ORIGINAL ARTICLE

Evolution of the choice of places in Endocrinology and Nutrition in the Spanish exam for accessing to the resident physicians training program 2001–2022 measured with the quotation index

José-Joaquín Alfaro-Martínez[a,*], Lourdes García Blasco[a],
Rosa Pilar Quílez Toboso[a], Maria Carmen López García[a], Andrés Ruiz de Asín Valverde[a],
Alejandro Sirvent Segovia[b], Pedro Pinés Corrales[a]

[a] *Servicio de Endocrinología y Nutrición, Complejo Hospitalario Universitario de Albacete, Albacete, Spain*
[b] *Unidad de Endocrinología y Nutrición, Hospital General de Almansa, Almansa, Albacete, Spain*

Abstract
Introduction: The comparison between specialties or the analysis of evolution over time of a speciality in the Spanish exam for accessing to the resident physicians training programme (RPTP) is difficult due to the changing of the number of places offered. In this paper we describe two parameters (quotation index and quotation order) that objectify the relationship between supply and demand for places in a given medical speciality in a RPTP call and analyse the evolution of the speciality of Endocrinology and Nutrition (E&N).
Material and methods: We analysed the evolution of the supply/demand ratio for the speciality of E&N in the 2001–2022 RPTP calls using the quotation index and quotation order. An increase in the quotation order implies a worsening of the supply/demand ratio. Robust correlation analysis between year and quoatation orden is used.
Results: E&N shows a worsening in the RPTP choice, both in relation to all specialties offered and in relation to specialties of medical area (robust correlation coefficient year-quotation order 0.72 (p = 0.0002) if all specialties are considered and 0.80 (p < 0.0001) if only medical area specialties are considered).
Conclusions: The specialty E&N has shown a negative evolution in the choice of RPTP, objectified through the quotation index and the quotation order, both in relation to all the specialties offered and in relation to all the specialties of the medical area, although it is still among the most sought-after medical specialties in the medical area.
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* Corresponding author.
E-mail address: jalfaro@sescam.jccm.es (J.-J. Alfaro-Martínez).

PALABRAS CLAVE
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médicos residentes;
Oferta;
Demanda;
Endocrinología y
Nutrición

Evolución de la elección de plazas MIR de Endocrinología y Nutrición 2001–2022 medida mediante el índice de cotización

Resumen

Introducción: La comparación entre especialidades, o el análisis de la evolución en el tiempo de una especialidad en el examen para acceder a una plaza de médico interno residente (MIR), es difícil debido al cambiante número de plazas ofertadas. En este trabajo analizamos la evolución de la especialidad Endocrinología y Nutrición (EyN) en España utilizando dos parámetros (índice de cotización y orden de cotización) que objetivan la relación entre la oferta y la demanda de plazas de una determinada especialidad médica en una convocatoria MIR.

Material y métodos: Se analizó la evolución de la relación oferta y demanda de la especialidad EyN en las convocatorias MIR 2001–2022 mediante el índice de cotización y orden de cotización. Un aumento del orden de cotización implica un empeoramiento de la relación oferta-demanda. Analizamos la correlación robusta entre año y orden de cotización.

Resultados: EyN presenta un empeoramiento en la elección MIR, tanto con relación al conjunto de especialidades ofertadas como con relación a las especialidades de área médica (coeficiente de correlación robusta año-orden de cotización 0,72 [p = 0,0002] si se consideran todas las especialidades y 0,80 [p < 0,0001] si solo se consideran las médicas).

Conclusiones: La especialidad EyN presenta una evolución negativa en la elección MIR, objetivada a través del índice de cotización y del orden de cotización, tanto con relación al conjunto de especialidades ofertadas como con relación al conjunto de especialidades de área médica, aunque sigue estando entre las especialidades de área médica más cotizadas.

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Introduction

Specialised medical training in Spain is based on a system of learning as a medical resident (médico interno residente [MIR] in Spanish) through a resident physicians training programme (RPTP), involving an employment relationship between the Health Service and the trainee specialist, which enables them to gradually take on more responsibilities as the training process progresses. To access this training, residents have to take a national entrance exam, known as the MIR exam,[1] held annually by the Spanish Ministry of Health. After the exam, applicants are assigned an order number with which they become potential candidates for one of the specialised training places.[2] The higher the score, the lower the order number, number one corresponding to the candidate with the highest grade and the first to choose a specialised training place. According to the position they achieve, the applicant chooses the speciality and their preferred teaching hospital from among the places offered and not already chosen by applicants with a better order number. A number of different factors have been said to influence this decision, such as the university school, personal circumstances, financial remuneration and the prestige of the speciality, plus the offer and demand.[3,4]

The selection results of the different medical specialities have traditionally stirred up keen interest. Studies published up to now have taken into account the mean and median of the place selection number.[5–9] However, comparing specialities and comparing different years for a particular speciality are difficult and not very rigorous due to the variability in the number of places offered. In recent years, the possibility has been raised that there may be less interest among applicants for the speciality of Endocrinology and Nutrition,[5] although other authors say figures are stable.[6]

The aim of this paper was to analyse changes in the choice of RPTP places in Endocrinology and Nutrition through a parameter which enables us to show the relationship between the supply and demand for places in a certain medical speciality at a MIR exam sitting.

Material and methods

Quotation index

To assess objectively the relationship between supply and demand of a medical speciality in the RPTP, we developed a parameter which we call the *quotation index* (QI). The calculation of the QI is based on the graph representation of the process of allocating places.

To calculate the QI of a certain speciality in a given exam sitting, we first have to plot on a graph the order number obtained in the sitting by each candidate awarded a place in that speciality (x-axis) and the percentage of places awarded for that same speciality after that place was awarded (y-axis),[i] joining the different points (x, y) by horizontal and vertical segments, so that the graph takes on the shape of a staircase.

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[i] We use the order number of the candidate in the sitting, not the order number with which they choose a place (as sometimes there are candidates who delay their choice). In this case, the percentage of places awarded refers to the percentage had the place been awarded to the candidate at the time that corresponded.
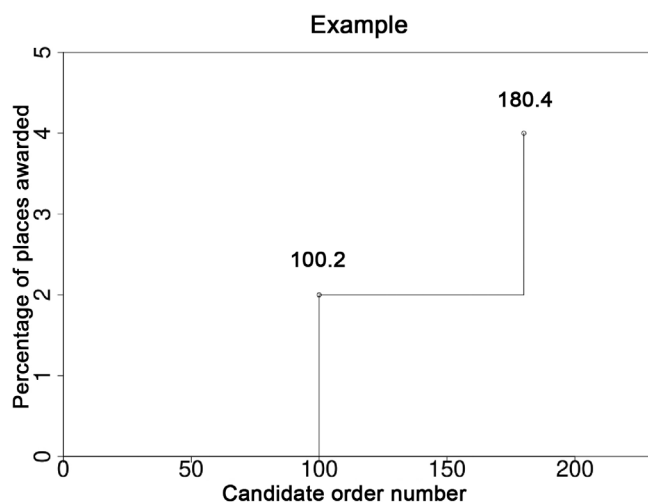
Figure 1 Graph representation of the first two places awarded in the example speciality.

Another graph is then made with identical Cartesian coordinates, for the total number of places for the sitting, considering all the places awarded in all specialities.

The QI of the speciality is the ratio of the area under the curve of the first graph to the area under the curve of the second, expressed as a percentage.

For example, in a speciality in which 50 places are offered in a sitting with a total of 5000 places offered for all specialities, in which the last place in the total number of specialities was awarded with the order number 5500 (there having been 500 waivers), we would proceed as follows:

If the first place in the speciality is awarded to a candidate with order number 100, the point (100, 2) would be plotted on the graph (because on awarding that first place, 2% of all the places offered in the specialty have been awarded). From the point (100, 0) a vertical line is drawn to the point (100, 2) (Fig. 1).

If the second place in the speciality is awarded to a candidate with the order number 180, the point (180, 4) would be marked on the graph and a horizontal line drawn from the previous point (100, 2) to the point (180, 2) and a vertical line from (180, 2) to (180, 4) (Fig. 1).

This is repeated until the last place in the speciality is awarded (100% of the total awarded). If this last place were awarded with the number 4000, the point (4000, 100) would be plotted and a horizontal line drawn from the point corresponding to the 49th place of the speciality to the vertical line from 4000 on the x-axis, and another vertical line from there to the point (4000, 100). Finally, a horizontal line would be drawn from the point (4000, 100) to the point (5500, 100), as 5500 is the last order number with which a place in any speciality has been awarded for the sitting.

The graph, in the shape of a staircase, represents for a certain order number in the sitting the percentage of places awarded for the speciality up to that moment. Thus, with the number 70, the graph will indicate that 0% of the places have been awarded; with the number 120, 2% will have been awarded; and with the number 4500, 100%.

Finally, we can calculate the area under the curve of the graph, which we will call A_1.

To represent the graph of all specialities (overall), continuing with the example of 5000 places offered, the point (1, 0.02) would be plotted with the first place, as one place is 0.02% of all those offered, the second place awarded would be plotted at the point (2, 0.04) and so on until, if the last place is awarded with the order number 5500, the point (5500, 100) would be plotted. The staircase segments would be represented in the same way as previously explained and the area under the curve calculated for the sitting overall, which we will call A_2.

The area under the curve, both for a specific speciality and for the overall sitting, is calculated using the following formula:

$$A = \frac{y_1 + y_{max} + 2\sum_{n=2}^{n=max-1} y_n}{2}.$$

where

A is the area under the curve;

y_1 is the percentage of places awarded in the speciality when the first place in the sitting is chosen (the first overall place, not necessarily in the speciality for which the area under the curve is being calculated);

y_{max} is the percentage of places awarded when the last place of the sitting is chosen, that is, 100;

max is the total number of places on offer at the sitting (for all specialities);

y_n is the percentage of places awarded in the speciality when place n in the sitting is chosen (the overall place n, not in the speciality for which the area under the curve is being calculated).

The quotation index of the speciality in question will be:

$$IC = \frac{A_1}{A_2}.100.$$

Fig. 2 shows the graphs of the example speciality and overall on the same axis, as well as the respective areas under the curve.

In our example A1 = 347,698 and A2 = 297,495. Consequently, the QI will be 116.9.

Obviously, doing the calculations manually would be extremely laborious, so the annex offers an R script, which means we can calculate the QI for a given sitting.

Table 1 shows the QI of the different specialities in the 2022 sitting as an example.

The proposed calculation of the QI based on the area under the curve in the process of awarding places combines the order number with which the first place is awarded (with which the area under the curve in the graph begins), the interval of awarding between place and place (the shorter the interval, the more in demand the speciality is, the graph has a steeper slope and, consequently, the area under the curve is greater) and the supply (the greater the supply, the slower the graph climbs, the longer it takes to reach 100% of places awarded and, consequently, the smaller the area under the curve will be).
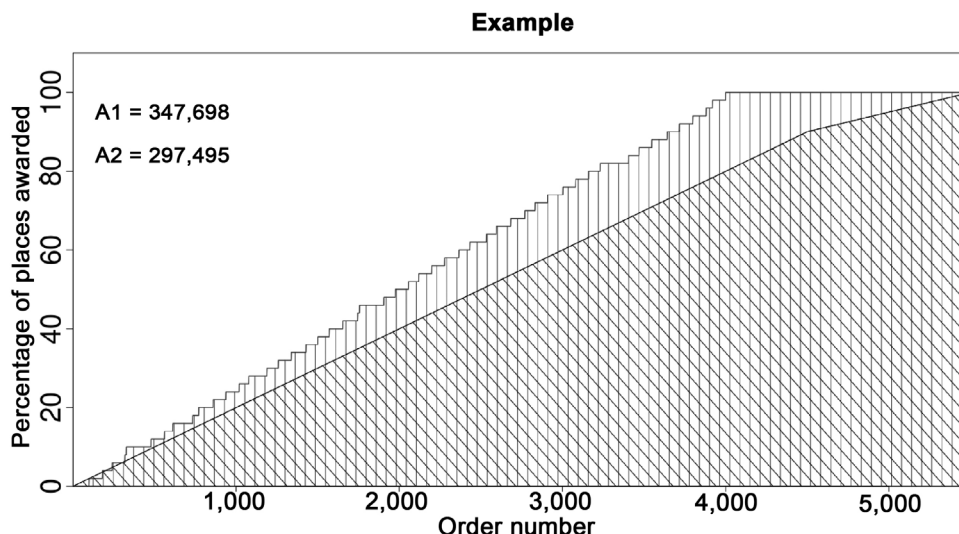
Figure 2 Simulation of exam session in which 5000 places are awarded in total.

The sitting overall is shown in black, and its area under the curve (A2) in oblique lines. The example speciality is represented in grey, and its area under the curve (A1) in vertical lines.

Up to order number 4,500, one place is awarded to each candidate, and from that point on, one in every two candidates withdraws, so the last place is awarded with order number 5500.

The example speciality begins to be awarded with the number 100, and then with a mean interval of 80 until the last place is awarded with the order number 4000. Despite the fact that the first place in the example speciality is awarded with an order number higher than the first place in the sitting, its area under the curve is greater than the overall one because the graph has a steeper slope and arrives first at 100% of the places awarded.

In effect, if the first place in one speciality is awarded with a lower number than the first place in a second speciality, we may think that the first is in greater demand. However, if after that first place in the second speciality, further places are awarded with short intervals, while there are longer intervals for the first, it is likely that the demand for the second place is actually greater. By combining the order number with which the first place is awarded and the allocation intervals between places throughout the sitting, the area under the curve objectively represents the demand for positions in each speciality.

From the supply point of view, if two specialities are equally in demand, such that each time a place is awarded in the first, a place is immediately awarded in the second (that is, the first place is awarded with virtually the same order number, and the following ones with the same interval), but the first speciality offers twice as many places as the second, the graph of the first speciality will rise more slowly than that of the second (because with each allocation the percentage of awarded places will increase by half, as twice as many places have been offered). Therefore, although the demand for the two specialities is the same, the area under the curve of the first (the one with twice the offer) will be smaller and consequently, so will its QI.

Expressing the QI as a percentage with respect to the area under the curve of the overall graph of the sitting helps determine whether the quotation of a certain speciality is above or below the average for the places offered.

Quotation order

From the QI of all the specialities for a given sitting, we can calculate the *quotation order* (QO). The speciality with the highest QI in each sitting, that is, the most valued, would have a QO = 1, the second a QO = 2, and so on. The QO can be calculated for one speciality with respect to the rest, or with respect to a subset of the total number of specialities (for example, of a surgical speciality with respect to the total number of surgical specialities).

Analysis of the changes for Endocrinology and Nutrition. Statistical methods

Based on the data for the allocation of RPTP places from the choices made from 2001 to 2022, we calculated the QI and then the QO for the speciality of Endocrinology and Nutrition for each of these years, both in relation to all specialities and to the adult medical specialities (Allergology, Gastroenterology, Cardiology, Endocrinology and Nutrition, Geriatrics, Haematology and Haemotherapy, Intensive Medicine, Internal Medicine, Nephrology, Respiratory Medicine, Neurology, Medical Oncology, Radiation Oncology, Psychiatry and Rheumatology).

For each sitting, we also analysed the total number of places awarded in all specialities, the places awarded in Endocrinology and Nutrition, the order number with which the first and last places in the speciality were awarded, and

Table 1 Quotation index (QI) and quotation order (QO) of the different medical specialities in the 2022 resident physicians training programme exam session.

Speciality	QI	QO
Medical-surgical dermatology and STD	170.16	1
Aesthetic and reconstructive plastic surgery	168.83	2
Cardiology	162.31	3
Oral and maxillofacial surgery	148.87	4
Anaesthetics and recovery	145.56	5
Ophthalmology	143.87	6
Neurosurgery	141.17	7
Trauma and orthopaedic surgery	139.18	8
Gastroenterology	138.64	9
Neurology	137.08	10
Legal and forensic medicine	137.02	11
Ear, nose and throat	136.35	12
Radiodiagnostics	133.87	13
Urology	132.59	14
Paediatric surgery	131.72	15
Obstetrics and gynaecology	131.13	16
Paediatrics and specific areas	129.37	17
Endocrinology and nutrition	128.81	18
Medical oncology	124.06	19
General and gastrointestinal surgery	119.51	20
Haematology and haemotherapy	119.47	21
Angiology and vascular surgery	116.5	22
Cardiovascular surgery	114.95	23
Rheumatology	112.94	24
Thoracic surgery	106.16	25
Nephrology	105.97	26
Internal medicine	105.66	27
Psychiatry	103.31	28
Intensive care medicine	101.53	29
Respiratory medicine	100.56	30
Physical medicine and rehabilitation	87.01	31
Radiation oncology	81.44	32
Allergology	76.49	33
Pathology	75.84	34
Immunology	74.6	35
Clinical neurophysiology	71.74	36
Nuclear medicine	62.63	37
Clinical pharmacology	59.61	38
Geriatric medicine	52.73	39
Family and community medicine	50.22	40
Preventive medicine and public health	46.97	41
Microbiology and parasitology	38.34	42
Clinical biochemistry	33.05	43
Clinical analyses	28.68	44
Occupational medicine	28.37	45

the median and the 25th and 75th percentiles of the order numbers with which Endocrinology and Nutrition places were awarded.

Additionally, the change in the number of places awarded in Endocrinology and Nutrition and other specialities was analysed as a percentage of the number of places awarded in 2001 (specialities not offered at the 2021–2022 sitting and Family and Community Medicine were excluded from the analysis due to a significant change in the award process

in 2002, as in 2001 there was a one-off sitting for graduates after 1995).

In order to assess whether or not the QO has improved (decreased) or worsened (increased) over these years, we calculated the robust correlation coefficient between the exam year and the QO. To determine the ''speed'' at which the QO improved or worsened over the years, a robust linear regression analysis was carried out, with the QO as the dependent variable and the exam year as the independent

Table 2 Endocrinology and Nutrition Statistics 2001–2022.

Year	QI	Overall QO	QO med. spec.	Total places	E&N places	First order no.	Last order no.	Order no. median	Order no. P25	Order no. P75
2001	121.20	6	2	3440	33	26	2246	588.0	399.00	737.00
2002	134.03	14	4	5130	44	174	2414	861.5	534.00	1471.25
2003	145.48	7	2	5417	47	37	2129	826.0	420.00	1194.50
2004	133.80	10	2	5661	52	86	2335	791.0	620.75	1403.75
2005	148.81	6	2	5480	51	92	2217	768.0	401.50	1070.50
2006	153.57	4	2	5682	55	19	2754	721.0	356.50	1000.50
2007	150.02	5	2	5792	56	3	2039	792.5	466.50	1429.75
2008	144.37	7	2	6214	62	32	3504	1151.5	458.00	1964.50
2009	140.47	10	3	6716	68	4	3882	1448.0	657.00	2376.00
2010	138.77	4	2	6922	75	28	2762	976.0	554.00	1525.00
2011	134.73	9	3	6835	74	122	3941	1403.5	710.50	2113.25
2012	133.14	10	3	6697	75	55	3803	1431.0	679.50	2482.50
2013	128.93	15	5	6337	76	23	4143	1915.0	1019.50	2743.50
2014	139.86	9	4	5921	73	14	3848	1485.0	843.00	2269.00
2015	132.91	9	4	5993	72	60	3618	1458.5	819.00	2177.50
2016	124.63	13	4	6089	72	108	3861	1750.0	1113.75	2311.25
2017	123.01	10	4	6322	77	134	3892	1786.0	903.00	2597.00
2018	115.03	18	5	6477	77	93	4284	2483.0	1460.00	3190.00
2019	113.69	20	5	6872	83	166	4482	2775.0	1669.00	3754.50
2020	120.71	17	5	7615	87	306	4827	2480.0	1689.00	3366.00
2021	125.23	17	4	7987	89	118	4713	2662.0	1603.00	3655.00
2022	128.81	18	4	7970	97	201	4782	2638.0	1630.00	3835.00

For each sitting, the awarded places are taken into account, not those offered (in some sittings, although all the E&N places were awarded, this was not the case for all specialities).

E&N: Endocrinology and Nutrition; QI: quotation index; Overall QO: quotation order with respect to all specialities; QO med. sp.: quotation order for adult medical specialities.

variable. The slope of that robust regression line is indicative of the change in QO over time.

The computer programme R version 4.1.2 was used for the statistical analysis (R Core Team (2021). R: A language and environment for statistical computing, R Foundation for Statistical Computing, Vienna, Austria, URL https://www.R-project.org/), using the RStudio integrated development environment. The calculation of the robust correlation coefficient was carried out using the pbcor() function of the WRS2 library (Mair, P., & Wilcox, R. R. (2020). Robust Statistical Methods in R Using the WRS2 Package. Behaviour Research Methods, 52, 464–488). The robust regression analysis was carried out using the robustRegH() function from the robustreg library (Ian M. Johnson (2019), robustreg: Robust Regression Functions. R package version 0.1-11, https://CRAN.R-project.org/package=robustreg).

Results

Table 2 shows the QI, the QO of Endocrinology and Nutrition, both in the specialities overall and among the medical specialities, the order numbers with which the first and last places in Endocrinology and Nutrition were chosen, and the mean, median and 25th and 75th percentile of the order numbers in the allocation of places from 2001 to 2022. As can be seen, in the last 20 years the number of RPTP places offered has doubled and the number of RPTP places for Endocrinology and Nutrition places has practically tripled. The QO for this speciality has increased, particularly in

recent years, irrespective of whether the comparison is made with all specialities offered in the RPTP or only with those in the medical area.

Fig. 3 shows the changes in the number of places awarded in Endocrinology and Nutrition and in the rest of the specialities at each sitting, taking as a reference those awarded in 2001. As we can see, Endocrinology and Nutrition is among the specialities to have increased their offer of places the most.

Fig. 4 shows the QO for the Endocrinology and Nutrition speciality over time, taking into account both all specialities and the medical specialities only, and the robust regression line between the QO and the year of choice, confirming in graph form the increase observed on analysing Table 2.

The robust correlation coefficient between the QO and the year of choice was 0.72 ($p = 0.0002$) if all specialities are considered and 0.80 ($p < 0.0001$) considering only the specialities in the medical area. Being positive and significant in both cases indicates that the QO increases over the years. The slope of the robust regression line was 0.59 if all specialities are considered and 0.15 considering only those in the medical area, which indicates that, on average, approximately one position is lost every two years in the first case and every seven years in the second.

Discussion

The QI described here allows us to evaluate objectively something as subjective as the valuation of a certain special-

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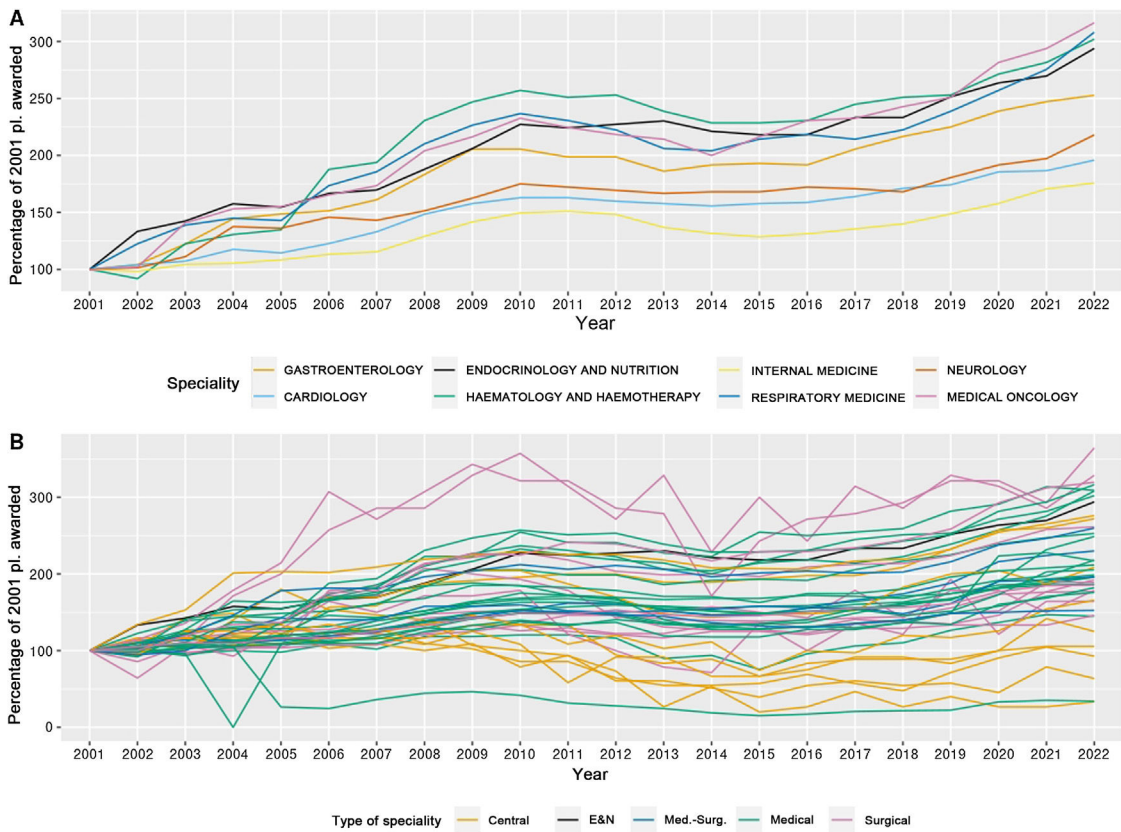
Figure 3 Changes in awarded places, for each speciality, from 2001 to 2022 as a percentage of those awarded (pl. awarded) in 2001. (A) Changes in a subset of medical area specialities. (B) Changes in places in Endocrinology and Nutrition (E&N) and other specialities grouped into medical, surgical, medical-surgical and central (Family and Community Medicine is not included because the selection model changed between 2001 and 2002, with significant changes in the number of places and specialities which are no longer offered).
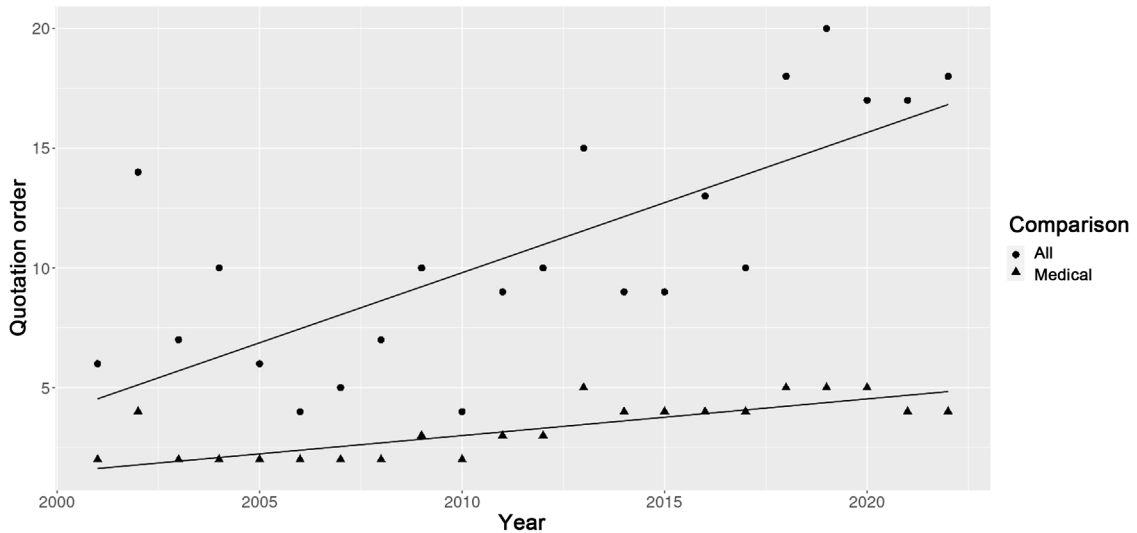
Figure 4 Changes in the quotation order of the Endocrinology and Nutrition speciality in the resident physicians training programme from 2001 to 2022 in comparison with all specialities (circles) and with specialities in the adult medical area (triangles), and robust regression lines for both comparisons.

ity, in this case Endocrinology and Nutrition, in a MIR exam sitting. The term ''valuation'' must be understood not in the sense of the intrinsic value of the speciality, something probably impossible to determine, but rather as the p̈riceöf the speciality, which would be equivalent in economics to a relationship between the supply (number of places offered) and the demand (number of candidates who would like to do said speciality as their first option).

Although interest in the speciality is the most important factor when choosing,[10] the type of medical school, demographic factors, and the supply and demand for places vary in each case and are aspects which have to be taken into account when analysing the particularities of the choosing process in each country. Bland and Meurer proposed a model on the factors which influence the choice of a speciality, grouped into five categories: the type of faculty in which the student was trained (public or private); the student's characteristics (demographics, personality); the student's values upon graduation from medical training (personal preferences); the needs to be met during the speciality (income, prestige, free time); and the way in which students perceive the speciality.[11]

For our work we designed specific tools, the QI and the QO. Other parameters which we could use to measure the demand or quotation of a speciality present problems. For example, exclusively analysing the order number with which the first or last place in the speciality is awarded is something that has a large chance factor.[6]

Curbelo et al. have published several articles on changes in the choice of different medical specialities over time where they use the mean or median of the order number with which the places are awarded.[6–9] However, these parameters depend on the number of places offered (an increase of a few places from one sitting to another can greatly increase the mean or median) and in the case of the mean, it is also very sensitive to atypical values, such as the last place awarded with a very high order number. The median, for its part, is less sensitive to atypical values, but it does not take into account the values from the 1st to the 49th percentile or those from the 51st to the 100th, which means information is lost, especially considering that the order with which the places are awarded does not follow a normal distribution. A more precise term would be p̈opularity indicator,̈ comparing the median obtained by chance with the actual median for each speciality in each year.[12]

Although it might be more interesting to analyse the mean or median interval for awarding places in the speciality, which is not affected by the number of places on offer, this has the problem that two specialities with the same number of places offered and the same interval, the first of which starts to be awarded from order number 50 and the second from order number 4000, would have the same valuation.

We must bear in mind that one QI greater than another implies a higher value than a lower QI, but it should be seen more as an order or rank than as an absolute value. That is, if at a certain sitting, one speciality has a QI of 140 and another speciality has a QI of 70, we cannot say that the value of the first is double that of the second, but we can say that the first is more valued.

It would be wrong to use the QI to make comparisons between different sittings, as when the offer of places varies, the QI changes for the same theoretical demand. For interannual comparisons, either between specialities or, as in our study, within the same speciality, it is preferable to use the QO, which compares the supply-demand ratio of one speciality to the rest.

The objective of finding out the QI for the different specialities and sittings is not simply morbid curiosity; wanting to determine which speciality is most or worst valued, or if speciality A is valued less than B. The scientific societies may be interested in knowing whether over the years their rating is remaining stable, improving or worsening and, accordingly, introducing measures to improve the perception of their speciality among students and RPTP candidates. Analysing the changes in the QO for the speciality at each sitting over the years helps us assess this objectively.

Our study shows how Endocrinology and Nutrition continues to be one of the most sought-after medical specialities by RPTP applicants, although with a decline in the QO in the exam sessions over the last 20 years, due in particular to the greater interest of candidates in surgical or medical-surgical specialities (deduced from a greater decline in the QO in the comparison with all specialities than when comparing Endocrinology and Nutrition with the medical area alone). The decrease in QO cannot be explained solely by an increase in the places offered over these years, as the increase has occurred in all specialities (although Endocrinology and Nutrition has definitely had one of the largest proportional increases in places). We believe new initiatives are needed to improve the visibility and awareness of the speciality among medical students, acting on factors involved in student's choices which are modifiable, including increasing the presence of Endocrinology and Nutrition specialists in undergraduate teaching, thereby giving the subject greater weight in the training plans and providing more internships. This would give all medical students the opportunity to learn about the excellent possibilities of this specialist area and all the associated techniques, for example, the new technologies applied to diabetes, thyroid ultrasound in the Endocrinology and Nutrition clinic, and the application of morphofunctional assessment in Clinical Nutrition.[13]

In any event, we cannot lose sight of the fact that Endocrinology and Nutrition continues to be among the specialities most valued by RPTP applicants, both when considering all specialities and only those in the medical area, and that people who have already chosen the speciality are satisfied with it; current specialists would recommend it to an RPTP applicant[14] and trainee specialists positively value the training they are receiving.[15]

Conclusions

Over the last twenty years, although it continues to be among the most valued by RPTP applicants, the Endocrinology and Nutrition speciality shows a downturn in the RPTP choice, as shown by the QI and the QO, both in relation to the overall range of specialities offered (medical, surgical, medical-surgical and central) and in relation to the subset of specialities in the medical area.

We need to take measures to enhance the perception of our specialist area among medical students and young doctors.

Conflicts of interest

The authors declare that they have no conflicts of interest.

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