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Research Productivity among Plastic Surgeons in the State of Israel: *h*-index and M-quotient Assessment

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Background: The *h*-index has been proven in the US and Canada to be a solid tool to assess the quality and impact of individual scientific work in the field of plastic surgery. M-quotient is an additional metric that mitigates the *h*-index's inherent bias toward more seasoned researchers. The objective of this study was evaluating the relationship between *h*-index and M-quotient and research productivity among plastic surgeons in the state of Israel.

Methods: A list of all Israeli board-certified plastic surgeons registered in the Israeli Society of Plastic and Aesthetic Surgery was obtained from the organization's website. Relevant demographic and academic factors of each surgeon were retrieved. The Scopus database was queried to determine each surgeon's *h*-index and M-quotient, among other bibliometric parameters.

Results: Our study included 173 plastic surgeons, 90% of whom were men. In total, 49.7% were working in academically affiliated hospitals; 14.4% of the surgeons had an academic rank. The mean *h*-index was 6.13; mean M-quotient was 0.27. Statistical analysis demonstrated a positive correlation between total number of publications ($P < 0.0001$), total number of citations ($P < 0.0001$), the surgeon's seniority ($P < 0.0001$), academic rank ($P = 0.007$), appointed as past/present plastic surgery department director ($P < 0.0001$), and working in an academic affiliated hospital ($P < 0.025$). The same parameters were found to have a positive correlation with M-quotient.

Conclusions: The *h*-index is an effective measure to compare plastic surgeons' research productivity in Israel. M-quotient is an ancillary tool for the assessment of research productivity among plastic surgeons, with the advent of neutralizing the surgeon's seniority. *(Plast Reconstr Surg Glob Open 2021;9:e3903; doi: 10.1097/GOX.0000000000003903; Published online 4 November 2021.)*

INTRODUCTION

Historically, research productivity was measured by quantity, namely the number of publications and the total number of citations. In recent years, the emphasis has shifted toward research quality, with new bibliometric measures available to quantify the impact of an author's work.[1] Over the last decade, the Hirsch index (*h*-index) has gained popularity among biomedical disciplines. The *h*-index measures a scientist's collective scholarly output, which may serve as a basis for comparison within the same field of expertise. Originally introduced by Jorge E. Hirsch in 2005, the *h*-index is described as the number of an author's published articles, *h*, that have been cited at least *h* times.[2–5] By doing so, the *h*-index corrects for the disproportionate weight of highly cited publications or publications that have not yet been cited.

It has been argued that journals' impact factors may not be reflective of the true impact and relevance of individual research work due to what is known as "citation skew." A recent study has demonstrated that citation skew exists within plastic surgery journals, similar to other fields of biomedical science, thus recommending that the journal's impact factor should not be used to assess the quality and impact of individual scientific work.[6]

Recent studies in multiple specialties in academic medicine, among them plastic surgery, have validated the *h*-index as a measure to assess research productivity and significance.[7–11]

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Another bibliometric that facilitates comparison between academics is the M-quotient, which is the *h*-index divided by the number of years since the author's first scientific publication. This tool mitigates some of the inherent bias of the *h*-index toward more seasoned researchers and has also been used for measuring research productivity among surgeons.[12,13] Previous studies have utilized the *h*-index to assess the impact of various factors on research productivity among plastic surgeons in the United States and Canada, including academic rank,[7,14,15] training institutions,[16] subspecialty fellowship training,[17–19] and gender disparities.[20]

The authors have pursued extending the above-mentioned research work done in the United States and Canada in recent years and evaluate the relationship between *h*-index/ M-quotient and research productivity among plastic surgeons in the state of Israel. To our knowledge, such a study has not yet been conducted among plastic surgeons outside North America. Therefore, this study aimed to validate the *h*-index and M-quotient as measures to evaluate plastic surgeons' research productivity in Israel, as a test case for academic practices outside the US and Canada.

PATIENTS AND METHODS

Study Population

All Israeli board-certified plastic surgeons registered in the Israeli Society of Plastic and Aesthetic Surgery website (www.plasticsurgery.org.il) were identified as of July 2020. Information regarding sex, current institution, academic affiliation, and private practice were gathered from the relevant websites and confirmed with the director of the relevant department. Each surgeon's seniority (years in practice as a board-certified plastic surgeon) and retirement status were gathered from the Israeli Ministry of Health website (practitioners.health.gov.il). An updated list of active plastic surgeons with academic ranks was gathered directly from the academic institutions in Israel and confirmed with the directors of the relevant plastic surgery departments.

Research Productivity

The public database Scopus (www.scopus.com) was used to gather the following information for each surgeon: *h*-index, total number of publications, first and last year of publication, and the total number of citations. M-quotient was calculated for each surgeon by dividing the *h*-index by the total years of academic activity (ie, number of years since the first scientific publication). The search was conducted by using the surgeon's name as it was spelled in English on the surgeon's website and in any other relevant sources found on the internet, in all possible variations.

Data Analysis

The data were compiled using Microsoft Excel (Microsoft 2016, Redmond, Wash.). Continuous variables were presented as mean ± SD (SD), as well as median and interquartile range (IQR). Pearson coefficient correlation test was used to assess the correlation between the study's continuous variables.

Takeaways

Question: Are the *h*-index and M-quotient valid measures to evaluate plastic surgeons' research productivity in Israel?

Findings: This cross-sectional study examined Israeli plastic surgeons' *h*-index and M-quotient along other relevant demographic and academic parameters. It demonstrated a positive correlation between the surgeon's h-index and M-quotient and certain academic parameters.

Meaning: The *h*-index is an effective measure to compare plastic surgeons' research productivity in Israel. M-quotient is an ancillary tool for the assessment of research productivity among plastic surgeons, with the advent of neutralizing the surgeon's seniority.

To compare the *h*-index and M-quotient between categorical variables with more than two independent groups, the Kruskal-Wallis test was used as appropriate, and the t-test or Mann-Whitney test between two independent groups. Data analysis was performed using the IBM SPSS statistical package, version 24. All *P* values were two-sided, and *P* values less than 0.05 were considered significant.

RESULTS

One hundred seventy-three plastic surgeons registered as members on the Israeli Society of Plastic and Aesthetic

Table 1. Study Demographics for 173 Israeli Plastic Surgeons

Variables	n (%)
Gender	
Men	156 (90.0)
Women	17 (10.0)
Academic affiliation	
Tel-Aviv University (TAU)	44 (49.4)
The Hebrew University of Jerusalem (HUJ)	16 (18.0)
Technion – Israel Institute of Technology (TEC)	16 (18.0)
Ben-Gurion University of the Negev (BGU)	10 (11.2)
Bar-Ilan University (BIU)	3 (3.4)
Academic rank	
No	148 (85.5)
Yes	25 (14.5)
Head of department	
No	141 (81.0)
Yes	32 (18.5)
Retired	
No	154 (89.0)
Yes	19 (11.0)
Type of practice	
Private	87 (50.3)
Hospital and private	86(49.7)
Geographic area	
North	18 (20.5)
Center	44 (50.0)
South	10 (11.4)
Jerusalem	16 (18.2)
	Mean ± SD, median (IQR)
h-index	6.13 ± 6.12, 4.0 (1.0–10.0)
M-quotient	0.27 ± 0.23, 0.22 (0.09–0.46)
Seniority years	27.1 ± 11.2, 26.0 (17.5–34.0)
Publications	22.5 ± 35.5, 8.0 (2.0–29.5)
Citations*	441.7 ± 425.7, 350.0 (90.0–670.3)

*n = 24.

Surgery website were identified. The majority of the cohort were men (90%, n = 156) (Table 1). Eleven percent of the surgeons (n = 19) have retired from academically affiliated hospitals. Approximately half (49.7%) of the cohort (n = 86) were working in academically affiliated university hospitals and had a private practice, whereas 50.3% (n = 87) were working only in private practice. In total, 18.5% of the cohort (n = 32) were active or retired directors of plastic surgery departments. The mean number of seniority (in years) was 27.1 ± 11.2 (median, 26.0; IQR 17.5-34.0). Only 14.4% of the surgeons (n = 25) had an academic rank with the following distribution: clinical instructor (two surgeons, 1.2%), clinical lecturer (six surgeons, 3.5%), clinical senior lecturer (seven surgeons, 4.0%), clinical associate professor (six surgeons, 3.5%), clinical professor (three surgeons, 1.7%), and adjunct professor (one surgeon, 0.6%).

Bibliometric parameters were as follows: mean *h*-index 6.13 ± 6.12 (median, 4.0; IQR, 1.0–10.0) (Fig. 1), mean M-quotient 0.27 ± 0.23 (median, 0.22; IQR, 0.09–0.46), total number of publications 22.5 ± 35.5 (median, 8.0; IQR, 2.0–29.5) and the total number of citations 441.7 ± 425.7 (median, 350.0; IQR, 90.0–670.3). It is important to mention that only 24 surgeons (13.8%) had citations recorded in the Scopus database.

Plastic surgeons with an academic rank had a mean *h*-index of 10.0 ± 8.1 (median, 10.0; IQR, 1.0–15.0) compared with their colleagues without an academic rank who had a mean *h*-index of 5.5 ± 5.5 (median, 4.0; IQR, 1.0–8.0).

The male surgeons in the cohort had a mean *h*-index of 6.4 ± 6.3 (median, 5.0; IQR, 5.0–10.0), whereas the female surgeons had a mean *h*-index of 3.7 ± 3.8 (median, 2.0; IQR, 2.0-6.0). Men had a mean M-quotient of 0.28 ± 0.23 (median, 0.22; IQR, 0.09–0.47), whereas women had a mean M-quotient of 0.26 ± 0.21 (median, 0.20; IQR, 0.05–0.34). Of the 25 surgeons holding an academic rank, only two surgeons (0.08%) were women.

Significant differences in the *h*-index were found with regard to the total number of publications ($P < 0.0001$, correlation 0.867) (Fig. 2), total number of citations ($P < 0.0001$, correlation 0.919), the surgeon's seniority ($P < 0.0001$, correlation 0.311), academic rank ($P = 0.007$), being a past or present plastic surgery department director ($P < 0.0001$), and working in an academic affiliated hospital ($P < 0.025$) (Table 2). There were no significant differences in the *h*-index with regard to gender, retirement status, the affiliated academic institution, or the geographic location of the hospital.

Significant differences in M-quotient were found with regard to the total number of publications ($P < 0.0001$, correlation 0.587), total number of citations ($P < 0.002$, correlation 0.596), academic rank ($P = 0.001$), being a past or present director of a plastic surgery department ($P < 0.0001$), and working in an academic affiliated university hospital ($P < 0.0001$) (Table 3). There were no significant differences in M-quotient with regard to gender, the surgeon's seniority, the affiliated academic institution, or the geographic location of the hospital.

DISCUSSION

Our study demonstrates that the *h*-index significantly correlates with the plastic surgeon's total number of publications, total number of citations, academic rank, and total number of seniority (years in practice as a board-certified plastic surgeon). Additionally, the *h*-index significantly correlates with being a past or present director of a plastic surgery

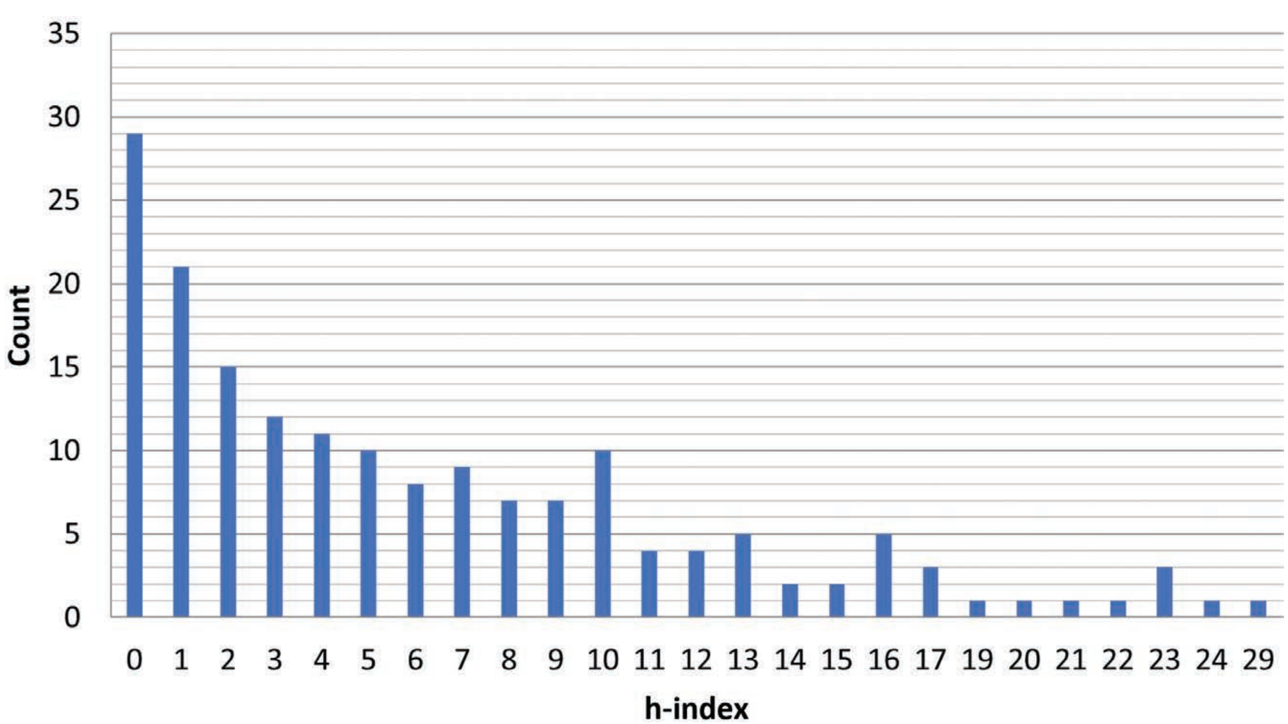

Fig. 1. The frequency distribution of the *h*-index among 173 Israeli plastic surgeons.

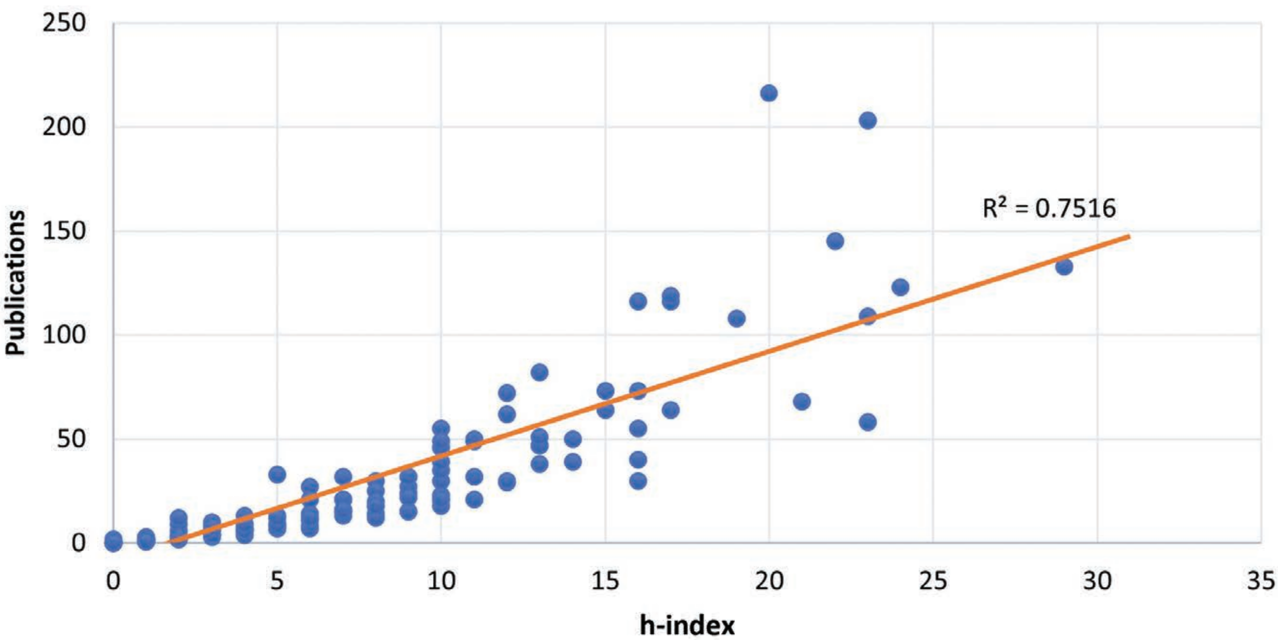

Fig. 2. Scatterplot demonstrating the correlation between the *h*-index and the number of total publications for Israeli plastic surgeons ($R^2 = 0.7516$, $P < 0.0001$).

department and with working in an academic affiliated hospital. When we tested the cohort's M-quotient, trying to neutralize the surgeon's seniority, we have found that the same parameters significantly correlated with the *h*-index, proving that these parameters are important predictors of the plastic surgeon's *h*-index.

Our results stand in line with similar studies performed in the United States and Canada which have demonstrated that total number of publications, total number of citations, working in an academic center, having an academic rank, and total years in practice are predictors of a higher *h*-index.[7,14,15,20]

To the best of our knowledge, this is the first work to test the predictability of *h*-index as a bibliometric measure for research productivity among plastic surgeons outside North America. Additionally, this is the first study that examines the relationship between the quantitative metric M-quotient and research productivity among plastic surgeons.

Table 2. Association of Demographic and Academic Variables with the *h*-index

		H-index			
Variables		Mean ± SD, Median	IQR	*P* Value	Correlation
Gender	Male, n = 155	6.4 ± 6.3, 5.0	5.0–10.0	0.1	
	Female, n = 17	3.7 ± 3.8, 2.0	2.0–6.0		
Seniority years				<0.0001	**0.311**
Academic affiliation	TAU, n = 44	7.0 ± 5.5, 6.0	2–10.8	0.70	
	HUJ, n = 16	7.4 ± 5.7, 5.0	3.25–11.5		
	TEC, n = 16	9.4 ± 10.0, 3.5	2.0–21.3		
	BGU, n = 10	4.8 ± 4.8, 2.0	1.0–10.3		
	BIU, n = 3	8.3 ± 7.5, 8.0	1.0–1.0		
Head of department	No, n = 141	4.6 ± 4.7, 3.0	1.0–7.0	<0.0001	
	Yes, n = 32	13.0 ± 6.7, 12.0	9.0–17.0		
Retired	No, n = 154	5.8 ± 5.8, 4.0	1.0–9.0	0.14	
	Yes, n = 32	8.8 ± 7.7, 6.0	3.0–17.0		
Type of practice	Private, n = 87	5.2 ± 5.5, 4.0	0.0–8.0	0.025	
	Hospital and private, n = 86	7.0 ± 6.5, 5.0	2.0–11.0		
Academic rank	No, n = 148	5.5 ± 5.5, 4.0	1.0–8.0	0.007	
	Yes, n = 25	10.0 ± 8.1, 10.0	1.0–15.0		
Geographic area	North, n = 18	9.6 ± 9.7, 4.0	1.8–17.8		
	Center, n = 44	7.0 ± 5.5, 6.0	2.0–10.8		
	South, n = 10	4.8 ± 4.8, 2.0	1.0–10.3		
	Jerusalem, n = 16	7.4 ± 5.7, 5.0	3.3–11.5		
Publications				<0.0001	**0.867**
Citations				<0.0001	**0.919**

*SD standard deviation
**IQR interquartile range

Table 3. Association of Demographic and Academic Variables with the M-quotient

Variables		M-Quotient Mean ± SD, median	IQR	*P*-value	Correlation
Gender	Male, n = 155	0.28 ± 0.23, 0.22	0.09–0.47	0.39	
	Female, n = 17	0.26 ± 0.21, 0.20	0.05–0.34		
Seniority years				0.15	**–0.11**
Academic affiliation	TAU, n = 44	0.34 ± 0.23, 0.30	0.0–0.31	0.69	
	HUJ, n = 16	0.35 ± 0.22, 0.32	0.17–0.52		
	TEC, n = 16	0.35 ± 0.27, 0.23	0.14–0.61		
	BGU, n = 10	0.24 ± 0.25, 0.1	0.04–0.50		
	BIU, n = 3	0.38 ± 0.24, 0.32	0.17–0.17		
Head of department	No, n = 140	0.23 ± 0.20, 0.17	0.06–0.38	<0.0001	
	Yes, n = 32	0.45 ± 0.24, 0.47	0.25–0.61		
Retired	No, n = 153	0.28 ± 0.23, 0.23	0.09–0.47	0.16	
	Yes, n = 19	0.20 ± 0.16, 0.17	0.08–0.31		
Type of practice	Private, n = 87	0.20 ± 0.19, 0.19	0.00–0.31	<0.0001	
	Hospital and private, n = 85	0.34 ± 0.24, 0.29	0.13–0.52		
Academic rank	No, n = 148	0.24 ± 0.19, 0.20	0.09–0.38	0.001	
	Yes, n = 25	0.45 ± 0.30, 0.50	0.12–0.67		
Geographic area	North, n = 18	0.36 ± 0.26, 0.27	0.16–0.64		**0.62**
	Center, n = 44	0.34 ± 0.23, 0.30	0.17–0.52		
	South, n = 10	0.24 ± 0.25, 0.11	0.03–0.51		
	Jerusalem, n = 16	0.35 ± 0.22, 0.33	0.15–0.51		
Publications				<0.0001	**0.587**
Citations				<0.002	**0.596**

*SD standard deviation
**IQR interquartile range

Table 4. Comparison of *h*-index Parameters between USA, Canada, and Israel[6,12]

	USA (Therattil et al, 2016)[7]	Canada (Hu et al, 2018)[14]	Israel (2020)
Mean *h*-index ± SD	8.97 ± 7.78	7.6 ± 7.5	6.13 ± 6.12
Plastic surgeons cohort (n)	592	175	173
Male/female ratio	4.86	4.30	9.18
h-index for men (mean ± SD)	9.57 ± 5.76	7.7 ± 7.9	6.4 ± 6.3
h-index for women (mean ± SD)	6.07 ± 6.33	5.8 ± 5.0	3.7 ± 3.8

Similar to previous studies performed in the United States, we intended to determine whether research productivity differed between certain geographic regions in Israel.[4,7] No significant regional differences in research productivity among plastic surgeons in Israel were detected. In addition, the results did not demonstrate any significant differences in *h*-index or M-quotient among academic plastic surgeons when comparing their affiliated academic institutions in Israel. A possible explanation for these findings is the relatively small size of the state of Israel, which minimizes the influence of regional or remote areas on research productivity.

As detailed in Table 4, while the male-to-female (M:F) ratio of plastic surgeons in Canada and the United States ranges from 4.30 to 4.86 respectively, in this presented cohort, the M:F ratio was 9.18.[7,14] Paik et al showed that 84% of academic plastic surgeons in the United States were men and 16% were women. Gast et al demonstrated that as of 2013, women constituted 14.1% of academic plastic surgeons in the United States.[16] In our cohort, female plastic surgeons represent only 8% of the plastic surgeons holding an academic rank. It seems that the representation of female plastic surgeons in Israel lags behind its North American counterparts. Although this finding is disturbing, this gender disparity might be attributed, as offered in other studies, to the disproportionate burden of family responsibility, as well as a lack of research mentorship for the female staff.[20,21]

In Israel, the average age of entry into medical school is 23, and the average age of completion of the medical degree is 30.[22] Hence, the average age for starting residency is above 30 years, making most of the surgical residents, including plastic surgery, parents of families with young children.[22] The mean number of pregnancies during residency in Israel is 1.3±1.2,[23] suggesting that during residency female surgeons might spend a considerable period of time on maternal leave and/or caring for young infants, creating a gap between them and their male colleagues that might perpetuate throughout their career.

Female representation in medical school enrollment in the US and Canada has been steadily increasing over the past few decades with a similar increase in the proportion of female plastic surgeons in those two countries.[14,20] In accordance, the female representation in medical school enrollment in Israel has been in a steady incline from 34.0% in 1983 to 54.7% in 2017.[24] Although we do not hold up-to-date data regarding the proportion of female plastic surgeons in Israel, it is assumed that the gender disparity found in our study will ameliorate dramatically in the near future, making an impact on Israeli female plastic surgeons' academic productivity and bibliometric indices.

We believe that potential steps that might improve an author's *h*-index are to publish articles in online access journals and to create profiles in professional networks for scientists and researchers (eg, ResearchGate, Publons). These two steps might expand the academic exposure of the authors' work and, hence, improve their number of citations.

There are a few limitations to this study: (1) the number of surgeons who had citations recorded in the Scopus database was small; (2) The use of an online resource to gather data may contain outdated or incorrect information. Moreover, not all desired information may have been available online; (3) The Scopus does not include publications before 1995 and the *h*-index may be skewed by self-citations.[3,7,18,19] However, some studies have shown that inflation of the *h*-index through self-citations is unlikely to result in inaccurate conclusions.[18,19,25] Finally, several studies have indicated that Scopus and h-index are acceptable metrics to use to evaluate scholarly impact in plastic surgery.[17–19,25] Further studies should be conducted in other countries and plastic surgeon populations to reinforce our study's conclusions.

CONCLUSIONS

The *h*-index is a simple and useful measure that is effective in comparing plastic surgeon research productivity in medical populations outside North America, as had been proven in this study for the Israeli plastic surgery community. Additionally, the M-quotient is an ancillary bibliometric tool for the assessment of research productivity among plastic surgeons, with the advent of neutralizing the surgeon's seniority. The directors of the plastic surgery programs in Israel should consider the adoption of those metrics as ancillary tools to other objective and subjective measures.

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