

A quarter-century of pain science in Türkiye: Thematic, institutional, and gender trends in *AĞRI* (2000-2025)

Türkiye'de çeyrek asırlık ağrı bilimi: *AĞRI*'da tematik, kurumsal ve cinsiyet eğilimleri (2000-2025)

Bora Uzuner¹, Ender Salbaş², Sinan Pektaş³

¹Department of Physical Medicine and Rehabilitation, Ondokuz Mayıs University Faculty of Medicine, Samsun, Türkiye

²Department of Physical Medicine and Rehabilitation, Balıkesir University Faculty of Medicine, Balıkesir, Türkiye

³Department of Algology, Muğla Sıtkı Koçman University Faculty of Medicine, Muğla, Türkiye

ABSTRACT

Background: This study aims to evaluate thematic, institutional, and gender-related changes of *AĞRI*, the official journal of the Turkish Society of Algology.

Material and Methods: We processed all open-access manuscripts published from January 2000 through December 2025 using a custom Python pipeline for metadata, affiliations, and rule-based topic clustering. Gender was inferred from a Turkish name-gender dictionary with manual adjudication. We measured female workforce participation, female corresponding authorship rate, and the Glass Ceiling Gap (GCG; workforce mean minus corresponding-author rate; negative values indicate leadership surplus). Trends used Cochran-Armitage tests with Benjamini-Hochberg correction. Female corresponding authorship was compared with 50% parity using two-sided z-tests and Wilson 95% confidence intervals (CIs). Logistic regression modeled female corresponding authorship and internationalization.

Results: A total of 855 manuscripts were analyzed, while 2003 was absent from the archive. Interventional pain papers rose from 34 in the first quinquennium to 151 in the last. Universities' share declined from 77.0% to 66.7%, whereas Training and Research Hospitals' share rose from 5.7% to 18.6%. Female workforce participation remained approximately 46.5%. Female corresponding authorship was 49.0% (95% CI: 45.7-52.4%), did not differ from parity ($p = 0.56$), and yielded a small, non-significant negative GCG (approximately -2.5%). Departmental gaps were precise only in high-volume disciplines; apparent surpluses in small departments had CIs spanning parity. Interventional studies were less likely to have female corresponding authors (odds ratio [OR] = 0.54).

Conclusion: *AĞRI* demonstrates procedural maturation, institutional decentralization, and female corresponding authorship near parity, suggesting no apparent glass ceiling. Departmental leadership surpluses require confirmation with seniority and governance indicators.

Keywords: Bibliometrics, interventional pain, pain management, physical medicine and rehabilitation, Türkiye.

ÖZ

Amaç: Bu çalışmada, Türk Algoloji Derneği'nin resmi dergisi olan *AĞRI*'da tematik, kurumsal ve cinsiyetle ilişkili değişimler değerlendirildi.

Gereç ve Yöntemler: Ocak 2000 - Aralık 2025 arasında açık erişim arşivinde yer alan tüm makaleler, meta veri, kurum ve kural tabanlı konu kümelerini çıkarmak üzere özel bir Python yazılımıyla işlendi. Cinsiyet, Türkçe isim-cinsiyet sözlüğü ve belirsiz/Türkçe olmayan isimlerin manuel değerlendirilmesiyle belirlendi. Kadın iş gücü katılımı, kadın sorumlu yazarlık oranı ve cam tavan farkı (CTF; iş gücü ortalaması eksi sorumlu yazar oranı; negatif değer liderlik fazlasını gösterir) hesaplandı. Zamansal eğilimler Benjamini-Hochberg düzeltilmeli Cochran-Armitage testiyle değerlendirildi. Kadın sorumlu yazarlığı %50 pariteyle çift yönlü z-testi ve Wilson %95 güven aralığı (CI) kullanılarak karşılaştırıldı. Lojistik regresyon, kadın sorumlu yazarlığını ve uluslararasılaşmayı modelledi.

Bulgular: Toplam 855 makale analiz edildi; 2003 arşivde yoktu. Yıllık yayın sayısı 2.6 kat arttı. Girişimsel ağrı makaleleri ilk beş yılda 34 iken, son beş yılda 151'e çıktı. Üniversitelerin payı %77.0'den %66.7'ye gerilerken, Eğitim ve Araştırma Hastanelerinin payı %5.7'den %18.6'ya yükseldi. Kadın iş gücü katılımı yaklaşık %46.5'te kaldı. Kadın sorumlu yazarlık oranı %49.0 (%95 CI: %45.7-52.4) olup pariteden farklı değildi ($p = 0.56$) ve CTF küçük ve anlamsız negatifti (yaklaşık -%2.5). Bölümsel farklar yalnızca yüksek hacimli disiplinlerde kesindi; küçük bölümlerdeki görünen fazlaların güven aralıkları pariteyi içeriyordu. Girişimsel çalışmaların kadın sorumlu yazara sahip olma olasılığı daha düşüktü (olasılık oranı [OR] = 0.54).

Sonuç: *AĞRI*; prosedürel olgunlaşma, kurumsal desantralizasyon ve pariteye yakın kadın sorumlu yazarlığı sergileyerek belirgin bir cam tavan olmadığını düşündürmektedir. Bölümlere özgü liderlik fazlaları, kıdem ve yönetim göstergeleriyle doğrulanmalıdır.

Anahtar sözcükler: Bibliyometri, girişimsel ağrı, ağrı yönetimi, fiziksel tıp ve rehabilitasyon, Türkiye.

Corresponding author: Ender Salbaş, MD.

E-mail: dreder.salbas@gmail.com

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Pain management has transformed over the last quarter-century from predominantly pharmacological and perioperative approaches to more technology-enabled, intervention-oriented, and multidisciplinary models. This shift has been driven by the need for opioid-sparing strategies, broader adoption of ultrasound-guided techniques, and a growing emphasis on mechanism-targeted neuromodulation and minimally invasive interventions. These forces have reshaped not only clinical care, but also the research questions and publication patterns that define the field's intellectual trajectory.^[1-5]

Bibliometric and semantic methods provide a rigorous framework for quantifying this evolution beyond simple citation counts by mapping thematic priorities, institutional productivity, and collaboration structures over time. These approaches are particularly valuable in national research ecosystems, where healthcare delivery models and academic structures may differ from those of high-income Western countries while remaining responsive to global standards and methodological expectations. In Türkiye, the rapid growth in academic health capacity and restructuring of tertiary care have intensified interest in understanding how research production is redistributed across institutions and specialties.^[2,6,7]

Gender equity represents a parallel and increasingly scrutinized dimension of academic health-care systems. Despite the feminization of the medical workforce, persistent glass ceiling effects and “leaky pipeline” attrition have been repeatedly documented in authorship leadership and editorial governance across many disciplines, including anesthesiology and surgical-adjacent fields. Whether national society journals in emerging scientific hubs mirror these disparities or develop distinct equity trajectories remains underexplored.^[8-14]

Therefore, using *AGRI* as a case study, in the present study, we aimed to evaluate (1) thematic migration in pain research, with emphasis on an “interventional pivot,” (2) institutional decentralization across universities and Training and Research Hospitals, and (3) leadership gender dynamics, including whether traditional glass ceiling patterns are present, absent, or reversed in this setting in the light of literature.^[1,2,7,14]

MATERIAL AND METHODS

Study design and data source

This retrospective, longitudinal bibliometric analysis of *AGRI*, the official journal of the Turkish

Society of Algology. The study universe included all manuscripts available in the open-access online archive from January 2000 through December 2025. Data were retrieved in December 2025 and analyzed. As the analyses were performed on publicly available secondary metadata, ethics committee approval was deemed inapplicable.

Data acquisition and quality control

A custom Python version 3.10 (Python Software Foundation, Wilmington, DE, USA) crawler was used to extract the structured metadata fields: paper identifier, year, volume/issue, title, language, author list, corresponding author (when available), DOI, PMID, ORCID IDs, abstract, keywords, and affiliation strings. The dataset was deduplicated using unique identifiers, yielding a final analytical sample of 855 records. One year (2003) was missing in the archive and was excluded from the time-series analyses. Automated checks were applied to page and author counts, followed by targeted manual correction when inconsistencies were detected.

Taxonomy and feature engineering

Article type classification: Items were categorized as Original Article, Case Report, Review, or Letter. Early entries with incomplete metadata were also manually reviewed.

Institutional mapping: The first author's primary affiliation was used to classify institutional types: Universities, Training and Research Hospitals (Ministry of Health), and Private/State Hospitals.

Departmental mapping: Affiliation strings were normalized to a predefined discipline taxonomy (granularity up to 81 mapped disciplines). Department-level analyses were restricted to those with sufficient publication volumes to support stable estimates.

Geospatial and international collaboration: Domestic affiliations were mapped to Türkiye's seven geographical regions via city extraction analysis. International collaboration was identified by detecting non-Turkish country names and standardizing them to ISO formats.

Gender inference and leadership metrics

Gender was inferred using a multistage approach with a Turkish name-gender dictionary, followed by manual adjudication of ambiguous, unisex, and non-Turkish names to reduce algorithmic bias. Two complementary metrics were computed.

Workforce mean female ratio: Mean proportion of female authors per paper (interpreted as workforce participation within the paper-level unit).

Female corresponding author rate: Proportion of papers with female corresponding authors.

We define the glass ceiling gap (GCG) as: $GCG = \text{Workforce mean female ratio} - \text{female corresponding author rate}$. Negative values indicate that female corresponding authorship exceeds workforce participation (a potential female leadership surplus). As corresponding authorship is a single, imperfect proxy for academic seniority, we treat negative GCG values as descriptive signals rather than as definitive evidence of a reversed glass ceiling. To assess whether leadership patterns could be explained solely by horizontal segregation, we performed a departmental audit comparing workforce and leadership within each discipline.

Thematic clustering and semantic migration

We implemented a rule-based clustering algorithm to categorize manuscripts into six prespecified thematic clusters: Interventional Pain, Chronic & Neuropathic Pain, Acute & Perioperative Pain, Cancer & Palliative, Pediatric Pain, and General/Other. The Interventional cluster prioritized procedural terms (e.g., “block,” “radiofrequency,” “injection,” “ultrasound,” “nerve block”). Era-based keyword frequency and cluster distribution were used to evaluate the semantic migration.

Readability

For English abstracts, readability was quantified using the Flesch-Kincaid Grade Level to track linguistic complexity over time.

Statistical analysis

Statistical analysis was performed in Python using Pandas, SciPy, and StatsModels. For trend testing, Cochran-Armitage trend tests for binary rates with Benjamini-Hochberg false discovery rate correction

were used. For comparisons, the Welch’s t-test was used for continuous variables with unequal variances; gender homophily quantified using Cohen’s d based on gender composition differences in the coauthor teams. Gender leadership metrics were additionally evaluated against the null hypothesis of gender parity. The female corresponding-author rate was compared with 50% using two-sided proportion z-tests, and Wilson 95% confidence intervals (CIs) were computed for overall and department-level rates to convey estimate precision; departmental gaps were interpreted in light of these intervals rather than point estimates alone. In the predictive modeling, multivariate logistic regression (Logit) was used. Model A used female corresponding authorship as the dependent variable, with covariates including year, author count, institution type, and cluster. Model B examined internationalization patterns; a ridge penalty ($\alpha = 1.0$) was applied when quasi-complete separation was encountered in the sparse strata. A two-sided p value of < 0.05 was considered statistically significant.

RESULTS

Longitudinal growth and editorial maturation

A total of 855 manuscripts published between 2000 and 2025 were analyzed, excluding 2003, which was missing from the digital archive. The journal’s productivity exhibited a robust linear growth trend (slope = +1.125 papers/year; $r = 0.864$, $p < 0.001$), with the average annual output surging from 18.0 papers in the initial triennium to 46.7 in the final three years, a 2.6-fold increase (Table 1, Figure 1). This growth was accompanied by a clear trajectory of academic professionalization: structured abstract adoption significantly increased ($Z = 2.28$, $p = 0.029$), and the use of colons in titles, a proxy for academic complexity, rose sharply ($Z = 6.26$, $p < 0.001$). Digital

Table 1. Longitudinal evolution of publication metrics (2000-2025)

Year range	Total papers (n)	Average authors per paper	Workforce female ratio (%)	Female corresponding author rate (%)	Glass ceiling gap (%)	International collaboration rate (%)	Structured abstract rate (%)
2000-2005	120	3.23	37.3	24.1	+13.2	11.9	18.2
2006-2010	136	3.83	53.5	55.7	-2.2	1.5	34.6
2011-2015	165	4.28	48.1	52.1	-4.0	3.0	61.2
2016-2020	195	3.85	46.3	54.8	-8.5	5.9	82.5
2021-2025	239	3.93	46.2	47.9	-1.7	13.0	94.1
Overall	855	3.91	46.5	49.0	-2.5	7.4	56.8

Summary of the bibliometric maturation of AGRI over a 25-year period. The data represent a transition from a small-scale national archive to a high-volume, digitally integrated scientific platform. The “Structured Abstract Rate” serves as a proxy for a journal’s standardization and adherence to international indexing requirements. Note: 2003 was excluded because of missing digital records.

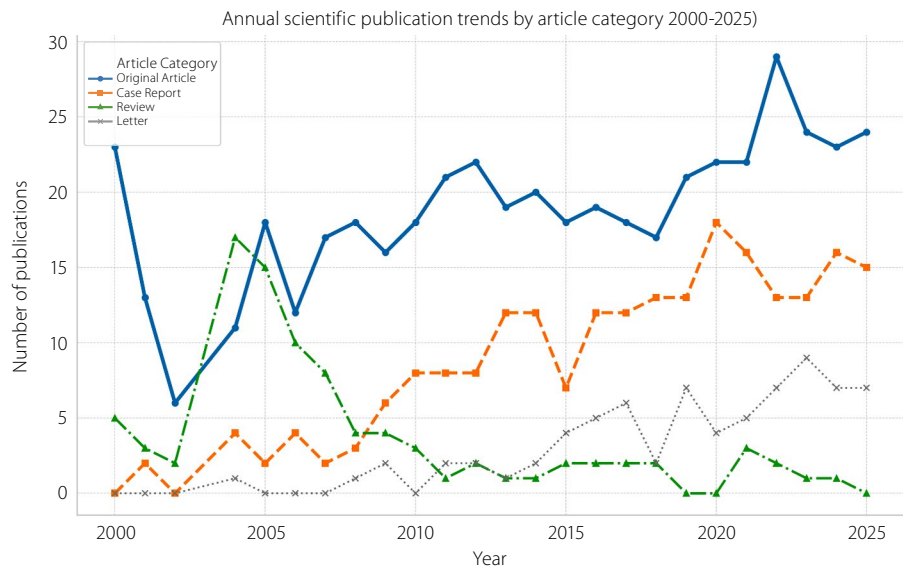


Figure 1. Annual publication volume by article type in *AGRI* (2000-2025). Annual number of original articles, case reports, reviews, and letters published in the journal. Original articles account for most of the growth over the study period, whereas reviews peaked in the mid-2000s and letters increased in recent years.

maturity was further evidenced by the successive adoption of PubMed (2004), DOI (2011), and ORCID (2018) identifiers.

Geographically, 92.6% of the output was domestic (led by Istanbul [n = 256] and Ankara [n = 160]), and overall international collaboration was 7.4%, but varied across eras (Table 1). The USA (n = 12), TRNC (n = 10), and Iran (n = 9) were the most frequent international partners. In the multivariate analysis, institutional setting was a strong determinant of international collaboration, with markedly lower odds in Training and Research Hospitals than in universities (Table 2).

Institutional decentralization and disciplinary expansion

The institutional distribution shifted significantly across eras. Universities remained the primary source of output but declined in share (77.0% to 66.7%), while Training and Research Hospitals tripled their contribution (5.7% to 18.6%), indicating the decentralization of scientific production toward high-volume tertiary care centers (Figure 2a). Concurrently, the disciplinary base broadened beyond anesthesiology/algology, with notable growth in Physical Medicine and Rehabilitation and Nursing,

Table 2. Multivariate logistic regression models (OR [95% CI])

Predictor variables	Model A: Female corresponding author			Model B: International collaboration		
	OR	95% CI	p	OR	95% CI	p
Private/State Hospitals	1.00	REF	-	1.00	REF	-
University Setting	2.59	1.66-4.05	< 0.001	0.26	0.15-0.46	< 0.001
Training and Research Hospital.	2.38	1.37-4.12	0.001	0.05	0.01-0.25	< 0.001
Interventional Pain Cluster	0.54	0.32-0.91	0.022	1.00	REF	-
Year (Continuous)	0.97	0.95-1.00	0.052	1.03	0.99-1.07	0.094
Author Count	0.92	0.84-1.00	0.054	1.04	0.97-1.11	0.204

OR, odds ratio; CI, confidence interval; Multivariate analysis identified predictors of academic leadership and internationalization. Model A (Dependent Variable: Female Corresponding Author) identifies factors associated with female leadership; institutional affiliation with Universities and Training/Research Hospitals showed significantly higher odds of female corresponding authorship than private/state hospitals. Model B (Dependent Variable: International Collaboration) highlights that international partnerships are primarily driven by university-affiliated institutions. REF: Reference Category. Statistical significance was set at *p* < 0.05.

Table 3. Disciplinary focus and gender representation by department

Department	n	%	Top research cluster	Female author ratio (%)	Focus on interventional pain (%)
Anesthesiology	440	33.2	Interventional	41.9	68.6
Algology	202	15.2	Interventional	43.3	58.4
Neurology	114	8.6	Chronic/Neuropathic	51.4	28.1
PMR	78	5.9	Chronic/Neuropathic	51.3	30.8
Nursing	61	4.6	General/Other	81.4	8.2
Physiotherapy	45	3.4	Chronic/Neuropathic	64.3	22.2

Cross-tabulation of major contributing departments, their thematic specializations, and gender demographics. The “Focus on Interventional Pain (%)” indicates the proportion of a department’s total output categorized within the Interventional Pain cluster. Note the distinct horizontal segregation, with Nursing and Physical Medicine and Rehabilitation (PMR) showing the highest female participation rates compared to traditionally male-dominated surgical subspecialties. Counts reflect departmental occurrences (a manuscript may contribute to more than one department based on affiliation parsing); therefore, the percentages do not sum to 100%.

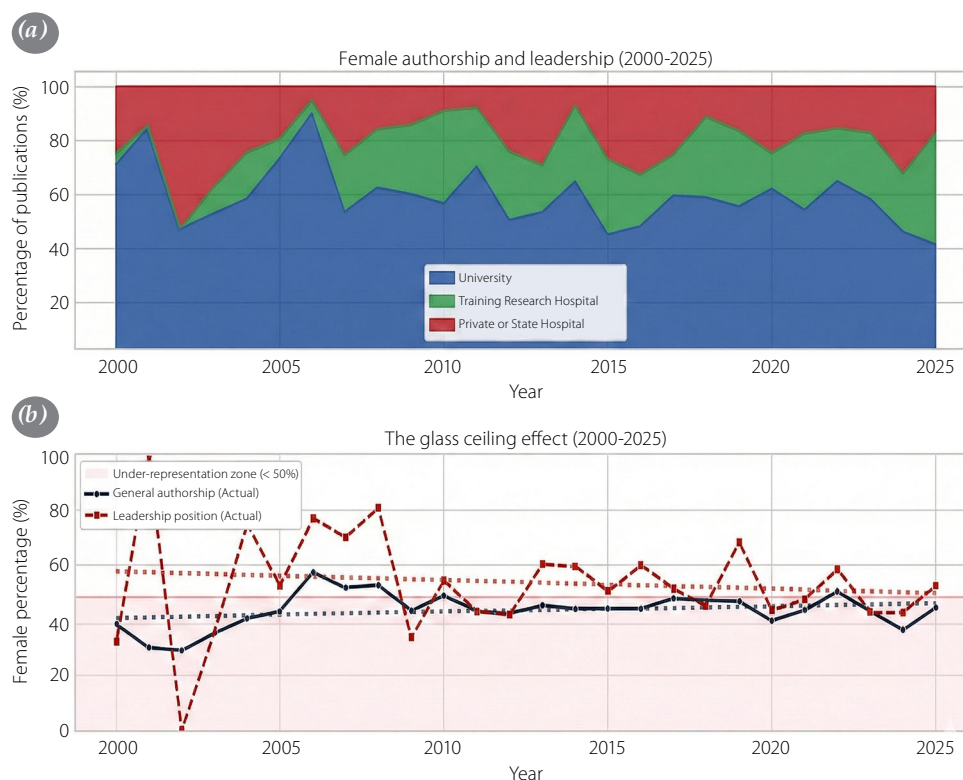


Figure 2. Institutional decentralization and gender leadership trends in *AGRI* (2000-2025). **(a)** Stacked area chart showing the annual proportion of publications by first-author affiliation type: universities (blue), Training and Research Hospitals (green), and private or state hospitals (red). Note the contraction of the university share and the corresponding rise of Training and Research Hospitals. **(b)** Annual female share of all authors (general authorship, black solid line) and of corresponding authors (leadership position, red dashed line), with dotted linear trend lines; the shaded area marks the under-representation zone (< 50%). In most years, and on the fitted trend lines, the female corresponding-author rate lay at or above workforce participation, with the gap narrowing over time; early-year values fluctuate because of small annual numbers. This pattern is consistent with the absence of an apparent glass ceiling rather than a consistent reversal.

consistent with an expanding multidisciplinary pain ecosystem (Figure 3 and Table 3).

Semantic evolution and the interventional pivot

Cluster analysis demonstrated a marked thematic shift. The early years featured a greater

relative representation of Acute & Perioperative Pain topics, whereas Interventional Pain expanded substantially, rising from 34 papers in the first quinquennium to 151 in the final quinquennium. Keyword patterns mirrored this shift, with early eras emphasizing analgesic and

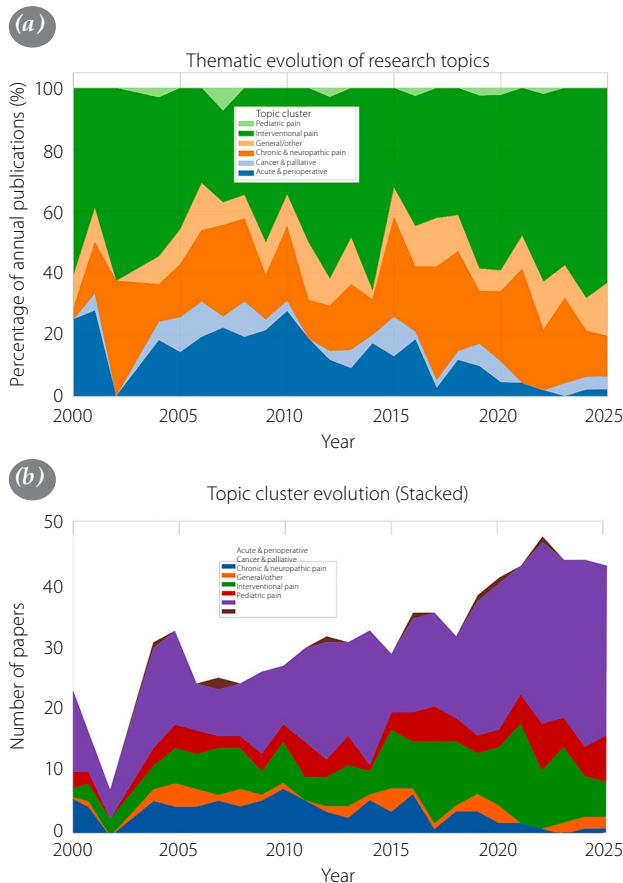


Figure 3. Thematic migration of pain research in *AGRI* (2000-2025). **(a)** Annual proportional distribution of the six thematic clusters (100% stacked area chart). **(b)** Annual number of papers per thematic cluster (stacked area chart). The share of acute & perioperative pain was larger in the early years and declined thereafter, whereas Interventional Pain became increasingly dominant, particularly in the last decade. Note that each panel has its own color legend.

postoperative themes, and later years increasingly featuring ultrasound-guided and block/injection terminology. Thematic focus also differed by department: interventional topics predominated in anesthesiology, algology, orthopedics, neurosurgery, and radiology, whereas neurology, PMR, and physiotherapy focused mainly on chronic and neuropathic pain (Figure 4).

International collaboration patterns

International collaboration remained a minority component overall (7.4%), but showed substantial era-to-era variability, with the highest proportion in the final period (Table 1). In the multivariate analysis, the institutional setting was a key correlate of international collaboration, with universities

exhibiting higher odds than Training and Research Hospitals (Table 2).

Gender dynamics: workforce participation, leadership, and homophily

Across the 25-year window, female workforce participation (mean female authorship proportion per paper) remained approximately 46.5%, while female corresponding authorship was 49.0% overall (95% CI: 45.7-52.4%). This rate was statistically indistinguishable from gender parity (two-sided proportion z-test versus 50%, $p = 0.56$), and the corresponding GCG ($\approx -2.5\%$) was small and not statistically significant. At the journal level, the data are, therefore, most consistent with the absence of the expected glass ceiling and leadership at or near parity, rather than a pronounced reversal. Exploratory departmental audits identified negative GCG values in several disciplines, including some traditionally male-dominated ones; however, these estimates varied markedly in precision. Surpluses were most robust in higher-volume departments (e.g., algology, female corresponding rate 55.1% [95% CI: 48.1-61.7%] versus 42.5% workforce participation), whereas the largest nominal gaps occurred in small departments whose confidence intervals were wide and encompassed parity (e.g., orthopedics, $n = 32$, 40.0% [25.5-57.7%]; general surgery, $n = 20$, 50.0% [29.9-70.1%]; pharmacology, $n = 14$, 53.8% [32.6-78.6%]). Physical Medicine and Rehabilitation demonstrated near-parity (GCG $\approx +1.0\%$). These department-level signals should, therefore, be regarded as hypothesis-generating (Table 4; Figure 2b). Gender homophily was substantial, with a large effect size (Cohen's $d = 1.76$). In multivariate Model A, university and Training and Research Hospital affiliations were associated with higher odds of female corresponding authorship compared with private/state hospitals, whereas Interventional Pain papers were less likely to be led by a female corresponding author (odds ratio [OR] = 0.54) (Table 2).

DISCUSSION

This 25-year audit of *AGRI* depicts a journal (and, by proxy, a national scientific community) undergoing simultaneous thematic, institutional, and sociological transformation. First, the data demonstrate clear growth and maturation consistent with the broader expansion of Turkish academic medicine, reflected in increased output and progressive adoption of standardized editorial

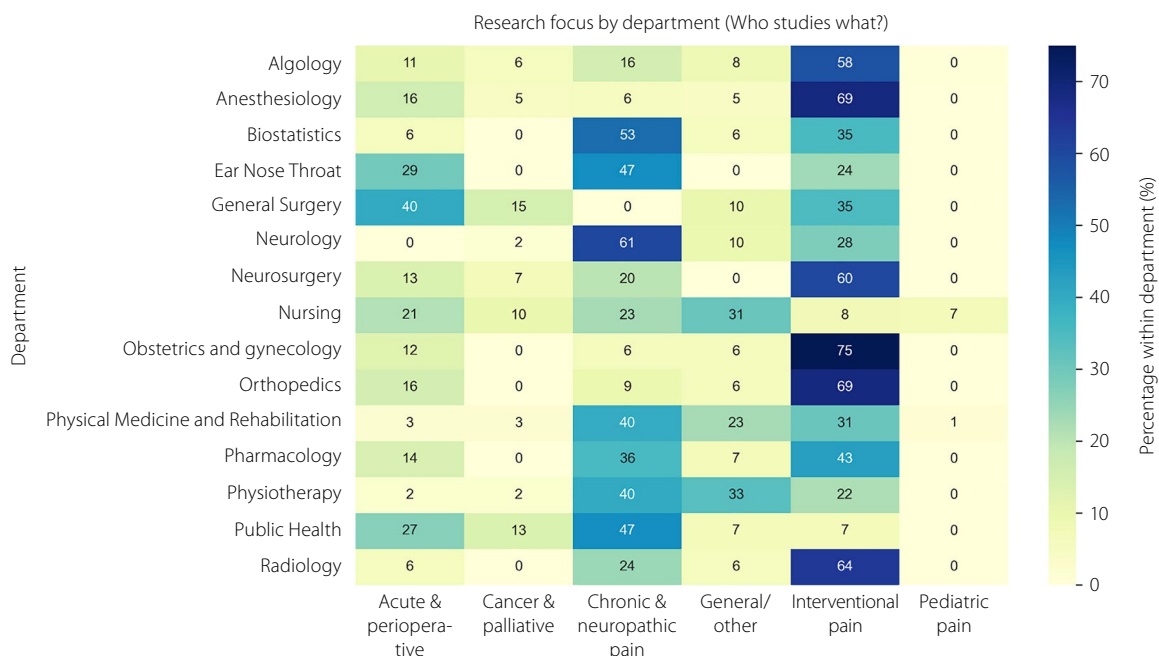


Figure 4. Departmental research focus across thematic clusters. A heat map showing the thematic focus of the major contributing departments; each cell shows the percentage of a department's papers falling within a given topic cluster (rows sum to approximately 100%). Color intensity ranges from light yellow (low) through green to dark blue (high), with darker cells indicating a higher concentration of papers from a given department within a particular topic cluster (e.g., Anesthesiology's strong focus on Interventional Pain vs. PMR's focus on Chronic and Neuropathic Pain).

Table 4. Departmental gender leadership and glass ceiling gaps

Department	Papers (n)	Workforce female mean	Female corresponding author rate	GCG
Anesthesiology	440	0.413	0.471	-0.058
Algology	202	0.425	0.551	-0.126
Neurology	114	0.503	0.533	-0.030
PMR	78	0.531	0.521	+0.010
Nursing	61	0.849	0.893	-0.044
Physiotherapy	45	0.681	0.757	-0.076
Orthopedics	32	0.250	0.400	-0.150
General Surgery	20	0.358	0.500	-0.142
Pharmacology	14	0.356	0.538	-0.182

GCG, glass ceiling gap (workforce female mean-female corresponding author rate); PMR, Physical Medicine and Rehabilitation. Negative GCG values indicate that female corresponding authorship exceeds workforce participation (a potential female leadership surplus); estimates from departments with small numbers of papers should be interpreted with caution.

and digital identifiers. These signals suggest a transition from a smaller society archive toward a more formalized scientific platform aligned with contemporary indexing expectations.^[2,6,7]

Second, we observed a marked “interventional pivot,” with a sharp growth in procedural pain research and parallel shifts in the vocabulary of published work. This pattern mirrors international

bibliometric observations that pain and regional anesthesia research has increasingly clustered around ultrasound-guided techniques, nerve blocks, and minimally invasive interventions, alongside opioid-sparing strategies and multimodal analgesia frameworks. Within *AGRI*, the rise of interventional keywords and the expanding share of the interventional cluster indicate the local

assimilation of global technological practice into regional academic output.^[2-5]

Third, institutional decentralization emerged as a prominent structural shift: Training and Research Hospitals substantially expanded their research share while the university proportion contracted. This redistribution plausibly reflects the growing research capacity of high-volume tertiary centers and evolving postgraduate training ecosystems in Türkiye, where clinical volume, case diversity, and structured training may generate publishable cohorts and procedural series that can contribute to interventional and applied pain research.^[7,15,16]

Furthermore, the multivariate analysis of international collaboration highlighted a distinct profile of institutional settings. While universities naturally drive the bulk of scientific output, the data imply that non-teaching hospitals (primarily private and state institutions) maintain a surprisingly strong international collaboration profile relative to their volume (often serving as the reference standard against which training hospitals show lower odds). This pattern likely reflects the unique structure of the Turkish healthcare landscape, where the Health Transformation Program has catalyzed a significant expansion of the private sector.^[17,18] Consequently, prominent senior academics often transition to specific, high-volume private centers. These institutions provide a platform for experienced researchers to leverage established international networks for multicenter trials and high-level reviews, free from the heavy service load typical of public teaching hospitals.

Finally, the gender analysis suggests a picture that diverges from many global narratives, although it should be interpreted conservatively. Large-scale studies have highlighted the persistent underrepresentation of women in leadership positions and their attrition in academic medicine and anesthesiology-related fields. In *AGRI*, by contrast, female corresponding authorship was statistically indistinguishable from parity and marginally exceeded workforce participation, indicating the absence of an apparent glass ceiling rather than a strong reversal of it. Exploratory departmental audits suggested leadership surpluses in several traditionally male-dominated specialties; while intriguing, the most striking of these rested on small samples with wide confidence intervals and require confirmation. Importantly, corresponding authorship is a single, imperfect proxy for academic leadership, and a definitive claim of a reversed glass

ceiling would require convergent indicators such as senior (last) authorship, editorial board membership, professorial rank, and society governance, which were beyond the scope of this metadata-based study. We, therefore, frame these findings as the absence of a measurable glass ceiling at the journal level, with department-specific leadership parity or surplus that constitutes a hypothesis for future, multi-indicator research. These patterns are nonetheless consistent with the Turkish literature documenting the increasing academic visibility of women in medicine, while team-composition homophily remains strong and interventional work retains a relatively male skew in leadership.^[8-16,19-21] Taken together, *AGRI* appears to function as an ecosystem in which procedural maturation, institutional redistribution, and discipline broadening coexist with female corresponding authorship at or near parity and the absence of an apparent glass ceiling, suggesting that the determinants of academic leadership can vary meaningfully across national and journal contexts, even within globally standardized scientific norms.^[7,14,15,22]

Nonetheless, this study has several limitations that should be acknowledged. First, this is a single-journal analysis and may not be generalizable to all pain or anesthesiology publications in Türkiye or internationally. Second, early archive metadata incompleteness, particularly in the early 2000s, may have affected classification accuracy. Although we implemented quality control and targeted manual correction, residual misclassification was possible. Third, corresponding authorship, while a widely used proxy, does not perfectly represent academic seniority or decision authority, and journal-specific practices (e.g., designating the most responsive author rather than the most senior) may influence leadership estimates. Relatedly, although we observed negative GCG values, the overall gap was small and not statistically significant, and several department-level surpluses were derived from small samples with wide confidence intervals; we therefore avoided characterizing these patterns as a definitive reverse glass ceiling and instead treat them as hypothesis-generating. Since we did not incorporate complementary leadership indicators, such as senior (last) authorship, editorial board composition, academic rank, or society governance, our analysis describes authorship-based leadership proxies rather than the full construct of the glass ceiling. Fourth, gender inference based on names can introduce errors, particularly for unisex and non-Turkish names; we mitigated this with manual

adjudication, but some misclassification may persist. Fifth, rule-based clustering trades interpretability for potential edge-case misassignment; although era-based keyword migration supported face validity, thematic boundaries in pain research are inherently overlapping. Finally, we did not incorporate citation-based impact metrics; thus, our findings primarily describe publication content, structure, and authorship patterns rather than downstream scientific influence or governance equity.^[2,6-14]

In conclusion, *AGRI* appears to function as an ecosystem in which procedural maturation, institutional redistribution, and disciplinary broadening coexist with female corresponding authorship at or near parity and the absence of an apparent glass ceiling, in contrast to widely reported global attrition patterns. Whether specific departments exhibit a genuine leadership surplus remains to be confirmed with additional indicators of seniority and governance. Overall, these findings suggest that the determinants of academic leadership can vary meaningfully across national and journal contexts, even within globally standardized scientific norms.

Author Contributions

E.S.: Concept, design, materials, analysis and/or interpretation, writing manuscript; S.P., B.U.: Resources, critical review; S.P.: Supervision; E.S., B.U.: Data collection and/or processing; B.U., S.P., E.S.: Literature search.

Conflict of Interest

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Data Sharing Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

AI Disclosure

The authors declare that artificial intelligence (AI) tools were not used, or were used solely for language editing, and had no role in data analysis, interpretation, or the formulation of conclusions. All scientific content, data interpretation, and conclusions are the sole responsibility of the authors. The authors further confirm that AI tools were not used to generate, fabricate, or 'hallucinate' references, and that all references have been carefully verified for accuracy.

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