Assessment of the Academic Productivity of Plastic Surgeons in Saudi Arabia Using the *h-index*

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Background: *Hirsch-index* (or *h-index*) is a bibliometric measure calculated for researchers based on number of publications and their citations. This study examined the *h-index* of board-certified plastic surgeons in Saudi Arabia and the different factors that may influence it.
Method: In this cross-sectional study, an electronic questionnaire was sent to 156 board-certified plastic surgeons practicing in Saudi Arabia. Using their names, we conducted an online search on Scopus, Semantic scholar, and Google scholar to calculate their *h-index*. Bivariate and multiple regression analyses were conducted to determine the relationship of those factors with the index.
Results: A total of 84 surgeons participated in this study, of whom 83.3% were men. Our sample scored a mean index of 1.7 and published a mean of 5 articles. More publications and a higher academic rank predicted a higher *h-index*, (β = 0.79, $P < 0.001$) and (β = 0.14, P 0.017), respectively. On the other end of the spectrum, the country of residency training (P 0.33), the year of training completion (P 0.95), attaining fellowship training (P 0.95), the number of fellowships (P 0.20), interest in research (P 0.74), working in an academic hospital (P 0.44), or attaining a higher degree (P 0.61) were not significant independent predictors of the index.
Conclusions: More publications and a higher rank predicted increased academic productivity among the plastic surgeons in Saudi Arabia. Despite its limitations, *h-index* is a useful measure that can be considered in promotions and applications to prestigious plastic surgery centers in adjunct to other factors. *(Plast Reconstr Surg Glob Open 2021;9:e3439; doi: 10.1097/GOX.0000000000003439; Published online 18 February 2021.)*

INTRODUCTION

With a rising influence over the past decades in the scientific and academic milieu, the concept of "publish or perish" represents one of the many "battlefronts" that demands plastic surgeon's attention. Although regular, continuous scientific contribution is encouraged, it should not come with sacrificing key standards like quality.[1] Taking the quantity and quality of the written scientific output into consideration, Hirsch-index (*h-index*) or Hirsch number is a widely used bibliometric measure proposed by Jorge E. Hirsch from University of California, San Diego in 2005, and is equal to *h* number of articles cited at least *h* times.[2] It enables within-field scholarly output comparison among researchers by measuring the numbers of publications and citations.[3] Apart from the objective assessment that results from combining a researcher's productivity with impact, the effectiveness of this index stems from its simplicity and superior reliability when contrasted against single measures, such as total citations or number of publications. However, the inability to draw inter-disciplinary comparison; assessment inflation by frequent self-citation; and underestimation of researchers working in small groups, solely, or women who change their surname following marriage limit the *h-index*.[4–6]

Different publications discussed plastic surgeons' research productivity by utilizing *h-index* as the main measure.[7] Paik et al examined the *h-index* of 506 faculty members across 83 plastic surgery departments in relation to gender and academic rank.[7] The latter was the focus of the

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US-based studies by Therattil et al and Susarla et al, where they investigated its association with the *h-index*, among a number of other research productivity measures and variables.[8,9] Studies were not bordered within the realm of general plastic surgery and took extra steps assessing the academic productivity in subspecialties such as hand and craniofacial surgeries.[10,11] Lopez et al and Susarla et al surveyed full-time academic hand surgeons (30% of whom were plastic surgeons) and craniofacial surgeons to determine their *h-indic*es in relation to academic rank.[10,11] Locally, the only article published was in 2015 presenting the *h-index* for neurosurgeons who practiced in the Kingdom of Saudi Arabia (KSA) over 1990–2014; the author discussed many factors that correlated positively with higher *h-index*, such as working in specific centers. The author suggested considering *h-index* as a criterion for applicants to academic positions in KSA.[5] However, there is no study that discussed the *h-index* and its relation with other influential factors, such as academic rank, in relation to plastic surgery in KSA; and this is the purpose of this survey.

METHODOLOGY AND DESIGN

In this cross-sectional study, a self-administered survey composed of 13 questions in English was sent to 156 members of KSA-based plastic surgery societies, aiming to unveil the quality and quantity of the academic productivity of the board-certified plastic surgeons and the factors that influence it. Collected data included: demographic information, number of publications, academic position, if the affiliated center had a research facility or was a university hospital, interest in research, and other aspects. The sole inclusion criterion was board-certified plastic surgeons working in KSA at the time of data collection. Data were collected during March and April 2020 with multiple reminders. Candidates were briefed about *h-index* and informed that participation was voluntary with no repercussions should they refrain from filling the questionnaire. Moreover, consent was obtained to publish the data in scientific platforms without including any identifiers or disclosure to a third party. Institutional review board approval was obtained from a local committee, and ethical principles stated in the Declaration of Helsinki were followed.

A divergent question asked about the attained fellowships to allow adding more than a single subspecialty if available. The answers were stratified into 7 categories, including pediatric plastic surgery, craniofacial surgery, cosmetic surgery, hand and peripheral nerve surgery, microsurgery, breast reconstruction surgery, and burn surgery. The *h-index* was documented for each surgeon after searching their name on Scopus, Semantic scholar, and looking for their Google scholar profile if available. In cases of discrepancy among the websites, a higher *h-index* was chosen and manual calculation through Google scholar was done.

Using Statistical Package for the Social Sciences (SPSS) 25th edition for Microsoft (Microsoft Corp, Redmond, Wash.), after importing the data from Excel to SPSS, frequencies, percentages, and measures of dispersion were calculated. Because of abnormal data distribution, non-parametric tests were used. Where applicable, outlier values were winsorized, a method to obtain accurate data by changing the values of the outliers to the closest non-outlier value.[12] Spearman rank order test was employed to investigate the correlation of *h-index* with number of publications, duration of practice, academic position, and number of attained fellowships. Mann-Whitney *U* and Kruskal-Wallis *H* tests were used to test the difference in mean *h-index* between graduates of different countries, academic ranks, genders, people who possessed post-graduate degrees and those who did not, surgeons with fellowship training and those without, surgeons interested in research and those who are not, and surgeons who worked in academic hospital and those who work in another settings. To control confounders, a multiple linear regression model with backward elimination was created, including variables with significance below 0.1. A probability value of 0.05 was adapted for significance.

RESULTS

With a response rate of 53%, this cross-sectional study surveyed 84 of 156 qualified plastic surgeons working in KSA at the time of data surveillance. Table 1 shows the demographic data. Before analyzing the participants' *h-indices*, 2 outliers were winsorized from 32 and 78 to 9. The mean *h-index* for plastic surgeons in KSA was 1.7 (SD = 2.1) with a minimum of 0 and maximum of 9; further details are shown in Table 2.

Spearman rank order test showed a significantly strong positive correlation between the *h-index* and number of publications ($r^2 = 0.76$, $P < 0.001$). Also, a significantly negative weak correlation between the *h-index* and year of graduation ($r^2 = -0.31$, P 0.004); in other words, the older the surgeon, the more likely they published more articles. A significantly positive weak relationship was also noted using the aforementioned test between the *h-index* and academic rank ($r^2 = 0.36$, $P < 0.001$). Notwithstanding, no significant association was found between the number of attained fellowships and *h-index* ($r^2 = 0.2$, P 0.05). Using Kruskal-Wallis *H* test followed by Bonferroni correction, the plastic surgeons who completed their training in Canada (Mean = 2.7; SD = 2.4) achieved a significantly higher *h-index* (P 0.004) compared with those who underwent training in KSA (Mean = 0.9; SD = 1.4). On the contrary, the *h-index* for surgeons trained in France, Germany, or other countries, including the United Kingdom, Egypt, Pakistan, India, and Malaysia, was not statistically different from that for the Saudi-trained plastic surgeons nor for that between each other. Using the same test, there was a significant difference in the *h-index* between academic ranks (P 0.002). However, applying Bonferroni procedure in pairwise comparison, to control for family-wise error rate, showed no significant difference among different ranks. Further details are mentioned in Table 3 and Figure 1. Although male plastic surgeons scored a mean *h-index* of 1.9 (SD = 2.2), it was not significantly different (P 0.25) than their female counterparts (Mean = 1; SD = 1.2) on Man-Whitney *U* test. Plastic surgeons with

Table 1. Demographic Data

Variable	No., %	Measures of Dispersion
Nationality	Saudi: 75 (89.3%) Non-Saudi: 9 (10.7%)	—
Gender	Men: 70 (83.3%) Women: 14 (16.7%)	—
Years practicing as a certified plastic surgeon	—	Mean: 8.5 y SD: 7 y Median: 7 y Mode: 3 y Min: 0 y Max: 31 y
Post-graduate degree	Yes: 23 (27.4%) No: 61 (72.6%)	—
Academic position	None: 48 (57.1%) Lecturer: 2 (2.4%) Assistant professor: 31 (36.9%) Associate professor: 1 (1.2%) Professor: 2 (2.4%)	—
The country of training	Saudi Arabia: 35 (41.7%) Canada: 26 (31%) Germany: 7 (8.3%) France: 6 (7.1%) Others*: 10 (11.9%)	—
Date of finishing training in plastic surgery	Before 2000: 9 (10.7%) 2000–2009: 15 (17.9%) After 2009: 60 (71.4%)	—
Fellowship training	Yes: 59 (70.2%) †No: 25 (29.8%)	—
Number of attained fellowships	†0: 25 (29.8%) 1: 33 (39.3%) 2: 13 (15.5%) 3: 12 (14.3%) 4: 1 (1.2%)	Mean: 1.1 fellowship SD: 1 fellowship Median: 1 fellowship Mode: 1 fellowship Min: 0 fellowship Max: 4 fellowships
Interest in research	Yes: 71 (84.5%) No: 13 (15.5%)	—
Type of affiliated hospital	University hospital or has a research center: 52 (61.9%) Non-university hospital without a research center: 32 (38.1%)	—
Affiliated center is recognized as a plastic surgery training center by the SCFHS	Yes: 51 (60.7%) No: 33 (39.3%)	—
Number of publications‡	—	Mean: 13 articles SD: 55 articles Median: 4 articles Mode: 2 articles Min: 0 articles Max: 480 articles

*The United Kingdom, Egypt, Pakistan, India, and Malaysia are grouped under "Others" in the section about the country of training.
†Four surgeons did not mention their fellowship, and thus are considered as having no fellowships.
‡Data in this section include outliers. Six surgeons reported to have published 480, 170, 36, 28, 25, and 25 articles, which were winsorized to 17, changing the mean of publications to 5 articles.
Max: Maximum; Min: Minimum; SCFHS: Saudi Commission for Health Specialties.

Table 2. Detailed Representation of Plastic Surgeons' *h-index* in Saudi Arabia

h-index	No., %
0	31 (36.9%)
1	14 (16.6%)
2	17 (20.2%)
3	11 (13.1%)
4	4 (4.8%)
5	1 (1.2%)
7	3 (3.6%)
9	3 (3.6%)

The *h-indices* projected here are after winsorization.

Table 3. Pairwise Comparison between Different Ranks before and after Bonferroni Correction

Comparison Variables	Before Bonferroni Correction	After Bonferroni Correction
No rank with assistant professor	**P 0.02**	P 0.19
No rank with lecturer	P 0.05	P 0.55
No rank with associate professor	P 0.06	P 0.61
No rank with professor	**P 0.005**	P 0.05
assistant professor with lecturer	P 0.24	P 1.0
assistant professor with associate professor	P 0.18	P 1.0
Lecturer with associate professor	P 0.67	P 1.0
Lecturer with professor	P 0.52	P 1.0
Associate professor with professor	P 0.91	P 1.0

Bold values indicate significance.

post-graduate degrees did not score a significantly different (P 0.06) *h-index* (Mean = 2.6; SD = 2.7) than those who did not acquired post-graduate degrees (Mean = 1.4; SD = 1.8). A similar non-significant difference in *h-index* (P 0.43) was found between the group of surgeons who underwent fellowship training (Mean = 1.8; SD = 2.1) and those who did not (Mean = 1.6; SD = 2.3). Further details on fellowships can be found in Table 4. The same test, however, showed a significantly (P 0.04) higher *h-index* in favor of surgeons who were eager to engage in research (Mean = 1.9; SD = 2.2) than the ones expressing disinterest in research (Mean = 0.69; SD = 0.75). Furthermore, the index for the plastic surgeons working in a university hospital or where a research center is available (Mean = 2.3; SD = 2.4) was significantly higher (P 0.007) than that for those who worked in hospitals without a research center (Mean = 0.9; SD = 1.1). A significant ($P < 0.001$) multiple regression model ($r^2 = 0.73$) predicting the factors that may influence the index while controlling for potential confounders was constructed. After eliminating the country of obtaining plastic surgery training, year of completing plastic surgery training, fellowship training and the number of obtained subspecialties, interest in research, post-graduate degrees, type of the affiliated hospital, and gender (because these factors were not significant predictors), the final model included number of publications and academic rank ($P < 0.1$). Increased number of publications strongly predicted a higher *h-index* ($\beta = 0.79$, CI = 0.30–0.41, $P < 0.001$); to a lesser extent, a higher academic rank also predicted a higher index ($\beta = 0.14$, CI = 0.05–0.53, P 0.017) (Tables 3 and 4; Fig. 1).
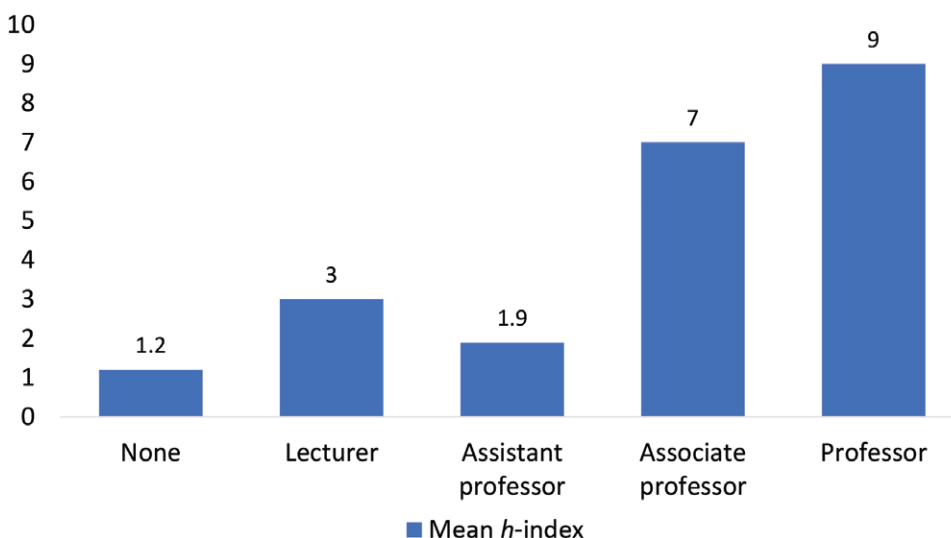
Fig. 1. Mean *h-index* for different academic ranks.

DISCUSSION

The plastic surgery community in KSA is home to 208 board-certified surgeons and 4 plastic surgery training programs, 2 of which are joint among multiple centers; these programs graduated 6 board-certified plastic surgeons in 2019. In their review on the publications in plastic surgery from KSA, Almarghoub and Al-Qattan reported an increase in the number of publications in the last 5 years, although majority were case reports (31.9%), case series (23%), and retrospective analyses (19.1%).[13]

On the premise of our analysis, the most important factor in determining a higher *h-index* was the number of publications (Mean = 5, SD = 4.7, β = 0.79, CI = 0.30–0.41, $P < 0.001$). A higher academic rank also determined a higher index (β = 0.14, CI = 0.05– 0.53, P 0.017). In our study, where 57% were non-academic plastic surgeons, the overall mean *h-index* was 1.7. A range of studies from other countries[7,8,14,15] reported mean *h-indicis* between 7.6 and 10.2 in their samples that consisted, with the exception of Hu et al, purely of academic plastic surgeons—a factor highly implicated for the disparity between our finding and theirs. The hand surgeons in our sample scored middle-ground *h-index*, at 2.4, compared with other plastic surgery subspecialties, but it was overshadowed by an index of 10.2 reported by Lopez et al, whose sample consisted of academic plastic surgeons.[10] Craniofacial surgeons in our sample had a mean *h-index* of 2.8 compared with another US-based survey of academic craniofacial surgeons, where they scored a mean of 12.4.[11] In contrast to a mean *h-index* of 2.2 in our microsurgeons, a median index of 11 was reported by Ruan et al in their cohort of microsurgeons.[16]

In concordance with other studies,[7,8,10,11,14–17] we found a positive correlation between higher academic rank and higher *h-index*. When examining our sample, a majority of the plastic surgeons (71.4%) graduated after 2009, whereas our analysis showed that the academic productivity is richer with more practice time, in alignment with other studies.[11,14,16,17] This effect was likely due to confounders because addition of the year of finishing plastic surgery training into the regression model showed its insignificant prediction when other factors were controlled (P 0.95). Nonetheless, the influence of age over the *h-index* had been heavily criticized because it presents a biased score that favors older age at the cost of a high-quality article that is undervalued because it was recently published.[18] Lesser renowned authors would be at a disadvantage compared with the seasoned veterans, further aggravating the bias.[19]

Interestingly, there was no significant difference in *h-index* between the surgeons with post-graduate degrees and those without in our sample. This finding is congruent with the conclusion of Lopez et al, where they reported no significant association between post-graduate degrees, with the notable exception of Doctor of Philosophy (PhD) degree, and *h-index*.[20] They concluded by advocating that formal research training for plastic surgeons was predictive of academic success, translated by higher *h-index*, academic rank, and chances of research grant procurement.[20]

A study looked into the impact of different plastic surgery fellowships on *h-index* reported no significant difference in the *h-index* between the surgeons with fellowships and those without a finding that resembled ours. However, it showed that surgeons with research fellowship had the highest *h-index* among their colleagues with

Table 4. Attained Fellowships with the Mean *h-index* for Each

Fellowship	Number of Surgeons with the Fellowship	Mean *h-index*
Pediatric plastic surgery	9 (11.3%)	3.2
Craniofacial surgery	10 (12.5%)	2.8
Cosmetic surgery	11 (13.8%)	2.5
Hand and peripheral nerve	21 (26.3%)	2.4
Microsurgery	36 (45%)	2.2
Breast reconstruction	12 (15%)	1.7
Burn	8 (10%)	0.5

In a descending order based on the *h-index*, this table shows the number of plastic surgeons who are certified in the abovementioned subspecialties. This table accounts for people with multiple fellowships. In total, 4 of the 59 surgeons did not mention their fellowships and, thus, are not shown in this list.

other subspecialty training.[14] We were unable to confirm a similar trend in our sample because only one surgeon completed a research fellowship. Hu et al[15] also reported that fellowship training does not alter the index among Canadian plastic surgeons. With a mean *h-index* of 3.2, pediatric plastic surgeons in our sample had the highest index, whereas the surgeons specialized in burn management scored the lowest, at a mean of 0.5. Sood et al[14] also reported that burn surgeons scored the lowest *h-index*. They demonstrated that more fellowships led to increased *h-index*, which contradicts our findings that showed no significant difference based on the number of subspecialties. Cosmetic surgeons in our sample scored a reasonable *h-index* of 2.5. It is possible that conceptualizing cosmetic surgeons to be dissociated from academic activities is a mere misconception. The mean *h-index* of the esthetic surgeons in the study by Chopra et al was comparable with craniofacial surgeons and microsurgeons, noting that their cosmetic surgeons were in practice for a long time.[17]

Women comprised 16.7% of our sample, which was comparable to other studies[21]; there was no difference in *h-index* based on gender in our sample, in contrast with other studies.[7,9,11,17] This picture might possibly change in the coming years as the currently male-dominant field witnesses the presence of more women. Shah Mardan et al reported that close to 40% of the Saudi plastic surgery trainees are women.[22] Moreover, it is suggested that female physicians tend to surpass their male counterparts in terms of scholarly productivity with age.[23]

More than 85% of the plastic-surgery–related publications from 2014 to the end of 2018 in KSA originated from academic hospitals.[13] Although we found that surgeons working in academic hospitals had a significantly higher *h-index* than their peers who worked in non-academic hospitals, working in an academic setting failed to predict a higher index (*P* 0.44), possibly due to confounders.

Among the countries of residency training, those who were trained in Canada, interestingly, displayed a significantly higher *h-index* (Mean = 2.7; SD = 2.4; *P* 0.004) compared with KSA and the other countries, the trainees of which had no significant *h-index* dissimilarity. These findings can be correlated with the study by Esmaeeli et al, where they reviewed original articles in 36 issues of the Plastic and Reconstructive Surgery journal from 2016 to 2018.[24] Although researchers from the United States contributed the most to all 6 journal categories, Canadian researchers came the third in breast, pediatric/craniofacial, and hand/peripheral nerve topics. None of the other countries where the cohort in our study finished their training was in the top 3 contributors on each topic. In fact, figure 4 in the same article shows that those countries are at a roughly similar level in terms of publication count, whereas Canada is placed at a relatively higher level.[24] It is impractical to pinpoint the causes behind this disparity, as limited data are available in the literature. However, factors such as busy clinical duty due to staff shortage and absence of research-fostering milieu could be implicated, as explained by Hu et al, where they reported that Canadian plastic surgery trainees in the United States had a significantly higher *h-index* than their peers in Canada.[15]

Looking at Table 2, close to 37% of our sample had a *h-index* of zero, reflecting non-existent scholarly contribution to the field. This high proportion is alarming and might, hopefully, regress in the coming years.

Many factors contribute to the limitations of this study. The *h-index* may not be consensual among different databases for a particular researcher. While the index calculated by Scopus and Google scholar are highly correlated for other fields such as neurosurgery,[25] the correlation was questioned in case of plastic surgery.[26] In our sample, manual cross-referencing was done where necessary, which can minimize chances of error. Furthermore, some imperfections are inherent in the databases. For example, publications before 1996 may not show on Scopus, leading to miscalculated *h-indices* for older researchers. Also, recent publications may take time to be indexed in some databases; however, this is evened out among all researchers and the recently published articles are less likely to change the index because they may not be frequently cited. Given the self-administered nature of the questionnaire, it is likely that surgeons with more interest and activity in research were more inclined to participate, thus inflating the *h-index*. The results of this study cannot be applied to other specialties nor plastic surgery programs in other countries.

CONCLUSIONS

Aside from treating their patients, one of plastic surgeons' duties is contribution to the growing body of science. *h-index* was proposed to serve as a "Quality check" that balances between quality and quantity. We looked into different factors that may influence the *h-index* of plastic surgeons in KSA and found that the most important predictors were the number of publications and academic rank. Gender, attaining fellowship training, and number of fellowships were not correlated nor predicted a higher index. The *h-index* could be a useful ancillary in promotion and application to prestigious plastic surgery centers, provided that it is validated within the context of plastic surgery niche and used as an adjunct to other merits.

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