

Comprehensive Evaluation of the Quality of Student Enrollment in a Medical School Based on Factor Analysis and RSR Method

Yafei Tang¹, Lianhua Liu^{1*}

¹ International School of Public Health and One Health, Hainan Medical University, Haikou, China

Email Address

liulianhua.009@163.com (Lianhua Liu)

*Correspondence: liulianhua.009@163.com

Received: 2 March 2024; Accepted: 25 March 2024; Published: 28 April 2024

Abstract:

To conduct a comprehensive evaluation of the quality of undergraduate enrollment sources in a medical school, with a view to providing a certain reference basis for decision-making on enrollment. Based on 7 admission-related indicators of 29 undergraduate majors of the institution in 2020, factor analysis was used to analyse and rank the quality of student sources of different majors, and RSR method was used for grading. Through factor analysis, three common factors were extracted, and the top three majors in terms of composite factor scores were Clinical Medicine, Dentistry, and Traditional Chinese Medicine. The bottom three majors were Labor and Social Security, Environmental Science, and Marine Pharmacy. The RSR method classified the 29 majors into three categories, and regression analysis showed that the differences between each level were statistically significant ($F=2310.697$, $P<0.001$). The quality of student intake at the university is influenced significantly by factors such as the highest score, average score, and comprehensive admission rate. Additionally, the evaluation results of student intake quality relatively consistent with the actual academic strength of each major.

Keywords:

Quality of Enrollment Student, Comprehensive Evaluation, Factor Analysis Method, RSR Method

1. Introduction

With the development of the times, the scale of higher education in various regions continues to expand. It is an undeniable fact that the competition among universities for student enrollment is becoming increasingly fierce. Student enrollment is a crucial lifeline for the survival and development of schools. In the strategic layout of the “three major strategies and two major markets” constructed by schools, enrollment plays a vital role in guiding and facilitating the development of the school’s academic quality [1]. The education of undergraduate students also serves as a bridge for talent cultivation. Therefore, it is necessary to cultivate the student body in a scientific and

reasonable manner and continuously modify strategies to enhance the quality of students enrolled. Only by doing can the teaching quality of the school be correspondingly improved [2]. At the same time, the quality of students enrolled significantly determines the starting point of teaching work at universities and influences the quality of education and talent cultivation. Enhancing and improving the quality of student intake is a fundamental aspect of enhancing the quality of education and teaching [3,4]. Medical education bears the heavy responsibility of nurturing and supplying medical talents. The competition among various medical schools also stems from the competition for high-quality student intake. The quality of student intake in medical schools lays the foundation for the cultivation of medical talents and influences the training of higher-level medical professionals in each institution [5]. Therefore, conducting a reasonable and objective evaluation of the quality of student intake in medical schools, selecting appropriate indicators, and constructing a comprehensive evaluation system to conduct a multidimensional study on the quality of student intake, is beneficial for further improving the quality of student intake. It provides a scientific basis for decision-making aimed at enhancing the quality of student intake.

The purpose of this study is to analyze the current situation and comparative evaluation of the recruitment quality of a medical school in 2020. Based on the admission data of 29 majors in the school, factors such as the highest score, lowest score, and average score will be evaluated using factor analysis and RSR (Relative Score Rank) method. The goal is to provide a scientific basis for decision-making in order to improve the quality of student intake in the following year.

2. Material and Method

2.1. Material

The data for this study was obtained from the admission and enrollment platform system of a specific medical school. The selected indicators for the 2020 undergraduate majors' entrance examination are as follows, as shown in Table 1. X1: Highest admission score, X2: Lowest admission score, X3: Average score of the total scores, X4: Comprehensive admission rate, X5: First-choice admission rate, X6: Registration rate, X7: Adjustment rate (comprehensive admission rate = number of applicants admitted to the major / total number of majors chosen by applicants). Since the adjustment rate is a reverse indicator, it was transformed into a positive indicator by taking the opposite value during the factor analysis.

Table 1. Raw data.

Majors	X1	X2	X3	X4	X5	X6	X7
Clinical Medicine	650	361	560	0.1239	0.94	0.99	0.00
Dentistry	651	366	557	0.0868	0.97	0.98	0.00
Medical Imaging	600	361	540	0.0836	0.31	0.97	0.03
Anesthesiology	620	361	533	0.0724	0.58	1.00	0.00
Pediatrics	628	351	537	0.0664	0.38	1.00	0.00
Traditional Chinese Medicine	679	358	549	0.0571	0.74	0.97	0.03
Preventive Medicine	598	341	506	0.0575	0.36	0.97	0.00
Medical Laboratory Technology	654	340	513	0.0552	0.40	0.99	0.01
Pharmac	629	357	531	0.0424	0.45	0.92	0.04
Clinical Pharmacy	597	358	522	0.0348	0.59	1.00	0.04
Chinese and Western Medicine	638	359	541	0.0333	0.43	1.00	0.00
Nursing	593	340	523	0.0364	0.60	0.99	0.19

Applied Psychology	593	357	526	0.0108	0.68	1.00	0.00
Psychiatry	598	357	526	0.0241	0.37	1.00	0.11
Traditional Chinese Pharmacy	588	350	514	0.0170	0.35	0.93	0.05
Rehabilitation Therapy	593	357	524	0.0157	0.47	1.00	0.09
Acupuncture and Massage	623	358	540	0.0197	0.29	0.96	0.08
Health Services and Management	591	350	516	0.0248	0.52	0.95	0.26
Public Utilities Management	568	416	520	0.0206	0.51	0.97	0.22
Biotechnology	574	450	531	0.0149	0.58	0.91	0.22
Bioinformatics	561	403	507	0.0116	0.34	0.97	0.17
Health Inspection and Quarantine	599	351	506	0.0160	0.31	0.94	0.19
Midwifery	587	357	531	0.0123	0.37	1.00	0.20
Marketing	571	357	517	0.0139	0.55	0.92	0.33
Information Management and Information Systems	569	350	510	0.0116	0.45	0.97	0.33
Labor and Social Security	578	406	513	0.0146	0.33	0.95	0.36
Applied Statistics	598	357	521	0.0084	0.31	0.97	0.51
Environmental Science	594	448	536	0.0065	0.13	0.97	0.59
Marine Pharmacy	579	358	514	0.0076	0.03	0.86	0.66

2.2. Statistical methods

2.2.1. Factor analysis

Factor analysis is a dimensionality reduction method that can transform multiple correlated variables into a few influential factors. It starts with the correlation relationships within the matrix of research indicators and converts the multiple indicators into a small number of factors based on their strength of correlation. The number of common factors is determined based on eigenvalues greater than 1 or cumulative variance contribution rate greater than 80%. Finally, the common factors and factor scores are calculated, and a comprehensive ranking is obtained [6,7]. The steps involved in factor analysis are as follows: (1) Standardization; (2) KMO and Bartlett's test (to assess the feasibility of factor analysis); (3) Calculating the total explanatory variance and factor loadings; (4) Extraction of common factors; (5) Calculating composite scores. The weights are determined based on the variance contribution rate of several indicators.

2.2.2. RSR method

Rank-sum ratio (RSR) refers to the average or weighted average of the sum of ranks for rows (or columns) in a table. It is a dimensionless statistical measure obtained through rank transformation in an n-row (n evaluation objects) by m-column (m evaluation indicators or levels) matrix. The RSR value is used to rank the evaluation objects in terms of their relative performance. Based on the number of comparison groups, the objects are classified into different categories. In this study, the composite factor scores obtained from factor analysis are used as RSR values in the rank-sum ratio method. The R values, which represent the ranks of objects listed in ascending order of RSR values, are calculated, and the cumulative frequency $P=R/n$ (where n is the number of evaluation objects) is computed. The NORMSINV function is used to transform the cumulative frequency P into Probit, a measure in probability units. A smaller Probit value indicates a better evaluation object. The RSR method extends the application of composite factor scores and addresses the limitation of factor analysis in not providing categorization. This makes the results more scientific and reasonable [8,9].

3. Results

3.1. KMO and Bartlett test

Factor analysis typically begins with the KMO (Kaiser-Meyer-Olkin) test and the Bartlett test. The KMO value ranges from 0 to 1, with higher values indicating greater suitability of the data for factor analysis. Generally, a KMO value above 0.5 is required. In this study, SPSS 22.0 was used for the analysis, and the KMO value was found to be 0.766, which indicates good correlation among the original data. The Bartlett's test of sphericity had a significance level of $P < 0.05$, rejecting the null hypothesis that the correlation matrix is an identity matrix and indicating the presence of correlation among the original variables. Based on these two tests, it can be concluded that the original data is suitable for factor analysis.

3.2. Determine the number of factors

To determine the number of factors, one can consider the magnitude of factor variance. Factors with eigenvalues greater than 1 (contributing significantly) or a cumulative variance contribution rate exceeding 80% are commonly chosen. In this study, factors with a cumulative variance contribution rate greater than 80% were selected to represent the common factors. Table 2 shows that the first three factors account for 81.125% of the information in the original data. Therefore, selecting the first three indicators can capture the comprehensive information reflected by the common factors F1, F2, and F3, reducing information loss as much as possible.

Table 2. Total Variance Explained.

Component	Initial eigenvalues			Extraction Sums of Squared loadings			Rotation Sums of squared loadings		
	eigenvalues	% of variance	Cumulative %	eigenvalues	% of variance	Cumulative %	eigenvalues	% of variance	Cumulative %
1	3.682	52.606	52.606	3.682	52.606	52.606	2.814	40.203	40.203
2	1.202	17.167	69.773	1.202	17.167	69.773	1.473	21.047	61.250
3	0.795	11.352	81.125	0.795	11.352	81.125	1.391	19.874	81.125
4	0.562	8.024	89.149						
5	0.326	4.664	93.813						
6	0.251	3.591	97.404						
7	0.182	2.596	100.000						

3.3. Factor Explaining

To establish the factor loading matrix, a varimax orthogonal rotation was conducted to simplify the structure of the factor loading matrix. This rotation ensures that each indicator has a high loading on one specific factor, while having smaller or moderate loadings on other factors, facilitating better interpretation. From Table 3, it can be observed that the factor loadings are clearly separated after rotation. Based on the criterion of factor loading bigger than 0.5, the following professional interpretations can be made. The first factor F1 has relatively high loadings on four indicators: X1 (highest score), X3 (average score), X4 (comprehensive admission rate), and X5 (First-choice admission rate). This suggests that these four indicators represent the most critical factors for evaluating the quality of enrolled students. They reflect

admission scores and first-choice admission rate. Therefore, this factor can be named “Comprehensive Influence Factor.” The second factor F2 has high loadings on two indicators: X2 (lowest score) and X7 (adjustment rate). These indicators reflect the minimum admission score and the rate of adjustment. Hence, this factor can be defined as the “Low Score Influence Factor.” The third factor F3 exhibits a high loading on X6 (registration rate). This indicator reflects the actual number of students who registered at the university. Therefore, it can be referred to as the “Registration Rate Factor.”

Table 3. Component Matrix.

Variables	Component Matrix			Rotated Component Matrix			Component score coefficient matrix		
	F1	F2	F3	F1	F2	F3	F1	F2	F3
X1	0.830	0.060	-0.330	0.817	0.360	0.075	0.346	0.181	-0.271
X2	-0.407	0.826	0.264	-0.033	-0.953	-0.085	0.122	-0.750	0.131
X3	0.730	0.559	-0.097	0.892	-0.189	0.154	0.421	-0.290	-0.093
X4	0.856	0.110	-0.206	0.819	0.283	0.187	0.319	0.093	-0.138
X5	0.734	0.223	0.178	0.646	0.009	0.451	0.176	-0.167	0.257
X6	0.582	-0.181	0.724	0.150	0.117	0.927	-0.245	-0.126	0.895
X7	0.827	-0.331	0.093	0.490	0.553	0.508	0.015	0.280	0.248

3.4. Composite factor score function

By utilizing the factor score coefficient matrix from Table 3, we can derive the calculation formulas for each common factor score: $F1 = 0.346X1 + 0.122X2 + 0.421X3 + 0.319X4 + 0.176X5 - 0.245X6 + 0.015X7$, $F2 = 0.181X1 - 0.750X2 - 0.290X3 + 0.093X4 - 0.167X5 - 0.126X6 + 0.28X7$, $F3 = -0.271X1 + 0.131X2 - 0.093X3 - 0.138X4 + 0.257X5 + 0.895X6 + 0.248X7$. By substituting the standardized data of each indicator into the above equations, we can calculate the scores for each comprehensive factor. Then, by weighting and summing these scores according to the variance contribution rate after the rotation of the common factors, we can obtain the comprehensive factor scores.

$$F = \frac{40.203F_1 + 21.047F_2 + 19.874F_3}{81.125}$$

3.5. Composite factor score and ranking

By utilizing the aforementioned common factor score calculation formulas and comprehensive factor score formula, we can calculate the common factor scores and comprehensive factor scores for each major, as shown in Table 4. By ranking the majors based on their comprehensive factor scores, we can provide a comprehensive evaluation and ranking. The results indicate that the top three majors are Clinical Medicine, Dentistry, and Traditional Chinese Medicine. The bottom three majors are Marine Pharmacy, Environmental Science, and Labor and Social Security.

Table 4. Factor Scores and Overall Rank.

Majors	F1	F2	F3	F	Rank
Clinical Medicine	2.72739	-0.19005	0.33189	1.38	1
Dentistry	2.36872	-0.35877	0.31250	1.16	2
Traditional Chinese medicine	1.98310	0.31066	-0.34353	0.98	3
Anesthesiology	0.65105	0.20749	0.78449	0.57	4
Pediatrics	0.58412	0.63264	0.46261	0.57	5
Medical Laboratory Technology	0.11456	1.54130	0.14161	0.49	6

Chinese and Western Medicine	0.53115	0.19128	0.53771	0.44	7
Medical Imaging	0.72759	0.36474	-0.21222	0.40	8
Nursing	-0.34183	0.74613	0.97709	0.26	9
Pharmacy	0.82202	0.74852	-1.40179	0.26	10
Clinical Pharmacy	-0.34967	0.21986	1.22513	0.18	11
Acupuncture and Massage	0.33757	0.27836	-0.56506	0.10	12
Psychiatry	-0.52780	0.38734	1.02056	0.09	13
Preventive Medicine	-0.60805	1.37483	0.07122	0.07	14
Rehabilitation Therapy	-0.65407	0.20174	1.16743	0.01	15
Applied Psychology	-0.48179	-0.26794	1.22654	-0.01	16
Health Services and Management	-0.44011	0.65204	-0.13669	-0.08	17
Midwifery	-0.65756	-0.14637	0.85261	-0.15	18
Traditional Chinese Pharmacy	-0.62287	0.80988	-0.84636	-0.31	19
Health Inspection and Quarantine	-0.84446	0.89922	-0.76637	-0.37	20
Marketing	-0.50356	0.17218	-0.81314	-0.40	21
Applied Statistics	-0.71245	-0.02654	-0.29272	-0.43	22
Information Management and Information Systems	-1.24227	0.14526	0.21923	-0.52	23
Public Utility Management	-0.52998	-1.67335	0.60537	-0.55	24
Biotechnology	0.43633	-2.52268	-0.76856	-0.63	25
Bioinformatics	-1.28347	-0.93941	0.58326	-0.74	26
Labor and Social Security	-0.74042	-1.13211	-0.31959	-0.74	27
Environmental Science	-0.13023	-2.83222	-0.38669	-0.89	28
Marine Pharmacy	-0.61302	0.20597	-3.66652	-1.15	29

3.6. RSR distribution and categorization

The scores of the comprehensive factors obtained from factor analysis are ranked in ascending order as RSR values. The cumulative frequencies and unit probit values are calculated according to the formula. Based on the RSR values, the rank order R is determined. The results are shown in Table 5. Regression analysis shows a linear relationship between RSR values and unit probit probabilities, with the regression equation as $RSR = -0.05 + 0.609 \cdot \text{Probit}$. Applying the optimal categorization criteria and referring to a reasonable categorization table, all majors can be divided into three categories. Analysis of variance shows $F=2310.697$, $P < 0.001$, indicating statistically significant differences among the categories. The categorization standards and results are shown in Table 6. The majors are divided into three levels: “Excellent”, “Intermediate”, and “Poor”. Clinical medicine, Traditional Chinese Medicine, Dentistry, Anesthesiology and Pediatrics have the highest quality of enrollment students. Environmental science, Marine Pharmacy, Bioinformatics, Labor and Social Security, and Biotechnology have relatively poorer quality of enrollment sources. The quality of enrollment sources for other majors are average.

Table 5. RSR distribution of comprehensive factor scores.

Majors	RSR	P	probit	R
Marine Pharmacy	-1.15	0.0345	-1.8186	1
Environmental Science	-0.89	0.069	-1.4835	2
Bioinformatics	-0.74	0.1034	-1.2621	3
Labor and Social Security	-0.74	0.1379	-1.0897	4
Biotechnology	-0.63	0.1724	-0.9447	5
Public Utility Management	-0.55	0.2069	-0.8172	6
Information Management and Information Systems	-0.52	0.2414	-0.7019	7
Applied Statistics	-0.43	0.2759	-0.5952	8

Marketing	-0.40	0.3103	-0.4949	9
Health Inspection and Quarantine	-0.37	0.3448	-0.3993	10
Traditional Chinese Pharmacy	-0.31	0.3793	-0.3073	11
Midwifery	-0.15	0.4138	-0.2178	12
Health Services and Management	-0.08	0.4483	-0.13	13
Applied Psychology	-0.01	0.4828	-0.0432	14
Rehabilitation Therapy	0.01	0.5172	0.0432	15
Preventive Medicine	0.07	0.5517	0.13	16
Psychiatry	0.09	0.5862	0.2178	17
Acupuncture and Massage	0.10	0.6207	0.3073	18
Clinical Pharmacy	0.18	0.6552	0.3993	19
Nursing	0.26	0.6897	0.4949	20
Pharmacy	0.26	0.7241	0.5952	21
Medical Imaging	0.40	0.7586	0.7019	22
Chinese and Western Medicine	0.44	0.7931	0.8172	23
Medical Laboratory Technology	0.49	0.8276	0.9447	24
Anesthetics	0.57	0.8621	1.0897	25
Pediatrics	0.57	0.8966	1.2621	26
Traditional Chinese Medicine	0.98	0.931	1.4835	27
Dentistry	1.16	0.9655	1.8186	28
Clinical Medicine	1.38	0.9914*	2.3824	29

Note: *Corrected to $[1-(1/4n)*100\%]$.

Table 6. RSR rating classification.

Rank	RSR fitted value	Majors
Poor	<0.5253	Environmental Science, Marine Pharmacy, Bioinformatics, Labor and Social Security, Biotechnology
Intermediate	0.5477 ~	Others majors
Excellent	0.5477~	Clinical medicine, Traditional Chinese Medicine Dentistry, Anesthesiology, Pediatrics

4. Conclusions

4.1. Evaluation Results

From the evaluation results, the majors with the best quality of enrollment sources in this college are clinical medicine, traditional Chinese medicine, and dentistry. By comparing the original indicator data, it can be observed that these three majors have significant advantages in terms of the highest, lowest, and average admission scores, as well as the comprehensive admission rate and the first-choice admission rate, compared to other majors. Therefore, they are leading in the overall rankings. On the other hand, the majors with the lowest rankings in terms of first-choice admission rate, transfer rate, and comprehensive admission rate have an impact on their overall rankings.

4.2. Evaluation Method

In this study, a combination of factor analysis and rank-sum ratio method was used to comprehensively evaluate the quality of enrollment sources of various majors in a medical college in 2020. The use of these two methods together provides a clearer understanding of the enrollment source situation among different majors in the college and allows for a comparison of the differences between majors. The comprehensive rankings obtained from this method are highly consistent with the actual rankings of

the majors in terms of their strengths, indicating that this method is scientific and reasonable for evaluating the quality of enrollment sources. It further demonstrates that the development strength of various majors in a school is closely related to the quality of students' source. To improve the academic strength of each major, scientific and reasonable enrollment strategies should be formulated to enhance the quality of enrollment sources.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

Funding

This work was supported by Hainan Medical University undergraduate innovation and entrepreneurship training program (No.X202111810091) and Natural Science Foundation of Hainan Province (No. 821QN0895).

References

- [1] Zeng, X., Optimized strategies for the management of teaching quality in county-level ordinary high schools. Guangzhou University, 2023. DOI: 10.27040/d.cnki.ggzdu.2023.001960.
- [2] Fu, J. Research on public physical education in ordinary colleges and universities in Jiangxi Province from the perspective of ecological education. Jingdezhen Ceramic University, 2023. DOI: 10.27191/d.cnki.gjdtc.2023.000440.
- [3] Cao, M.; Yue, G.; Zhang, S. Research on the evaluation model of the quality contribution of students in universities. *Higher Engineering Studies*, 2014(5), 130-134.
- [4] Wei, Z.; Qian, Y.; Mao, J. Research on the evaluation model of the quality of student sources in universities. *Science and Technology Information*, 2010, 33, 187-205.
- [5] Du, B.; Wang, K.; Li, W. et al. An empirical study on the evaluation of the quality of undergraduate enrollment of a medical university based on factor analysis. *Chinese Higher Medical Education*, 2023, 06, 9-11.
- [6] Zheng, Y.; Shi, G. An empirical study on the evaluation of the quality of undergraduate sources based on factor analysis. *Journal of Hefei University of Technology (Natural Science Edition)*, 2016, 39(11), 1571-1575.
- [7] Dong, Y.; Li, R.; Zhu, W. et al. Comprehensive evaluation of the allocation of health resources in different social circles in Beijing based on grey correlation analysis and factor analysis. *Chinese Journal of Social Medicine*, 2023, 40(01), 101-105.
- [8] Wu, X.; Yin, Y.; Gan, Y. et al. Evaluation of clinical specialties in tertiary comprehensive hospitals under the background of high-quality development: based on entropy-weighted TOPSIS method and RSR method. *Modern Preventive Medicine*, 2023, 50(13), 2410-2415.

- [9] Yang, F.; Li, Y. Evaluation of elderly health status under different medical insurance using entropy weighted TOPSIS method and RSR method. *Modern Preventive Medicine*, 2021, 48(11), 2001-2005.



© 2024 by the author(s); licensee International Technology and Science Publications (ITS), this work for open access publication is under the Creative Commons Attribution International License (CC BY 4.0). (<http://creativecommons.org/licenses/by/4.0/>)