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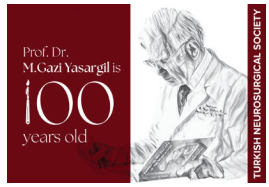

A Bibliometric Analysis of the Contributions of Turkish Female Authors to "Turkish Neurosurgery"

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ABSTRACT

AIM: To assess the contributions of Turkish female authors to the field of neurosurgery through "Turkish Neurosurgery", the only neurosurgery journal in Türkiye indexed by The Science Citation Index Expanded (SCIE).

MATERIAL and METHODS: A bibliometric analysis was conducted on articles published in "Turkish Neurosurgery" from 2019 to 2023. Data were gathered on authorship, gender distribution, article types, topics, and institutional affiliations. Statistical analyses included chi-square tests, the Cochran–Armitage test, and logistic regression to evaluate the association between female senior and first authorship.

RESULTS: Of the 751 articles reviewed, 505 featured contributions from at least one Turkish author, comprising 2,601 Turkish contributors (24.8% female, 74.4% male). Turkish female authors appeared in 292 of these publications (57.8%), serving as first authors in 103 (20.4%) and senior authors in 92 (18.2%). The proportion of Turkish female first authorship increased significantly over the study period, peaking at 31.2% in 2022 (p=0.049). Logistic regression analysis revealed that the presence of a Turkish female senior author significantly increased the likelihood of female first authorship (OR = 3.96, p<0.001). Only 16.2% of Turkish-authored articles included female neurosurgeons. Of all Turkish female authors, 23.6% of first authors and 19.6% of senior authors were neurosurgeons. Most publications by Turkish female authors (59.7%) were original research articles, primarily focusing on neuro-oncology, spine, and functional neurosurgery.

CONCLUSION: This study highlights encouraging progress in the representation of Turkish female authors, particularly neurosurgeons, who exhibit strong academic engagement relative to their workforce proportion in neurosurgical academic publishing. Mentorship plays a crucial role in increasing female first authorship. To strengthen this effect, academic institutions could implement structured mentorship programs, fund collaborative research, and establish platforms to connect senior and junior female researchers.

KEYWORDS: Neurosurgery, Female authorship, Gender disparity, Bibliometric analysis, Academic publishing

ABBREVIATIONS: WFNS: World Federation of Neurosurgical Societies, **SCIE:** Science Citation Index Expanded, **EANS:** European Association of Neurosurgical Societies, **FIENS:** International Education in Neurological Surgery

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INTRODUCTION

In 2005, at the World Federation of Neurosurgical Societies (WFNS) Congress, Romanian neurosurgeon Sofia Ionescu was recognized as the world's first female neurosurgeon for successfully performing surgery on a living patient in 1944 (5). Similarly, Diana Beck from the United Kingdom emerged as one of the pioneering women in neurosurgery, with her first documented operation performed in 1952 (8). Historically, Türkiye witnessed the early inclusion of women in neurosurgery, beginning with Aysima Altınok, who completed her training in 1959 (2). Since then, the number of female neurosurgeons has steadily increased worldwide, including in Türkiye (4,12). Despite this upward trend, women in neurosurgery continue to face limited academic visibility in the field (6,20).

Publishing in a peer-reviewed journal not only secures a study's place in the literature but also serves as a benchmark of its validity. Moreover, it plays a vital role in career development and academic advancement within the profession. This study aimed to assess the representation of Turkish female authors in articles published in *Turkish Neurosurgery*, the only neurosurgery journal from Türkiye indexed in the Science Citation Index Expanded (SCIE).

MATERIAL and METHODS

Ethical approval was obtained from the Ethics Committee of Izmir Katip Celebi University (Date: 19.12.2024, Decision Number: 0280). This bibliometric study analyzed articles published in *Turkish Neurosurgery* over the past five years (2019–2023). The journal's archival information was retrieved from its official website (https://turkishneurosurgery.org.tr/archive.php).

The articles were categorized by type into "original research," "case reports," "meta-analyses or systematic reviews," and "letters to the editor." Additionally, the articles were further classified by topic into subgroups, such as spinal, neurovascular, neuro-oncological, pediatric, trauma, peripheral nerves, neurocritical care, radiosurgery, neuroanatomy, cerebrospinal fluid circulation, and others.

For each article, data were recorded on the total number of authors; the number of Turkish female and male authors; the number of Turkish female first and senior authors; the number of Turkish male first and senior authors; the affiliated institutions; and the region of the institution where the study was conducted. The final listed author was designated as the senior author. In cases where the gender of an author could not be confidently determined based on their name, an internet search was performed.

All statistical analyses were performed using IBM SPSS Statistics for macOS, Version 27.0 (IBM Corp., Armonk, NY, USA) with R integration through R Syntax for advanced procedures (R Core Team, 2023; https://www.R-project.org/). Comparisons were conducted using the chi-square test. The Cochran-Armitage trend test was employed to assess the proportion of female authors over the years. The association between female senior authorship and the probability of female first authorship was also examined using a binary logistic regression model. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Turkish female author participation

This study included 751 publications from *Turkish Neurosurgery*, published between 2019 and 2023. Among the 751 publications reviewed, 505 included contributions from at least one Turkish author, irrespective of gender. Out of the 2,601 individual Turkish contributors identified, 644 (24.8%) were female and 1,935 (74.4%) were male. Of these, 292 (57.8%) included contributions from at least one Turkish female author, while 492 (97.4%) featured at least one Turkish male author. The Cochran-Armitage test showed no statistically significant change in the proportion of publications with Turkish female authorship relative to the total number of Turkish-contributed publications between 2019 and 2023 (p=0.917) (Table I).

Turkish female authors served as first authors in 103 (20.4%) of the 505 publications that included contributions from at least one Turkish author, while Turkish male authors held the first author position in 397 publications (78.6%) (χ^2, p<0.001). The proportion of Turkish female first authorship among Turkish-contributed publications increased from 12.9% in 2019 to a peak of 31.2% in 2022, before declining to 23.4% in 2023. This upward trend was found to be statistically significant (Cochran–Armitage test, p=0.022).

Turkish female authors were senior authors in 92 (18.2%) of the Turkish-contributed publications reviewed in this study, while Turkish male authors held the senior author position in 410 (81.2%) of these publications. The proportion of Turkish female senior authorship remained relatively stable over the years, ranging from 15.8% in 2019 to 19.1% in 2023. No statistically significant trend was observed (Cochran-Armitage test, p=0.872).

A total of 38 publications featured both a Turkish female first author and a Turkish female senior author. Logistic regression analysis revealed that the presence of a Turkish female senior author significantly increased the likelihood of Turkish female first authorship (OR=3.63, p<0.001), suggesting a strong mentorship effect.

Participation of Turkish female neurosurgeon authors

Of the 505 Turkish-contributed publications reviewed, 411 included contributions from at least one Turkish neurosurgeon, irrespective of gender. Turkish male neurosurgeon authors were identified in 403 publications (98.1%), while Turkish female neurosurgeon authors were identified in 75 publications (18.2%) (χ^2, p<0.001).

The rate of first authorship among Turkish neurosurgeons was higher in males (71.8%, 285 out of 397) than in females (21.9%, 23 out of 105) (χ^2, p<0.001). Among Turkish senior authors, 273 (66.6%) males and 15 (16.2%) females were neurosurgeons. The proportion of neurosurgeons was significantly higher among male authors (χ^2, p<0.001).

Of the 75 publications featuring a Turkish female neurosurgeon author, 20 listed her as the first author (26.7%) and 15 as the senior author (20.0%). In contrast, Turkish female authors from other medical specialties contributed to 260 publications, serving as first authors in 83 (31.9%) and as senior authors in 77 (29.6%) (χ^2, p=0.008; 0.038). A total of 43 publications included both a Turkish female neurosurgeon and a Turkish female author from another specialty.

Article types and locations

The majority of the analyzed publications were original research papers (84.95%, 638 articles). Among the 505 publications with Turkish contributions, 457 (90.5%) were original articles. Turkish female authors contributed to 59.7% of these (273 articles), serving as first authors in 21.4% (98 articles) and as the senior authors in 18.6% (85 articles). The distribution of Turkish female authorship across other article types is presented in Table II.

The most prevalent research areas in the overall dataset were spine, neuro-oncology, and neurovascular. Among articles authored by Turkish female researchers, the most frequent topics were neuro-oncology, spine, and functional neurosurgery. Similarly, articles led by a Turkish female first author most

Table I: The Proportion of Publications with Turkish Female Authors Relative to the Total Number of Publications Involving Either Turkish Female or Male Authors by Year

Publication Year	Total Publications	Publications Contributed Turkish Authors	Publications Contributed Turkish Female Authors, n (%)	Publications Contributed Turkish Female Neurosurgeon Authors, n (%)	Turkish Female First Author, n (%)	Turkish Female First Neurosurgeon Author, n (%)	Turkish Female Senior Author, n (%)	Turkish Female Senior Neurosurgeon Author, n (%)
2019	149	101	60 (59.4)	12 (11.9)	13 (12.9)	3 (3.0)	16 (15.8)	4 (4)
2020	148	110	60 (54.5)	21 (19.1)	19 (17.3)	6 (5.5)	23 (20.9)	4 (3.6)
2021	149	104	59 (56.7)	15 (14.4)	21 (20.2)	6 (5.8)	17 (16.3)	0 (0)
2022	150	96	56 (58.3)	11 (11.5)	30 (31.2)	3 (3.1)	18 (18.8)	3 (3.1)
2023	155	94	57 (60.6)	19 (20.2)	22 (23.4)	5 (5.3)	18 (19.1)	4 (4.3)
Total	**751**	**505**	**292 (57.8)**	**78 (15.4)**	**105 (20.8)**	**23 (4.5)**	**92 (18.2)**	**15 (3)**

Table II: Distribution of Article Types and the Proportion of Publications with Turkish Female Authors Relative to the Total Number of Publications Involving Either Turkish Female or Male Authors by Article Types

Article Type	Total Publication	Total Publications with Turkish Contribution	Turkish Female Author Contribution, n (%)	Turkish Female Neurosurgeon Author Contribution, n (%)	Turkish Female First Author, n (%)	Turkish Female First Neurosurgeon Author, n (%)	Turkish Female Senior Author, n (%)	Turkish Female Senior Neurosurgeon Author, n (%)
Original Investigation	638	457	273 (59.7)	72 (15.8)	98 (21.4)	22 (4.8)	85 (18.6)	14 (3.1)
Case Report	62	32	16 (50)	4 (12.5)	5 (15.6)	1 (3.1)	6 (18.8)	0
Meta-analyses/ Systematic reviews	19	4	2 (50)	1 (25)	2 (50)	0	1 (25)	1 (25)
Letters to the Editor	32	12	1 (8.3)	1 (8.3)	0	0	0	0
Total	**751**	**505**	**292 (57.8)**	**78 (15.4)**	**105 (20.8)**	**23 (4.6)**	**92 (18.2)**	**15 (3)**

commonly focused on neuro-oncology, functional neurosurgery, and spine. In studies where a Turkish female researcher was the last author, the predominant research areas included functional neurosurgery, neuro-oncology, and spine, respectively. The comparative distribution of research topics is illustrated in Figure 1.

Of the 292 publications involved the participation of Turkish female authors. The vast majority of these studies were conducted in Türkiye (n=286), with a few originating from other countries, including the United States (n=4), Germany (n=1), and Iran (n=1). Of the 105 publications with Turkish female first authors, 104 were conducted in Türkiye, with the remaining one originating from the United States. Similarly, among the 92 publications with Turkish female senior authors, 91 were affiliated with studies conducted in Türkiye, and one originated from Germany.

DISCUSSION

Historically, Türkiye was among the first countries to integrate women into the field of neurosurgery on a global scale (9). Aysima Altınok completed her training in 1959, becoming Türkiye's first female neurosurgeon. In 1968, Altınok was one of the 21 founding members of the Turkish Neurosurgical Society (2). The second female neurosurgeon in Türkiye was Yıldız Yalcınlar, who was certified in 1965 (4). Several other pioneering female neurosurgeons followed, including Nilgün Alp, Dilek Könü-Leblebicioğlu, Hamiyet Camuşçu, and Nurperi Gazioğlu (12). A study published by Kuzucu et al. in 2022 reported that between 1960 and 1980, there were only four female neurosurgeons in Türkiye (12). The same study also stated that, according to the year-end 2020 data from the Turkish Neurosurgical Society, 94 (5.5%) of the 1,699 registered neurosurgery specialists in Türkiye were women. Among them, 10 were full professors (10.6%), 16 were associate professors (17%), five were assistant professors (5.3%), and 63 were neurosurgery specialists (67%). Additionally, the study reported that nine female academic neurosurgeons (9.5%) had an h-index greater than 10. Nurperi Gazioğlu became Türkiye's first female professor of neurosurgery and, in 2013, was elected the first female president of the Central Nervous System Surgery Society (12). Despite having appointed 23 presidents over 38 years, the Turkish Neurosurgical Society elected its first female president, Emel Avcı, in 2021 (15). Prof. Dr. Pınar Akdemir Özışık became the first female neurosurgeon to be appointed as dean in 2021 (12). Prof. Dr. Melike Mut Aşkın was a co-founder of the Turkish Society of Neuro-Oncology (14). In addition to holding the titles FAANS, FAAP, and FACS, Eylem

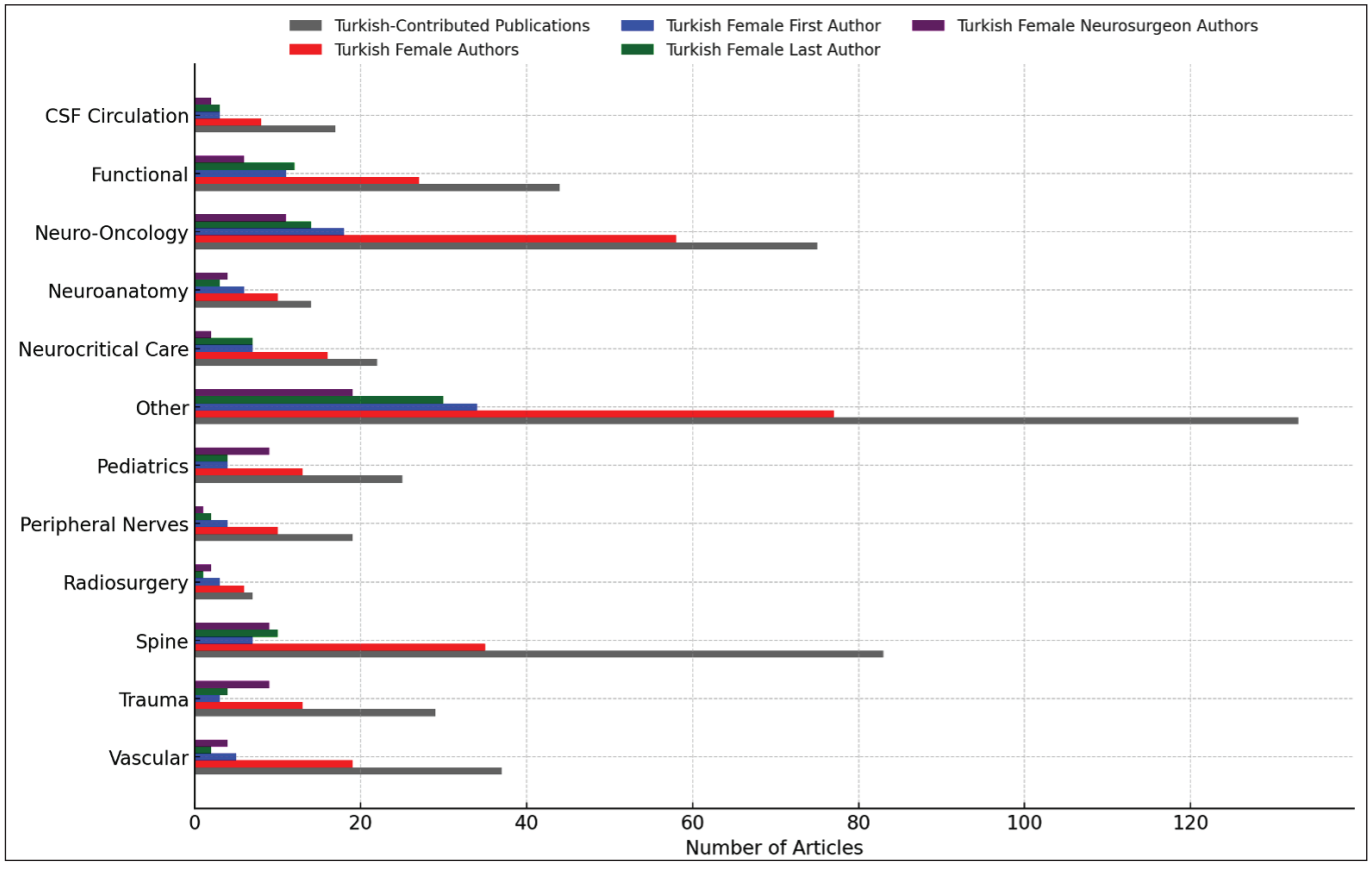

Figure 1: Comparative bar chart illustrating the topic distribution of general articles with Turkish author contributions and those authored by Turkish female researchers in *Turkish Neurosurgery*. The chart displays all Turkish-contributed publications (gray), those involving Turkish female authors (red), Turkish female first authors (blue), Turkish female last authors (green), and Turkish female neurosurgeon authors (purple).

Ocal was awarded the title of Professor in 2022, becoming the first Turkish female neurosurgeon to attain an academic rank abroad. In 2024, Ayşegül Esen Aydın was elected to the Individual Membership Committee of the European Association of Neurosurgical Societies (EANS), becoming the first Turkish female neurosurgeon to hold an administrative position within the international organization. The number of women entering the field of neurosurgery in Türkiye is increasing, reflecting global trends. A 2017 study surveying neurosurgeons across 39 EANS member countries found that 12% (1,565 out of 12,985) were women (19). Similarly, 2016 data showed that only 6.1% (259 out of 4,178) of board-certified neurosurgeons in the United States were women (17).

In 2021, the study titled "Female Participation in Academic European Neurosurgery" reported that female authors comprised 17.5% (670 out of 3,821) of all contributors to European neurosurgical publications (6). Another study analyzing 66,546 articles across 16 major neurosurgical journals found that the proportion of female first authorship increased from 5.8% in 2002 to 17.2% in 2019 ($p<0.001$) (20). In comparison, our findings reveal a notably higher level of female representation (24.8%) among Turkish-contributed studies published in *Turkish Neurosurgery*. These results suggest that Turkish female neurosurgeons contribute to academic publishing at rates comparable to those of their European counterparts. In our study, the rate of Turkish female first authorship is 20.4%, which falls between the previously reported rates (13.3% and 15.7%) (1,6,16,20). These findings suggest that Turkish female researchers contribute to scientific publishing at rates comparable to—even exceeding—those of their international peers.

The number of female senior authors in publications was examined as an indirect representation of leadership in academic neurosurgery. Previous studies have reported female senior authorship rates in neurosurgical literature ranging from 7.3% to 10.8% (1,6,16,20). In contrast, our study found a higher proportion of female senior authors (18.2%), indicating a comparatively stronger presence of Turkish female neurosurgeons in senior academic roles compared to international averages. This finding demonstrates the notable progress women in Turkish neurosurgery are making in their academic careers. The literature has reported an increase in female senior authorship from 5.5% in 2002 to 12.0% in 2019 ($p<0.001$) (20). Regional analysis of female authorship trends in neurosurgical research suggests that Europe has reached a plateau, with women accounting for approximately 20% of first (junior) authors and 10% of last (senior) authors (6,16,20). In contrast, in the US and Canada, although the percentages of first and senior female authors were lower in early 2009, they have increased in the years since (16). However, researchers have expressed concerns that this trajectory mirrors the trend observed in Europe a decade earlier, suggesting that the US and Canada may likewise approach a plateau in the coming years (10,16,20). Similarly, our findings from the past five years in Türkiye indicate a potential plateau phase, suggesting that if this mirroring trend continues, Türkiye may also experience stagnation in the growth of female authorship over the next decade.

Previous studies across various fields—not limited to neurosurgery—have shown that the presence of a female senior author significantly increases the likelihood of female first authorship (7,13). One study reported that articles were 2.69 times more likely to have a female first author when the senior author was also female (20). Another study found that female first authorship increased to nearly 30% when the senior author was a woman, compared to just 12% when the senior author was a man (16). Our findings further reinforce this mentorship effect, demonstrating that in *Turkish Neurosurgery*, the presence of a Turkish female senior author was significantly associated with a higher likelihood of female first authorship (OR=3.63, $p<0.001$). Despite the growing presence of women in surgery, they remain underrepresented on editorial boards, which may contribute to unconscious bias and the lower proportion of female authors (11). A study of high-impact general surgery journals found that female editorial board membership increased from 5% to 19% over two decades (11), while another study reported that women comprised only 9% of the editorial boards of leading neurosurgery journals (3). Further research is needed to assess the evolution of editorial boards and their impact on female faculty publishing, particularly in the field of neurosurgery.

While most Turkish male authors in the journal were neurosurgeons, the majority of Turkish female authors belonged to non-neurosurgical specialties. These results are consistent with previous studies highlighting the underrepresentation of women in neurosurgical authorship and leadership roles (1,6,16). This disparity highlights a potential gender gap in neurosurgery-specific academic contributions and underscores the need for targeted initiatives to support and retain women in neurosurgical academia. Although women comprise only 5.5% of the 1,699 registered neurosurgeons in Türkiye (94 female), no statistically significant difference was observed between male and female neurosurgeons in first authorship or senior authorship, despite the lower female representation (χ^2, $p=0.133$; 0.902)

Most of the Turkish-contributed publications in Turkish neurosurgery were original investigations, with Turkish female authors contributing to 59.9% of these articles. In contrast, an international study reported a higher female authorship rate of 66.2% in original investigations (6). Among articles authored by Turkish female researchers, the most frequently studied topics were neuro-oncology, spine, and functional neurosurgery. Similarly, previous studies have reported that these research areas are also among the most common for female authors in neurosurgery (16). This consistency suggests that women in neurosurgical research tend to engage in similar subspecialties worldwide. Our findings indicate that the vast majority of publications involving Turkish female authors originated from institutions within Türkiye, with minimal contributions from international affiliations. Multiple factors may contribute to this pattern, including limited opportunities for global academic collaboration among Turkish female researchers. These limitations—such as language barriers, funding constraints, and restricted access to international research networks—can hinder their visibility and career advancement. As a potential solution, similar efforts, such as global education initiatives by

the Society of Neurological Surgeons and the Foundation for International Education in Neurological Surgery (FIENS), could be implemented to support young female researchers (3,18). However, another explanation is that Turkish female neurosurgeons affiliated with international institutions may prefer to publish in other SCIE-indexed journals rather than in *Turkish Neurosurgery*.

Limitations

Our study has several limitations that need to be acknowledged. First, it focuses exclusively on the proportion of Turkish female authors in Turkish-contributed publications in *Turkish Neurosurgery*. Second, the analysis was limited to a five-year period, which may have contributed to the apparent plateau in female authorship trends.

CONCLUSION

This bibliometric analysis reveals encouraging progress in the representation of Turkish female authors in neurosurgical academic publishing. The overall proportion of female authorship in *Turkish Neurosurgery* remains below that of their male counterparts. However, Turkish female researchers—particularly neurosurgeons—demonstrate a noteworthy level of academic engagement, especially given their limited representation in the national workforce. Furthermore, the presence of a Turkish female senior author was associated with a 3.63-fold increase in the likelihood of Turkish female first authorship compared to publications without a female senior author. This highlights the crucial role of female mentorship in advancing female authorship in neurosurgical research. To further strengthen this effect, academic institutions could implement structured mentorship programs, allocate funding for collaborative research, and establish platforms to connect senior and junior female researchers. Nevertheless, the underrepresentation of women in neurosurgical subspecialties, leadership roles, and international collaborations indicates that structural and systemic barriers persist. Identifying barriers or the absence of key facilitators in this advancement process is essential for developing targeted strategies to enhance academic visibility and leadership opportunities for female neurosurgeons.

Declarations

Funding: No funding was received for this study.

Availability of data and materials: The datasets generated and/or analyzed during the current study are available from the corresponding author by reasonable request.

Disclosure: The authors declare no competing interests.

AUTHORSHIP CONTRIBUTION

Study conception and design: IES, SB, HKS
Data collection: IES, SH, BG, ES, MG, SB
Analysis and interpretation of results: IES, SH, BG, ES, MG, SB
Draft manuscript preparation: IES, SB
Critical revision of the article: HKS
Other (study supervision, fundings, materials, etc...): HKS
All authors (IES, SH, BG, ES, MG, SB, HKS) reviewed the results and approved the final version of the manuscript.

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