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Analysis of Research Productivity of Neurosurgical Residents in Turkey and Publication Rates of Theses

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ABSTRACT

AIM: To analyze the resident's contribution toward research productivity and the publication rates of theses conducted in neurosurgery departments across Turkey.

MATERIAL and METHODS: A retrospective bibliometric analysis was conducted using databases of Council of Higher Education Thesis Center (TC), Scopus, and Journal Citation Reports. Neurosurgeons who uploaded their graduation thesis to the TC database between the years 2000 and 2017 were considered. Each neurosurgeon was individually searched for in the Scopus database regarding their publication production. Mann-Whitney U and Kruskal-Wallis tests were employed for statistical analysis.

RESULTS: We identified 709 neurosurgeons, and 269 (37.9%) of them published their theses in indexed journals. The average interval between the publication year of the thesis and the year of the neurosurgery training completion was 3.8 ± 2.7 years. Neurosurgeons who published their theses in the first two-year period after graduation had published their theses in significantly higher impact factor journals than those who published theirs between 3–5 years ($p=0.015$) and more than 5 years after graduation ($p<0.001$). We identified 8 (1.1%) and 347 (49%) neurosurgeons who had pre-residency and intra-residency publications, respectively. Neurosurgeons who published an intra-residency article had a significantly higher overall publication counts compared with those who did not ($p<0.001$).

CONCLUSION: The ratio of publication of theses in the field of neurosurgery is higher than the ratios previously indicated for various studies. We have provided new benchmarks for individual academic productivity during and after the residency.

KEYWORDS: Bibliometrics, Neurosurgery, Research activities, Residency, Thesis

INTRODUCTION

In Turkey, it is mandatory to write a thesis to be awarded a medical specialty degree; however, it is optional to publish this thesis in an indexed journal. This prerequisite leads to several research projects being conducted, although it is unclear what percentage of these get published in scientific journals, and has been analyzed previously with only a limited study in the field of neurosurgery (3).

Nevertheless, the resident research productivity of the neurosurgery department is a crucial determinant of the overall research productivity of the department (2,4). To the best of our knowledge, no study has analyzed the research contribution of neurosurgery residents in Turkey.

Here, we aimed to analyze the resident's contribution to research productivity and the publication rates of theses conducted in neurosurgery departments across Turkey.

MATERIAL and METHODS

A retrospective bibliometric study was conducted using databases of the Council of Higher Education Thesis Center (TC) (https://tez.yok.gov.tr), Scopus (http://www.scopus.com; Elsevier, Amsterdam, Netherlands), and Journal Citation Reports (JCR) (https://jcr.clarivate.com; Clarivate Analytics, PA, USA). This study was exempted from the approval of the institutional review board. A search was performed using the "Division" section of the TC database. "Beyin ve Sinir

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Cerrahisi Anabilim Dalı"; "Beyin-Sinir ve Omurilik Cerrahisi Anabilim Dalı"; "Nöroşirürji Anabilim Dalı" were chosen as the search criteria for identification of neurosurgeons. Only neurosurgeons who uploaded their graduation thesis to TC database between the years 2000 and 2017 were considered. Each neurosurgeon was searched for individually in the Scopus database for their publication production. The search was conducted between September 6, 2018, and October 23, 2018. Collected data included gender, the department where the neurosurgery training was completed, the year of neurosurgery training completion, the publication year of the thesis in Scopus-indexed journals, the journal wherein the thesis was published, and the publication count (overall, post-residency, intra-residency, and pre-residency). The 5-year impact factors of journals in 2017 were taken from JCR. Furthermore, to identify the publication counts during medical studentship, we subtracted six years from the year of neurosurgery training completion, and the studies published before that year were considered as pre-residency publications. We identified 13 authors in the Scopus database whose publications were merged with their namesakes', and they were separated. We performed a Google search of women authors along with their department, where they completed the neurosurgery training, to not miss an author because of a probable surname change after marriage.

The normality of the data was assessed using the Kolmogorov-Smirnov test. Because of the non-normal distribution of data on the Kolmogorov-Smirnov test, non-parametric inferential tests were employed. The Mann-Whitney U test was used to assess differences between two independent samples, and the Kruskal-Wallis test alongside the post-hoc Mann-Whitney U test was used to compare more than two independent samples. IBM SPSS Statistics for Windows, Version 21.0 (Released 2012, IBM Corp, Armonk, NY, USA) was used for the statistical analysis, and a *p* value less than 0.05 was considered statistically significant.

RESULTS

We identified 709 neurosurgeons [668 males (94%) and 41 females (6%)] who had uploaded their theses between 2000 and 2017 from 49 different universities and 19 different training and research hospitals all across Turkey. The full list of neurosurgeons is provided in Supplementary Material 1 (can be found on electronic document; please visit:http://turkishneurosurgery.org.tr/uploads/jtn-28459-supplement-material-1.xlsx).

Publication Ratios of Theses

As of October 2018, 269 (37.9%) neurosurgeons [255 males (95%) and 14 females (5%)] published their theses. The average interval between the year of publication of theses and the year of the neurosurgery training completion (shortly called "*interval*" throughout the text) was 3.8 ± 2.7 years (range = −1 to 16). We grouped the publications from the overall 85 journals according to the 5-year impact factors of journals in which they published (Table I). The total citation received by all publications was 2115, with an average of 7.8 ± 10.8 (range: 0–55), and the h-index was 24. The list of the 24 articles (8.9%) that received a citation of above 25 is given in Table II. The mean *interval* of these 24 articles was 1.5 ± 1.4 years (range = −1 to 4), and the average citation received was 36 ± 8.9 (range: 25–55). Even though these articles constituted 8.9% of all articles, they received 40.9% (866/2115) of the total citations.

The average 5-year impact factor of journals was 1.5 ± 1.3 (range: 0.1–9.5). The most preferred journals, in the order of preference, were Turkish Neurosurgery; Journal of Neurological Sciences; Journal of Clinical Neuroscience; Neurosurgery; and Ulusal Travma ve Acil Cerrahi Dergisi, with publication counts of 51, 22, 14, 13 and 12, respectively. We analyzed the relationship between the *interval* and the 5-year impact factors of journals that published the papers (Table III). Neurosurgeons who published their theses in the first two-year period after graduation published their theses in significantly higher impact factor journals than those who

Table I: The Distribution of Publications according to the Impact Factors of Journals in Which They Published

Group	# of publications	# of separate journals	Total Citation	Average Citation
Scp + / WOS -	5	4	0	0
ESCI	7	5	14	2
0.1 - 0.9	120	20	377	3.1
1.0 - 1.9	63	22	571	9
2.0 - 2.9	41	19	473	11.5
3.0 - 3.9	12	9	185	15.4
> 4,0	21	6	495	23.5
Total	**269**	**85**	**2115**	**7.8**

The numbers in groups denote 5-year impact factor intervals of journals.
***ESCI:** Emerging Sources Citation Index; **Scp + / WOS - :** Journals indexed in Scopus (Scp), but not in Web of Science (WOS).*

Table II: The Most Cited Theses That Were Published in SCI/SCI-E Journals

Article	Citation	Journal (JIF), Publication Year	Graduation Year
Hicdonmez, T., Kanter, M., Tiryaki, M., Parsak, T., Cobanoglu, S. Neuroprotective effects of N-acetylcysteine on experimental closed head trauma in rats	55	Neurochem Res (2.7), 2006	2006
Ugur, H.C., Attar, A., Uz, A., (...), Caglar, S., Genc, Y. Surgical anatomic evaluation of the cervical pedicle and adjacent neural structures	53	Neurosurg (4.2), 2000	2001
Kilic, T., Sohrabifar, M., Kurtkaya, O., (...), Gunel, M., Necmettin Pamir, M.N. Expression of structural proteins and angiogenic factors in normal arterial and unruptured and ruptured aneurysm walls	47	Neurosurg (4.2), 2005	2004
Baydas, G., Ozveren, F., Akdemir, I., Tuzcu, M., Yasar, A. Learning and memory deficits in rats induced by chronic thinner exposure are reversed by melatonin	46	J Pineal Res (9.5), 2005	2004
Ersahin Y., Arslan, D. Complications of endoscopic third ventriculostomy	46	Childs Nerv Syst (1.3), 2008	2006
Kaynar, M.Y., Tanriverdi, T., Kafadar, A.M., (...), Dirican, A., Kuday, C. Detection of soluble intercellular adhesion molecule-1 and vascular cell adhesion molecule-1 in both cerebrospinal fluid and serum of patients after aneurysmal subarachnoid hemorrhage	42	J Neurosurg (4.4), 2004	2003
Ak, H., Ay, B., Tanriverdi, T., (...), Ozyurt, E., Uzan, M. Expression and cellular distribution of multidrug resistance-related proteins in patients with focal cortical dysplasia	42	Seizure (2.6), 2007	2005
Tanriverdi, F., De Bellis, A., Ulutabanca, H., (...), Casanueva, F.F., Kelestimur, F. A five year prospective investigation of anterior pituitary function after traumatic brain injury: Is hypopituitarism long-term after head trauma associated with autoimmunity?	40	J Neurotrauma (5), 2013	2010
Deniz, M.L., Kilic, T., Almaata, I., (...), Rutka, J.T., Piepmeier, J.M. Expression of growth factors and structural proteins in chordomas: Basic fibroblast growth factor, transforming growth factor α, and fibronectin are correlated with recurrence	39	Neurosurg (4.2), 2002	2002
Yuruker, V., Naziroglu, M., Senol, N. Reduction in traumatic brain injury-induced oxidative stress, apoptosis, and calcium entry in rat hippocampus by melatonin: Possible involvement of TRPM2 channels	39	Metab Brain Dis (2.4), 2014	2014
Abas, F., Alkan, T., Goren, B., (...), Sarandol, E., Tolunay, S. Neuroprotective effects of postconditioning on lipid peroxidation and apoptosis after focal cerebral ischemia/ reperfusion injury in rats	38	Turk Neurosurg (0.8), 2010	2007
Kerman, M., Cirak, B., Ozguner, M.F., Dagtekin, A., Sutcu, R., Altuntas, I., Delibas, N. Does melatonin protect or treat brain damage from traumatic oxidative stress?	35	Exp Brain Res (2.1), 2005	2001
Kilic, T., Bayri, Y., Ozduman, K., (...), Kaye, A.H., Rutka, J.T. Tenascin in meningioma: Expression is correlated with anaplasia, vascular endothelial growth factor expression, and peritumoral edema but not with tumor border shape	33	Neurosurg (4.2), 2002	2001
Gurkanlar, D., Er, U., Sanli, M., Ozkan, M., Sekerci, Z. Peritumoral brain edema in intracranial meningiomas	32	J Clin Neurosci (1.5), 2005	2004
Akakin, A., Ozkan, A., Akgun, E., (...), Pamir, M.N., Kilic, T. Endovascular treatment increases but gamma knife radiosurgery recreases angiogenic activity of arteriovenous malformations: An in vivo experimental study using a rat cornea model	31	Neurosurg (4.2), 2010	2008
Sencer, A., Yorukoglu, A.G., Akcakaya, M.O., (...), Boyali, O, (...), Izgi, N., Canbolat, A.T. Fully endoscopic interlaminar and transforaminal lumbar discectomy: Short-term clinical results of 163 surgically treated patients	31	World Neurosurg (2.3), 2014	2014

Table II: Cont.

Article	Citation	Journal (JIF), Publication Year	Gradiation Year
Ozsuer, H., Gorgulu, A., Kiris, T., Cobanoglu, S. The effects of memantine on lipid peroxidation following closed-head trauma in rats	31	Neurosurg Rev (2.3), 2005	2003
Akyol, S., Senel Eraslan, B., Etyemez, H., Tanriverdi, T., Hanci, M. Catabolic cytokine expressions in patients with degenerative disc disease	30	Turk Neurosurg (0.8), 2010	2010
Abuzayed, B., Tanriover, N., Ozlen, F., (...), Eraslan, B., Akar, Z. Endoscopic endonasal trans-sphenoidal approach to the sellar region: Results of endoscopic dissection on 30 cadavers	28	Turk Neurosurg (0.8), 2009	2009
Sonmez, E., Kabatas, S., Ozen, O., (...), Caner, H., Altinors, N. Minocycline treatment inhibits lipid peroxidation, preserves spinal cord ultrastructure, and improves functional outcome after traumatic spinal cord injury in the rat	26	Spine (3.3), 2013	2010
Solmaz, I., Gurkanlar, D., Gokcil, Z., (...), Ozkan, M., Erdogan, E. Antiepileptic activity of melatonin in guinea pigs with pentylenetetrazol-induced seizures.	26	Neurol Res (1.4), 2005	2009
Ozay, R., Bekar, A., Kocaeli, H., (...), Filiz, G., Ulus, I.H. Citicoline improves functional recovery, promotes nerve regeneration, and reduces postoperative scarring after peripheral nerve surgery in rats	26	Surg Neurol (1.8), 2007	2005
Emmez, H., Kardes, O., Dogulu, F., (...), Memis, L., Baykaner, M.K. Role of antifibrotic cytokine interferon-γ in the prevention of postlaminectomy peridural fibrosis in rats	25	Neurosurg (4.2), 2008	2005
Sahin, S., Alkan, T., Temel, S.G., (...), Tolunay, S., Korfali, E. Effects of citicoline used alone and in combination with mild hypothermia on apoptosis induced by focal cerebral ischemia in rats	25	J Clin Neurosci (1.5), 2010	2006

Cit.: *Citation;* ***Pub. Year:*** *Publication year;* ***Grad. Year:*** *Graduation year;* ***JIF:*** *Journal Impact Factor.*

Table III: The Relationship Between the Publication Year and The Impact Factor of the Journal

Group	Interval P - C (years)	# of total publications (%)	# of publications in SCI-E journals (%)	Average impact factor*	Statistical Analysis
1	-1, 0, 1, 2	99 (37)	97 (38)	1.9 ± 1.5 (range: 0.1-9.5)	Group 1 -> 2 **(p=0.015)** Group 1 -> 3 **(p<0.001)**
2	3, 4, 5	111 (41)	109 (42)	1.4 ± 1.0 (range: 0,1-5)	Group 2 -> 3 **(p<0.001)**
3	>5	59 (22)	51 (20)	1.0 ± 1.0 (range: 0.1-4.4)	
Total		**269**	**257**	**1.5 ± 1.3 (range: 0.1-9.5)**	

Interval P - C: *The interval between the publication year in a journal and the year of the neurosurgery training completion*
****:*** *Average 5-year impact factor of journals that published the papers in the given group.*

published theirs between 3–5 years (p=0.015) or more than 5 years after graduation (p<0.001).

Publication Productivity

The distribution of overall publication counts of neurosurgeons in our cohort is given in Figure 1A. We identified that 158 (22.2%) neurosurgeons [150 males (95%) and 8 females (5%)] had not published any articles yet. The number of neurosurgeons and the range of the overall publications (in parenthesis) are as follows: 226 (1–3); 69 (4–6); 48 (7–9); 77 (10–19); 50 (20–29); 51 (30–49); 28 (50–99); and 2 (>100).

We noted that 8 neurosurgeons (1.1%) had published articles during pre-residency, and the publication/matriculant ratio was 0.015 (11/709, range: 1–3). The average overall publication count of neurosurgeons who had pre-residency publication was 21.1 ± 17.1 (range: 1–49). Overall, 362 (51%) neurosurgeons had no intra-residency publications (Figure 1B). The number of neurosurgeons and the range of intra-residency publications (in parenthesis) are as follows: 254 (1–3); 53 (4–6); 16 (7–9); 22 (10–19); and 2 (>20). The average overall publication count of neurosurgeons who had an intra-residency publication was 16.1 ± 18.7 (range: 1 –127). Neurosurgeons who published an intra-residency article had a significantly higher overall publication counts compared with those who did not (p<0.001).

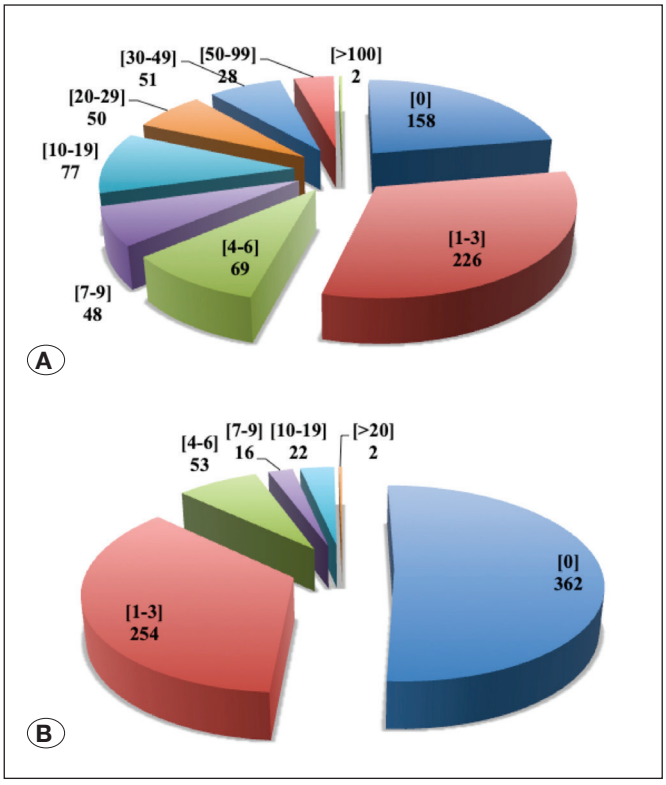

Figure 1: The pie charts showing the research productivity (publication count) of neurosurgeons. Numbers in the first line in brackets denote interval of total publication counts; numbers in the second line indicate number of neurosurgeons in the given group. **A) Overall research productivity.** It was found that 158 (22%) neurosurgeons had not published any articles yet. The majority of the neurosurgeons [226/709 (32%)] had 1 to 3 publication(s). The number of neurosurgeons and the range of the overall publications (in parenthesis) are as follows: 226 (1–3); 69 (4–6); 48 (7–9); 77 (10–19); 50 (20–29); 51 (30–49); 28 (50–99); and 2 (>100). **B) Research productivity during residency.** The number of neurosurgeons and the range of intra-residency publications (in parenthesis) are as follows: 362 (0); 254 (1–3); 53 (4–6); 16 (7–9); 22 (10–19); and 2 (>20).

DISCUSSION

In this study, we noted that the publication rate of theses of residency training completion among the Turkish neurosurgeons is 36% in SCI/SCI-E journals. Another similar study conducted by Ogrenci et al. in 2015 reported a publication rate of 18% in SCI/SCI-E journals among Turkish neurosurgeons (3). Notably, the use of different methodologies may underlie such an immense difference between the two studies.

Instead of searching the exact title of a thesis, as in the TC database, in search engines, we preferred to use the Scopus database to check the publications of neurosurgeons individually. We believe such a methodology provides more accurate data because we observed that most theses were published under different titles than that provided in the TC database. Our ratio is in the mid-range of previously reported theses publication rates of various studies (17–60, 5%) (3).

One of the dramatic findings of our study is the relatively lower amount of women neurosurgeons in Turkey. We observed that women constituted only 6% of former neurosurgery residents in Turkey. In contrast, the ratio of women residents in the USA is 17% (2). This difference in ratios may be related to the probable discouragement of women applicants by the existing faculty and neurosurgery residents of the program when they intend to apply for residency training. In addition, possible higher workload ratios in neurosurgery-training programs in Turkey could have played a role in this situation.

The pre-residency publication to matriculant ratio was 0.015 in Turkey. By contrast, 206 first-year neurosurgery residents had published 775 pre-residency articles in the USA, with a publication to matriculant ratio of 3.7 (1). The incredibly lower amount of pre-residency publications among neurosurgeons in Turkey can be directly related to the application criteria of a neurosurgery-training program in Turkey. The sole criterion to be accepted to a residency program is to pass a specialty examination, which is unnecessarily detailed and difficult and takes at least two productive years of medical students to prepare for it. We believe the criteria for residency program appointment needs to be revised if higher scientific productivity is expected in Turkey.

Approximately 51% of neurosurgical residents in Turkey had not contributed to any Scopus-indexed publications during their residency. On the other hand, 1352 neurosurgery residents in the USA had published 10,645 articles, of which 3985 were resident first-author publications, during their residency period (4). Notably, there can be various reasons for the low research contribution of residents in Turkey, such as inadequate research supervision, high clinical workloads, lack of research tradition in the training department, or lack of funds. One probable factor that we want to emphasize is the regulations of academic promotion in Turkey. Intra-residency publications have an easily neglectable impact on neurosurgeons' career and later academic advancement in Turkey. For an academic advancement, a neurosurgeon must have articles that were published after the completion of residency training. Therefore, most neurosurgeons conduct research activities during their residencies and publish them after residency. Overall, 204 (56%) of the 362 neurosurgeons, who had no intra-residency publications, published at least one article after their graduation. Therefore, we firmly believe that academic regulations concerning advancement must also be revised in Turkey to increase intra-residency publications.

CONCLUSION

The ratio of publication of theses in the field of neurosurgery is higher than the ratios previously indicated for various studies. We have provided new benchmarks for individual academic productivity during and after the residency.

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