, Y.Y. A quantitative relationship between per capita GDP and scientometric criteria. *Scientometrics,* 2007, **71**(3), 407–13. doi: 10.1007/s11192-007-1678-z
14. Hamadeh, N.; Van Rompaey, C.; Metreau, E. & Grace Eapen, S. New world bank country classifications by income level: 2022-2023. *World Bank Blogs. 2022.* https://blogs.worldbank.org/opendata/new-world-bank-country-classifications-income-level-2022-2023 (accessed 15 Jan 2024)
15. Moradian, M.; Erfanmanesh, M.A. & Asnafi, A. Relationship between the performances of top world universities based on scientometric indicators and their position in ten international academic ranking systems. *J. Sci. Tech. Inf. Manag.,* 2018, **3**(4), 23-42 doi: 10.22091/stim.2018.2612.1174 [In Persian].
16. Wu, Q. & Borhan, M.T. Sustainable development of Chinese higher education through comparison of higher education indices. *Front Educ.,* 2024, **9**, 1340637 doi: 10.3389/feduc.2024.1340637
17. Benito, M.; Gil, P. & Romera, R. Funding, is it key for standing out in the university rankings? *Scientometrics,* 2019, **121**(2), 771-92. doi: 10.1007/s11192-019-03202-z
18. Williams, R.; De Rassenfosse, G.; Jensen, P. & Marginson, S. The determinants of quality national higher education systems. *J. High Educ. Policy Manag*., 2013, **35**(6), 599-611. doi: 10.1080/1360080X.2013.854288
19. Maslow, A.H. A theory of human motivation. *Psychol Rev.,* 1943, **50**(4), 370-96. doi: 10.1037/h0054346
20. Zhao, L.; Cao, B.; Borghi, E.; Chatterji, S.; Garcia-Saiso, S.; Rashidian, A. *et al.* Data gaps towards health development goals, 47 low- and middle-income countries. *Bull. World Heal. Organ.,* 2022, **100**(1), 40-9. doi: 10.2471/BLT.21.286254
21. Herrera-Viedma, E.; Arroyo-Machado, W. & Torres-Salinas, D. Losing objectivity: The questionable use of surveys in the Global Ranking of Academic Subjects. *Quant. Sci. Stud*., 2024, **5**(2), 484-6. doi: 10.1162/qss_c_00289
22. Calderon, A. The geopolitics of university rankings

not all regions and university networks stand equal. In: E. Hazelkorn, M.G.; editors. *Res. Handbook on Uni. Rankings: Theory, Methodology, Influence and Impact*. Cheltenham, UK: Edward Elgar Publishing, 2021, 382–98.
doi: 10.4337/9781788974981.000401

ACKNOWLEDGEMENT

This study was supported by grant number 43009271 from School of allied Medical Sciences, Shahid Beheshti University of Medical Sciences Tehran, Iran. The code of ethics is IR.SBMU.RETECH.REC.1402.855.

CONTRIBUTORS

Ms. Romina Sepehr has a Master Degree in Mecical Libarary and Information Science from Shahid Beheshti University of Medical Science, Tehran, Iran. she is the member of Scientometrics Department of School of Health Management and Information Sciences, Iran University of Medical Sciences. This article is based on her Master thesis. Her areas of intersts are Scientometrics, International university raning and database. She has contributed to this study by carrying out literature review, data collection, data analysis, and writing the initial draft of the manuscript.

Dr. Maryam Shekofteh is an associate professor at the Department of Medical Library and Information Science, School of Allied Medical Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Iran. She has published more than 70 research papers. Her areas of interests include Scientometrics, Altmetrics, Scientific communication, etc.
She is the corresponding author and contributes to this study by leading the research team, preparation the final draft of the study.

Dr. Azam Shahbodaghi serves as an assistant professor and also leads the Department of Medical Library and Information Science, School of Allied Medical Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Iran. Her interests encompass Scientometrics, Research methodology, Executing systematic search strategies for systematic reviews and Meta-analyses, etc.
She engaged in developing the research plan for the article as a methodology advisor and also contributed to shaping all sections of the manuscript.

Dr. Sara Jambarsang is an associate professor at the Center for Healthcare Data Modeling, Departments of Biostatistics and Epidemiology, School of public health, Shahid Sadoughi University of Medical Sciences, Yazd, Iran. Her areas of interests include: Application of statistical analyst of the data in this study.