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The *h*-index in Academic Morphology

El Índice *h* en la Morfología Académica

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SUMMARY: The *h*-index is an objective and easily calculable measure that can be used to evaluate both the relevance and amount of scientific contributions of an individual author and field. The aim was to examine how the *h*-index of academic morphologists in Chile relates with academic rank. A descriptive and correlational study was design. We accessed the Chilean Society of Anatomy professor list in January of 2015, for analysis of academic morphologists' *h*-indexes using the Scopus database, and data was organized by academic rank. Also, *m*-Quotient was calculated. Institutional productivity was measured, and institutions were ranked on the basis of cumulative *h*-index, *m*-Quotient and the total number of publications and citations. For all morphologists analyzed, the mean *h*-index was 2.9±2.94 (range 0–12). The mean h-indexes were 1.9±2.135 for instructors, 2.5±2.54 for assistant, 5.1±2.89 for associate and 4.7±3.92 for professors. There was a significant relationship between *h*-index and academic rank (P<0.001). The *m*-Quotient were significantly different between assistant/associate and professors (P<0.001). By academic degree, the mean h-indexes were 1.0±1.92 for Bachelor, 1.6±2.0 for specialists, 2.3±2.26 for masters and 4.9±3.4 for Ph.D. The total number of publications for Chilean morphologist was 1343 publications (13.85±18.392), with 5321 citations (54.86±106.392). The top 3 institutions were Universidad de La Frontera, Universidad de Chile and Pontificia Universidad Católica de Chile. Multivariate logistic regression analysis demonstrated that *h*-index (P<0.001) and number of publications (P<0.001) were the best predictors of academic rank. There exists a significant relationship between *h*-index and academic rank, with *h*-index increasing with academic rank. It is a reliable tool for quantifying academic productivity within morphology, easily calculable and may be useful when evaluating decisions regarding advancement within academic morphology departments. These results should serve as benchmarks for future studies.

KEY WORDS: h**-index; Morph**ology**, Morph**ological sciences**; Bibliometrics; Bibliometrics tool; Number of publications; Number of citations; Academic researc**h**; Citation analysis.**

INTRODUCTION

Scientific research and publishing are important components in assessing academic faculty members of many fields, including the morphology. Although not the sole component, these measurements play an important role in faculty member evaluation and consideration of tenure status, academic rank, and other advancement opportunities (Svider *et al*., 2013). Publish their academic work is the goal of all researchers (the most important factors are the number of publications that an academic generate and their quality), besides being recognized by peers, and influencing development in the field. Citing another researcher's work is a method of formally recognizing the contribution of that researcher to the literature (Klimo *et al*., 2014).

Citation analysis is a fundamental tool of bibliometrics; is the study of references cited in the bibliographies of scholarly publications. A well-recognized example of citation analysis is the journal impact factor by Web of Science (WoS), which is calculated as the average number of citations per paper published in a journal during the two preceding years. The subject of a bibliometric analysis can be an individual researcher, a group (e.g., department), or a Journal.

The *h*-index, created by JE Hirsch in 2005, is one of the most well-known measures of academic productivity (Hirsch, 2005) and has gained popularity as an attractive alternative that can supplement and even replace other

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measures (such as impact factor). An individual's *h*-index is defined as the number of his or her papers (h), with at least h citations. It is the point at which the number of citations intersects the number of publications listed in decreasing order of citations (Hirsch, 2007), and its calculation includes all publications regardless of the author position on a particular paper (Babineau *et al*., 2014), in a single database (Scopus, WoS or Google Scholar). Although there is debate regarding the accuracy of each of these indexes, it seems as though the *h*-index is increasingly in use (Rad *et al*., 2010).

As the *h*-index becomes widely accepted in academic environments, and has been examined in a diverse array of medical and surgical fields, including otolaryngology (Svider *et al*.), radiology (Rad *et al*.), digestive surgery (Cantín, 2014), gastroenterology (Poynard *et al*., 2011), anaesthesiology (Pagel & Hudetz, 2011), urology (Benway *et al*., 2009), among others, some evidence suggests that the *h*-index varies from one scientific field to another as a result of the number of investigators and the overall citation rate (Kalra & Kestle, 2013).

To our knowledge, a comprehensive assessment of the h-index is not available for the field of morphology (anatomy, histology and embryology). The purpose of this study was to evaluate the *h* index among Chilean academic morphologists relates with academic degree and academic rank, using the h-index available from the Scopus database to provide a benchmark for evaluating individuals in this area.

MATERIAL AND METHOD

A descriptive and correlational design was used. We accessed the Chilean Society of Anatomy (Sociedad Chilena de Anatomía - SCHA) professor list (http://www.sociedadchilenadeanatomia.cl/scha/index.php/pc) in January of 2015. SCHA is the main society for academic morphology (anatomy, histology, embryology, physical anthropology and related materials) in Chile, and maintains a list of qualified academic. The list contains 96 names from 23 institutions. Four persons listed were retired and one individual was deceased, therefore withdrawn from the study. Web site were used to compile a list of members organized by institutions and academic ranks (instructor, assistant professor, associate professor, professor) and academic degrees (bachelor, specialist, master or Ph.D.). Additionally, any nonacademic faculty, that is, adjunct faculty and instructors, were included in this analysis. Residents and fellows were not included in this analysis. In cases in which faculty rank could not be determined via the SCHA website, department websites were searched or contacted directly.

Calculation of *h*-index. The *h*-index of each faculty member was calculated using the Scopus database (http: // www.scopus.com) by clicking on ''Author search''. We utilized the author's last name, and first and middle initial as the initial search strategy. This was sometimes combined with a search strategy that did not include a middle initial, as a number of authors did not consistently use their middle initial on their publications, or a search strategy that include the author's second last name (combined or not with the last name). When search results by author, not be shown by full, was selected "Show Profile Matches With One Document" to include in the calculation of the profiles all results, including those with a single publication that is not displayed in the first instance. After the query results were reported, the affiliation and each reference were further reviewed to ensure that the results correctly included publications by the intended author by noting the journal in which it was published and, if necessary, linking to the article to review it. Any incorrect references were removed and the h-index recalculated. Numbers of publications, citations and year of first publication were also included. Similar names were differentiated on the basis of their affiliation histories and research subjects. All data was collected in Febrary 2015.

Calculation of *m*-Quotient. The *m*-Quotient is the *h*-index divided by the number of years since the author's first publication (Hirsh, 2005). It is a metric of continued publishing productivity and was developed to correct for the duration of an author's career.

Statistical Analysis Data was entered and stored into a Microsoft Excel file. Descriptive statistics were calculated and analysis of variance was performed to detect differences among different groups. Correlation coefficients between *h*-index, *m*-Quotient, number of publications and also number of citations were calculated. A multivariate logistic regression analysis was performed to determine which variables (*h*-index, *m*-Quotient, number of publications and number of citations) were best associated with academic rank. All statistical analyses were performed using the statistical software IBM SPSS Statistics Grad Pack 22.0. P-values less than 0.05 were considered statistically significant. No institutional review board approval was obtained as this is not a human research study.

RESULTS

For all morphologists analyzed, the mean *h*-index was 2.9±2.94 (range 0–12), with a Mode value of 2. The mean *h* indexes were 1.2±1.34 for non-academic (range 0–5), 1.9±2.135 for instructors (range 0–7), 2.5±2.54 for assistant

professors (range 0–11), 5.1±2.89 for associate professors (range 0–11) and 4.7±3.92 for professors (range 0–12). These data are summarized in Figure 1. A one-way analysis of variance demonstrated that *h*-indexes were significantly different among academic ranks (P<0.001). Regarding the differences between groups, other than nonacademic versus instructors (P= 0.31) and instructors versus assistants (P=0.6), comparisons between the other groups had significant differences. The *h*-indexes were significantly different between assistant and associate professors and between associate and professors (P<0.001, respectively). However, there was not a significant difference among the *h*-indexes of non-academic and instructors within morphology departments (t-test, p>0.05). By academic degree, the mean *h*-indexes were 1.0±1.92 for Bachelor, 1.6±2.0 for specialists, 2.3±2.26 for masters and 4.9±3.4 for Ph.D. (Fig. 2). The *h* indexes were significantly different from degrees (P<0.05 to bachelor, specialist, and masters; P<0.001 to Ph.D.).

The mean *m*-Quotient were 0.16±0.16 for non-academic, 0.15±0.13 for instructors, 0.27±0.22 for assistant professors, 0.31±0.28 for associate professors and 0.18±0.13 for professors (Fig. 3). The *m*-Quotient were significantly different between assistant/associate and full professors and between non-academic/instructors and assistant/associate professors (P<0.001). However, there was not a significant difference among the *m*-Quotient of assistant and associate professors (p>0.05).

The mean number of publications for Chilean morphologist was 13.85±18.392 (total 1343 publications), ranged from 7.54±12.95 for non-academic, 6.70±7.581 for instructors, 11.96±20.16 for assistant professors, 23.06±14.88 for associate professors to 25.71±26.15 for professors. There was a significant relationship between the number of publications and academic rank (P<0.05). However, there was not a significant difference among the number of publications of non-academic and instructors within morphology departments (t-test, p>0.05). Total number of citations was 5321, with a mean of 54.86±106.392, which varied from a mean of 21.32±66.44 for non-academic, 20.41±51.40 for instructors, 50.96±114.9 for assistant professors, 92.18±96.88 for associate professors to 107.5±160.5 for professors. Again, there was a significant relationship between the total number of citations and academic rank (P<0.05), and there was not a significant difference among citations of non-academic and instructors within morphology departments (t-test, p>0.05).

Each morphology academic department was ranked in cumulative *h* and *m*-Quotient-indexes of its current members and the total numbers of publications and citations. The top 3 institutionts were Universidad de La Frontera, Universidad de Chile and Pontificia Universidad Catolica de Chile (Table I).

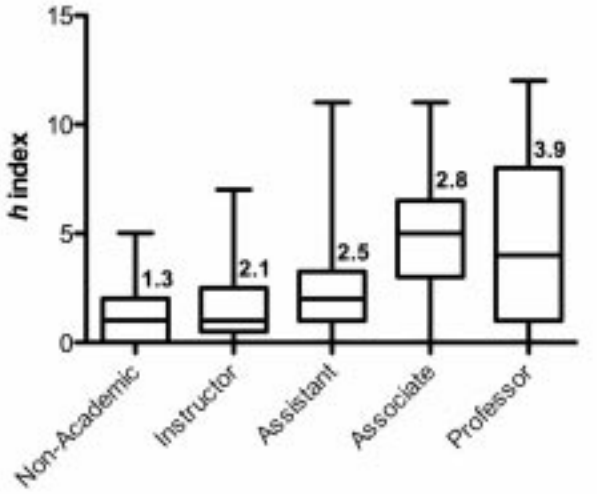

Fig. 1. The *h* index in academic morphology of various academic ranks (with standard error of measurement).

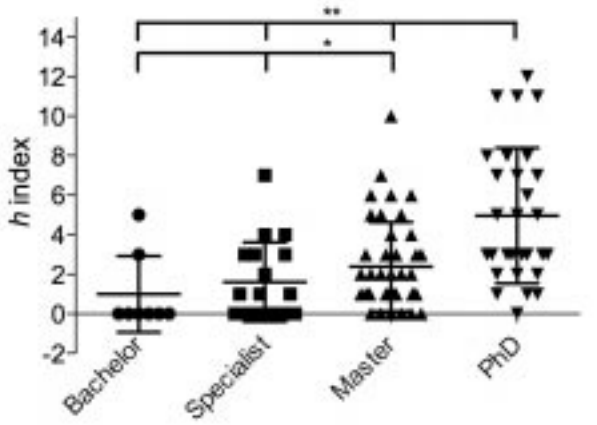

Fig. 2. The *h* index in academic morphology of various academic degrees (with standard error of measurement). *= P<0.05; **= P<0.001.

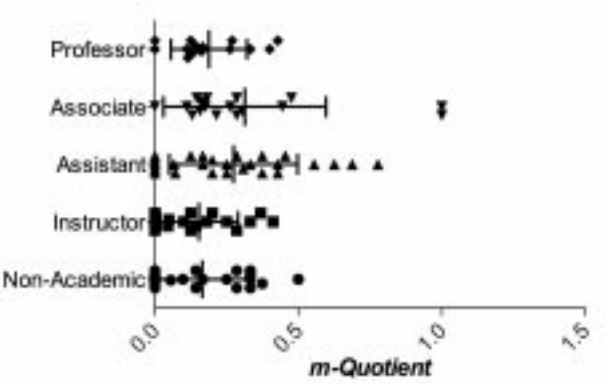

Fig. 3. The *m*-Quotient in academic morphology of various academic ranks (with standard error of measurement).

Table I. Rank list of Chilean institutions with research in morphological sciences.

Institution	Σ *h*-Index	Rank	Publications	Rank	Citations	Rank	Σ *m*-quotient	Rank
Univ La Frontera	86	1	570	1	1701	1	6.0175	1
Univ Chile	60	2	252	2	1116	3	4.7149	2
Pontificia Univ Catolica de Chile	40	3	100	3	1261	2	1.8251	3
Pontificia Univ Catolica Valparaíso	13	4	46	7	252	5	1.4069	4
Univ Autonoma de Chile	11	5	57	4	78	8	1.2088	5
Univ Talca	10	6	49	6	44	11	1.0965	6
Univ del Desarrollo	10	7	33	9	110	7	0.8036	7
Univ Los Andes	8	8	55	5	324	4	0.7487	8
Univ Andres Bello	8	9	18	12	65	9	0.5602	9
Univ Valparaiso	7	10	29	10	160	6	0.4	11
Univ Austral	4	11	20	11	28	13	0.0976	21
Univ Santo Tomas	3	12	7	14	10	16	0.3725	12
Hospital de Antofagasta	3	13	6	16	22	14	0.1	19
Univ Tarapaca	3	14	44	8	56	10	0.4286	10
Univ Antofagasta	2	15	9	13	36	12	0.0714	22
Univ Mayor	2	16	7	15	4	19	0.2532	15
Univ Playa Ancha	2	17	4	20	11	15	0.1304	18
Univ del BioBio	1	18	1	23	1	22	0.2632	13
Univ Concepcion	1	19	5	18	6	18	0.1429	17
Univ San Sebastian	1	20	2	22	1	23	0.2632	14
Univ Catolica Temuco	1	21	4	21	2	21	0.0488	23
Univ Catolica del Maule	1	22	5	19	7	17	0.098	20
Univ Diego Portales	1	23	6	17	3	30	0.1818	16

Multivariate logistic regression analysis was performed with academic rank as the dependent variable and *h*-index, *m*-Quotient, the number of publications and number of citations as independent variables. The goodness of fit of our model was excellent (P<0.001). *m*-Quotient was not significantly associated with academic rank (P= 0.65). The *h*-index (P= 0.003), the number of citations and number of publications (P< 0.001) were significantly associated with academic rank.

DISCUSSION

Measuring the academic impact of scientists has gained considerable importance and is increasingly used by academic, research, and federal institutions worldwide for research policymaking, monitoring of scientific developments, department rating, and comparisons between institutions, as well as individual scientists (Cucchetti *et al*., 2013). The popularity of this measure is demonstrated by the fact that Hirsch's original article has already received over 400 citations and over 110,000 downloads (Fersht, 2009), and has been used widely to evaluate the impact of authors in many fields of medicine (Cantín; Svider *et al*.; Fuller *et al*., 2009; Benway *et al*.; Rad *et al*.; Pagel & Hudetz; Lee *et al*., 2009; Poynard *et al*.)

Our study provides the average *h* index for given academic ranks across a large number of Chilean academic morphologies departments. We found that the average *h* index for morphologists varied significantly by academic rank; in the multivariate analysis, we noted that the *h* index and number of publications were correlated with academic rank. These findings suggest that the sheer volume of academic productivity is correlated with rank. This is possibly because publications in morphology are usually specific to morphologists and are less likely to apply to the readership of large-distribution general medical journals than other fields, such as pathology or surgery, where morphological research could be more cited. Moreover, in Chile, there are still few morphologists those who develop research, although they have increased rates due to the formation of master and Ph.D., who are improving their academic rank, and appear to be a generational change by the data observed in the *m*-Quotient.

The variability of the average h-indexes across different fields can be explained by factors such as the number of scientists in a field (Galdames, 2013), the average number of publications per scientist in the field, and the applicability of the field to other fields. In addition, it is important to note that scientists working in less main-stream fields (as morphology) (Garay & Cantín, 2013; Cantín *et al*., 2013) are bound to have lower h-indexes than those

working in mainstream fields. These factors likely play into the seemingly lower *h* indexes of morphologists compared to other medical specialties (Hirsch, 2005, 2007; García-Pérez *et al*., 2009). This metric should be replicated to academic morphologists in other countries to know each situation, and to compare the status of this field specifically.

The three highest ranked institutions were Universidad de La Frontera, Universidad de Chile and Pontificia Universidad Católica de Chile to *h*-index, the number of publications and citations. Also, these same institutions show higher values of *m*-Quotient, which suggest the presence of news or young academics as well as a good scientific production of the oldest academic. The other institutions showed comparable with earlier in ranking 1, 2 and 3, although all have more than an academic in the department of morphology, they do not belong to the Chilean Society of Anatomy, either have no production and interest in scientific publishing. Possibly, the institutions that have low ranking, ask not support or academic research; nor that they, integrate scientific societies of their fields of knowledge, increasing the gap with top-ranked institutions.

As limitation, this metric may not fully capture the quality of a scientific research: a published article could be cited not because of its quality but rather because of its poor value that raised harsh criticism (negative citation) (Lee *et al*., 2009). An example of a negative citation is a highly criticized paper that is cited for the purpose of opposing or debunking the data or viewpoints it contains. Another potential weakness of the *h*-index is selfcitation. Also, similarity in name may cause erroneous calculation of *h* indexes, as will the use of various combinations of a person's first and middle initials when doing a given search. To overcome this disadvantage, Scopus has its own author-locating program (Manterola *et al*., 2014), which is very powerful and is updated automatically. This makes Scopus very user friendly compared to WoS (Hamidreza *et al*., 2013). By the other hand, several Chilean last names (first or last surnames) are composed of two parts, and even authors use both surnames, which can cause inaccuracies during the indexing process (first, last or both surnames can be indexed). Some researchers had frequently used first and last surnames, and we had to search several different profiles or author sets to find their publications (Hamidreza *et al*.) Another important limitation of calculating the *h*-index is that it cannot account for the size of an institution at which an academician works. Smaller institutions do not have the same means to perform research as larger institutions, and thus assessing research productivity at smaller institutions may be difficult. Sypsa & Hatzakis (2009) addressed this concern by proposing a modified impact index that can complement the use of the *h* index in comparing research productivity at research institutions of various sizes.

It is important to take these results properly, only to morphology, and not compare it to other areas of knowledge, as when using other methods for measures of academic productivity. Radicchi *et al*. (2008) showed that the index itself is only a valid metric within a specific field and that comparison across scientific fields or even medical specialties is not valid because of the widely disparate number of investigators in each field. It provides a robust measure of an individual's contribution to the morphologic literature. Like others medical fields, the h index for morphologists correlates with academic rank.

In conclusion, the *h*-index provides a robust measure of an individual's contribution to the morphologic literature. Like others medical fields, the *h* index for morphologists correlates with academic rank (increases as academic rank and degree increases), although the average *h*-index at each academic rank appears to be lower than that for other fields of medicine. Our results can serve as a benchmark so that the *h*-indexes of academic morphologists can be evaluated by comparing to national averages for specific academic ranks in Chile.

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RESUMEN: El índice *h* es una medida objetiva y fácilmente calculable que se puede utilizar para evaluar la importancia y cantidad de contribuciones científicas de un autor y área del conocimiento. El objetivo fue evaluar el índice *h* de morfólogos académicos en Chile, y su relación con la jerarquía académica. Se diseño un estudio descriptivo correlacional. Se accedido a la lista de profesores de la Sociedad Chilena de Anatomía en enero del 2015; para el análisis del índice *h* de los académicos morfólogos se utilizó la base de datos Scopus, y los datos fueron organizados por jerarquía académica. Además, se calculó cociente *m*. Se midió la productividad institucional clasificándose sobre la base de índice *h* y cociente m acumulados, y el número total de publicaciones y citaciones. Para todos morfólogos analizados, la Media del índice *h* fue de 2,9±2,94 (rango 0–12). Según jerarquía académica, se observaron índices *h* de 1,9±2,135 para instructores, 2,5±2,54 para asistentes, 5,1±2,89 para asociados y 4,7±3,92 para profesores titulares. Hubo una relación significativa entre el índice *h* y jerarquía (P<0,001). Los Cocientes *m* fueron significativamente diferentes entre los profesores asistente/asociado (mayor) y titulares (P<0,001). Según el grado académico, la Media de los índices *h* fueron 1,0±1,92 para licenciados, 1,6±2,0 para especialistas, 2,3±2,26 para magíster y 4,9±3,4 para los Ph.D. El número total de publicaciones para los morfólogos chilenos fue 1.343 (13,85±18,392), con 5.321 citas (54,86±106.392). Las 3 mejores instituciones fueron Universidad de La Frontera, Universidad de Chile y Pontificia Universidad Católica de Chile. El análisis de regresión logística multivariante demostró que el índice *h* (P<0,001) y el número de publicaciones (P<0,001) fueron los mejores predictores de jerarquía académica. Existe una relación significativa entre el índice *h* y jerarquía, al aumentar el índice *h* aumenta

la jerarquía. El índice *h* es una herramienta fiable para cuantificar la productividad académica dentro de la morfología, fácilmente calculable y puede ser útil en la evaluación de las decisiones relativas a la promoción dentro de los departamentos académicos en el área morfológica. Estos resultados deben servir como puntos de referencia para futuros estudios.

PALABRAS CLAVE: Índice *h*; Morfología, Ciencias morfológicas; Bibliometría; Herramientas bibliométricas; Número de publicaciones; Número de citas; Investigación académica; Análisis de citas.

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