Assessing Impact of Citation Laureates Using Improved Dimensions of h-index

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ABSTRACT

Impact factors and citation indices are used to evaluate the impact Research publications .There are several citation indices that are proposed and existed to assess the value of a research publication or the research impact of an author or a journal. In this paper, a survey of selected (evolutionary basis) citation indices is conducted to evaluate them. Using examples, we demonstrated some of the limitations and problems with those indices. It is observed that h-index and m-quotient fails to differentiate among the authors having different citation count and hit papers. The flaw is rectified by A-index, M-index and R-index. A-index more closely ranks the authors on the basis of hit papers and highest no. of Average Citation per Paper (ACPP). Thus among the selected citation indices A-index is considered as best to rank the authors on the basis of their hit contributions in the field. However the study is open to future research by putting more and recently evolved citation indices into test and comparison within the researchers of same field or from diverse fields. There is a need for more sensitive and comprehensive citation indices that can take into considerations all the factors that may impact a research publication or author and looks beyond the h-core.

Key words: Impact Factor, h-index, h-index variants, a-index, g-index, m-index, m-quotient

INTRODUCTION

It is important to determine the excellence of knowledge for the country heads in order to supersede their counter parts, it may be in the field of healthcare, education, defence, social status etc all of whom needs some established measures by which to distinguish and acknowledge good research and researchers. Identifying high quality science is important, but to measure the quality of the science has become even more important. The need for accountability in Higher Education has led governments, research authorities and University administrators to assess research performance using multiple indices that allow comparisons and rankings.[1] In the last few years, several research and publication papers related to research indices were proposed to assess the quality of the academic research publications started in the year 2005 when harsh proposed h-index. Many funding agencies use the metrics to evaluate institutional performance, compounding the problem.[2] While using h index to measure the quality of the research experts found some deficiencies.[3] "In certain cases, the mechanism used by the h-index to aggregate publication and citation statistics into a single number leads to inconsistencies in the way in which scientists are ranked. Our conclusion is that the h index cannot be considered an appropriate indicator of the overall scientific impact of a scientist".[4] "Situation which questions the use of the h-index is that concerning those scientists who attain a similar h-index result and yet have different total citation counts". There is no logical connection between number of citations and publication sequence. New authors have a problem with H-index as they have no or low index value due to time constraints. H-index does not take the actual number of citations; the content of H-core is not sensitive with more citations.[5]

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Although the H-index has many limitations and seems biased or unfair in many cases and currently, we can count more than 100 indicators potentially applicable at individual author level. The no. of variables seems high given the fact that it's the same variables that are manipulated through different algebraic and arithmetic formulas. H-index is taken as base and produces these indices with some behavioural enhancements in order to overcome its limitations. With so many indicators and so much widespread use, it is important to examine the characteristics of those author level indicators in order to quantify their use by administrators, evaluators and researchers. Thus the study is initiated to draw attention to the use of multiple indicators which allow users to tell more explicit story. With this aim, it is important to examine and compare author level indicators in relation to what they are supposed to reflect and especially their specific and still evolving limitations. The sample population was taken from *Thomson Reuters Citation Laureates* established in 1989. The list pertains to likely Nobel Prize winners in medicine, chemistry, physics, and economics. There appears to be a correlation between high citation rates for a published researcher and the award of prestigious accolades. Finally, choosing one tenth of one percent (0.1%) of the highest impact papers winnows the analysis to the topics and people most likely to be selected by Nobel selection committee.

Scope

The current study is confined to the citation laureates in the field of medicine. The focus was laid on 22 citation laureates, calculating their TNP, TNC, AC, H-index, A-index, R-index, M-index & M-quotient using web of science.

Objectives

The objectives of the study are:

- To determine the total number of publications of each citation laureate pertaining to the field of medicine in the timeline from 1980 to 2015.
- To determine the total number of citations received.
- To determine the total number of publications of citation laureate at the interval of 5 years.
- To calculate the H-index of the citation laureates.
- To calculate A-index, R-index, M-quotient and M-index.

Methodology

In this study, we started from a set of researchers and evaluate their performance according to set criteria. To do so, we first created a comprehensive dataset with information about each researcher. The study was further carried out in the following steps.

Step 1: **Defining a target set of researchers:** the research was initiated by consulting Science Watch's Hall of Citation Laureate keeping in view the service providers for web of science and the used source is same. The product provides information of citation laureates which includes name and affiliation in three fields (Physics, Chemistry and Medicine). The study focused on the field of medicine confining it to 22 citation laureates.

Step 2: **Collecting the researcher's achievements:** the name variants of the researcher were entered in web of science for collecting the publication details. Each of the records was analysed to overcome the name ambiguity. As a result total earlier displayed record count did not match with the exact actual Authors' publications.

Step 3: Data cleaning: the displayed record count by web of science was reduced to those publications matching the author name variants and affiliation. After data cleaning the h-index of each author was manually calculated.

Step 4: Calculation and Comparison of indices: further, selected variants of h-index:

A-index, R-index, M-index & M-quotient, on their evolutionary basis, were calculated and compared. The data was collected from March 2015 to May 2015. The formulae used for the calculations are as

A-INDEX

$$A = 1/h \sum_{j=1}^{h} cit_j$$

Where h is the h-index and cit_j is the number of citations of the jth most cited paper. Similar as the g- index, the A-index has the particular advantage of taking into account the citations of the Hirsch core, and thus, the A-index may increase even if the h-index remains the same as the scientist's citation counts increase.

R-INDEX

$$R = \sqrt{\sum_{j=1}^{h} cit} = \sqrt{A \quad h}$$

where h is the h-index and cit is the number of citations of the j-th most cited paper.

M-QUOTIENT

$$m = h/y$$

Where h is the h-index and y is the number of years since the first paper published by the author.

M-INDEX

The m-index is proposed as the median number of citations received by papers in the Hirsch core (this is the papers ranking smaller than or equal to h).

Literature Review

Hirsch (2005) *"proposes the h index, defined as the number of papers with citation number >h, as a useful index to characterize the scientific output of a researcher".* Further explaining h index Hirsch says it's an easy computable index, as it provides an estimate of importance, significance and broad impact of scientist's cumulative research contribution. Hirsch suggests that this index may prove very useful to compare, in an unbiased way, different individuals competing for the same resource when an important evaluation criterion is achieved. Many papers[6,7] supported the hirsh views. H-index is based on scientist's lifetime citedness which incorporated productivity as well as citation impact. However Glänzel[8] views h index is an extremely simple and comprehensible composite indicator which can be applied to any level of aggregation. Huang and Chi[9] are of the view that h-index integrates the evaluation of productivity and impact in a single indicator. It is rather insensitive to both the lowly and highly cited papers which may distort the assessment of productivity and impact in the other approaches. It is also free from the influences of document types when counting the total publications and citations. Bormann and Daniel[10] reveals in a study on young scientists work using h index, found that it is a promising tool to measure the scientific output of an author. According to Hirsch, h index is not only used to assess the past output of a researcher but it also anticipates the scientist's future productivity.[11] Wu[12] reveals that currently h-index has been used for evaluation of scientists, journals; conferences scientific topics research institutions and so on. H index is a mathematically simple index, encourages large amount of high quality work Jin, Liang, Rousseau and Egghe[13,14] H index is a robust indicator Rousseau[15] increasing publications don't have an effect on the index. Hirsch[16] that it gives a robust estimate of the broad impact of a scientist's cumulative research contributions and no. of publications and citations in a balanced way[17] Kelly and Jennions[18] states that the h index is in favour of those authors who have influential publications in their name rather than those authors which are non-influential. **Glanzel** state that the strength of the h index is that for the assessment of small paper set it is particularly well suited when other, traditional bibliometric indicators often fail or at least were their application proved usually problematic. H index is a tool used for determining the relative quality of a research. Schreiber[19] states that the advantage of the h-index is its insensitivity to the number of uncited or lowly cited papers. Therefore it discourages the publication of unimportant work, the partitioning into insignificant pieces or the repeated publication of similar results. H index can also be applied to some other source-item pairs, besides a scientist's publications and citations.[20] However since its inception the index were critically evaluated and disapproved as a suitable simple factor to measure the multidimensional achievements of researchers and likewise. H-index is not a suitable indicator for scientists with short career and they are at an inherent disadvantages.[21] the h-index has less predictive accuracy and precision, and cannot be used to compare scientist's work of different fields. Egghe[22] states that the problem with h-index is that it put small but highly-cited scientific outputs at a disadvantage. While the h-index de-emphasizes singular successful publications in favour of sustained productivity, it may do so too strongly. The issue related to the H-index calculation and that there is no logical connection between number of citations and publication sequence. In addition, new authors have a problem with H-index as they have no or low index value due to time constraints. As the value of the H index will never decrease, then some of researchers may depend on high values and therefore their real production or activity will decrease with time.[23] In h index once a paper is selected to belong to the top h papers, this paper is not used any more in the determination of h-index.[24] Schreiber[25] g index measures the impact of the productive core. Indeed, once a paper is selected to the top group, the h-index calculated in subsequent years is not at all influenced by this paper's received citations further on: even if the paper doubles or triples its number of citations (or even more) the subsequent h-indexes are not influenced by this. G and H index taken together presents a precise look of scientist's achievements in terms of publications and citations.[14] Bornmann et al.[10] has been pointed out that the h index is only weakly sensitive to the number of citations received by single publications. Also, as the h index is highly dependent upon a scientist's number of years of active research, strictly speaking we

should only compare the h values of scientists that have been active re- searchers for a similar number of years. According to Egghe[13] an index should be sensitive to the level of the highly cited papers. As the h index is defined now, once an article belongs to the h-defining class, it is totally unimportant whether or not these papers continue to be cited and, if cited, it is unimportant whether these papers receive 10, 100, or 1,000 more citations. Eliminating the disadvantages of h index AR index takes age of publication into consideration and R index measures the H core's citation intensity.[5] However, the h-index has various shortcomings, in particular when comparing individual scientists,[26] reveals that h index cannot differentiate between active and inactive scientists, it is affected by different discipline-dependent citation patterns etc. In order to overcome such deficiencies numerous variants have been proposed that aim to overcome some of these disadvantages. Like, the m quotient allows to compare different lengths of scientific career the g and h (2) indices give more weight to highly cited papers the impact index hm provides an evaluation of the impact of the production and the contemporary h index gives more weight to newer articles.[7] Other indices like f index[27] w index[28] pi index[29] ch-index[30] iQp index[31] w index evolved with the passage of time to measure the scientific output. The variants continue to emerge and the literature has not so far given a concrete and one shop solution for evaluation of the scientific performance. Thus various studies have been initiated to compare the proposed indices to reach to a definite Solution. Most of the studies show varying degree of correlation of h-index with all the other proposed variants[32] disagree with helpfulness of the variants of h-index as they reveal similar information to a large extent about the data they explain.[33] worked on calculation of correlation between h-index and its 37 variants, and concluded that the h-index is strongly correlated with most of its variants, which implies that these variants of h-index repeat the information regarding the data under study. However, [34] finds a modest correlation between h-index and g-index for individuals and departments under study.[35] depict that an evaluation of h-index and g-index showed very much similarity with regard to their performance.[36] finds in his study that the Google-derived indices (h, hc, g, e, AR) are strongly and linearly correlated with one another, and the values for correlations are more than 0.75.[37] find that h-index and g-index show almost a perfect correlation, indicating strong redundancy of results. Likely, [38] find that correlation coefficient between h-index and g-index is very high but it does not disapprove that g-index is a strong alteration of the h-index, as g-index can compute actual scientific productivity as well as the scientific impact of a scientist, while h-index calculates mostly the quantitative aspect. determine that the variants of h-index are different from the original h-index; however, these variants are extremely correlated with one another. Additionally, the extent of correlation between h-index and its variants determines the extent of redundancy of data.[39] finds that h-index shows a significant correlation with A and R.

However[40] found m-index and p-index weakly correlated with h-index.[41] also finds there is a strong correlation between π-index and h-index.[42] again in his later study finds that π-index shows an important correlation with h-index. However[43] give a surprising finding that π-index and h-index were not correlated with each other.[44] in his study contradicts it by saying that the correlation among the various indices is complicated.

Citation Indices Limitations and Issues

The strengths and weakness of the proposed indices are discussed in the section. The data is presented in the tables comparing and calculating h-index and its different variants in order to assess whether the proposed variants are overcoming the flaws of h-index taking into account the real time data of citation laureates in the field of medicine drawn from web of science database.

Calculation of H-index, Total No. of publications, Average & Total no. of citations.

Case 1: as shown in table 1 for author Hynes and Hartl have same index while as table shows a difference of more than 10000 in citations count. Thus Hynes has more hit papers than Hartl. However their h-index is same.

Case 2: The authors Blackburnburn, Capecchi, Takiechichi, Ruvkun have different publication and citation count. However h-index ranks them the same. There is no logical connection between no. of citations and publication sequence.

Case 3: the citation laurel Szostak has more papers and citations with h-index 63 than the authors like Capecchi and Takiechichi. However their h-index is higher which is not justifiable

Calculation and Comparison of A-index with H-index

Although the A-index calculation is based on h-index core. However it is evident from the data A index gives proper weightage to the work of authors on the bases of

Table 1: Calculation of H-index, Total No. of publications, Average & Total no.of citations

Author	TNP	TNC	Avg. Citations	H-index
Allis	306	57342	186.78	119
Hynes	278	44533	160.19	93
Hartl	246	33974	138.11	93
Klionsky	336	32290	96.1	86
Coffman	234	34560	147.69	77
Blackburnburn	223	19397	86.21	68
Capecchi	193	15920	82.06	68
Takiechichi	86	18345	213.31	68
Ruvkun	160	22833	307.07	68
Szostak	217	18712	86.23	63
Horwich	134	15806	117.96	57
Mosmann	127	31976	251.78	49
Cedar	91	10565	116.1	48
Ambros	82	22624	275.9	43
Miller	113	8652	76.56	43
Nishizuka	81	15557	192.06	43
Bird	57	8543	149.88	37
Langer	92	4427	48.12	26
Knudson	53	3413	64.39	26
Razin	59	2020	34.23	19
Till	38	359	9.44	9
Jensen	11	584	58.4	8

their citation counts. Ranking the authors as per A-index is to some extend justifies the work of authors clearly. The limitations of the h-index can be demonstrated using the case of authors:

Case 1: Mosmann & Cedar have h-index of 49 and 48 respectively whereas the difference is of more than 21,000 citations is reflected from the data, which is huge, and h index is not able to differentiate between the two authors. While as their A-index is 633.08 and 205.58 clearly demarcating them.

Case 2: Analysing the case 2nd we assess the Langer & Knudson as there H index is 26 but when we look at their citation counts the difference is of more than 1000 citations out of 4000 citations which is a huge difference. So analysis the data we found that A index (159.53 & 124.19) gives due credit to the work of Authors while as H index has failed to do so.

Case 3: Studying the authors Ambros, Nishizuka & Miller are having h index 43 each but their citation counts are 22549,8652,15557 respectively. Hirsh has put all the authors at par while as their A-index (514.11, 347. 51 & 187.25) is giving them due credit.

Case 4: H-index has ranked Mosmann at 12 in the data while as Allis is leading the table. But when we look at their A-index, Mosmann **(633.08)** is staged at no.1 while as and Allis **(422.57)** is at 3rd. Analysing their first 10 papers Mosmann have more hit papers than Allis and ranking is done accordingly. A-index is focussing on the quality rather than quantity.

Thus data depicts that A-index gives credit on the basis of citation count not on the basis of no. of citations and publication sequence. Thus author having more hit papers is ranked accordingly by A-index.

We have found out that h index no matter has initiated a revolution in the field of scientometric but it has numerous short coming and the variants of H index like A index are to some extend trying to overcome those loopholes.

Table 2: Calculation and Comparison of A-index with H-index

A-INDEX	SUM OF H-CORE	H-INDEX	TNC	TNP	CUMM. CITA. OF 11-LAST CITED PAPER	10	9	8	7	6	5	4	3	2	1	PAPER ID
422.57	50286	119	57251	306	39895	760	774	936	941	997	1039	1089	1457	4277	5086	ALLIS
425.9	39609	93	44514	278	24427	609	727	801	812	828	1101	1101	1389	4076	8643	HYNES
324.58	30186	93	33936	246	22991	655	677	684	700	771	796	933	1338	1895	2496	HARTL
322.94	27773	86	32213	336	19974	706	766	868	879	916	1230	1374	1576	1785	2139	KLIONS
407.01	31340	77	34573	234	17744	700	702	776	814	943	1023	1198	1349	3423	5901	COFFM
246.48	16761	68	19337	223	10647	310	502	543	559	634	679	967	1046	1162	2288	BLACKBURN
201.7	13716	68	15904	193	10441	330	337	371	375	400	444	481	691	695	1339	CAPECCHI
254.28	17291	68	18345	86	9780	405	400	454	477	537	561	775	1075	1073	2808	TAKIECHI
307.07	20881	68	22833	160	12588	483	530	549	779	1089	1038	1032	1185	1690	1870	RUVKUN
251.08	15863	63	18712	217	10361	385	425	429	516	522	536	583	647	664	3644	SZOSTAK
257.29	14666	57	15784	134	8427	339	363	401	512	517	677	771	796	1037	1944	HORWICH
633.08	31021	49	31976	127	10495	932	1013	1185	1585	1859	2120	2168	2258	2582	5779	MOSMAN
205.58	9868	48	10542	91	5688	298	322	340	441	472	522	542	570	653	694	CEDAR
514.11	22107	43	22541	82	5648	632	633	786	820	874	911	1630	1862	3828	4925	AMBROS
187.25	8052	43	8652	113	4132	237	237	238	277	299	319	436	504	519	1454	MILLER
347.51	3229	43	15557	81	544	378	409	419	438	456	462	537	750	2110	4154	NISHI
225.59	8347	37	8525	57	3025	299	305	359	372	442	471	497	548	1039	1168	BIRD
159.53	4148	26	4426	92	1138	118	120	120	177	180	185	201	290	632	1265	LANGER
124.19	3229	26	3413	53	973	93	93	114	129	149	250	236	266	433	677	KNUDSON
100.1	1902	19	2020	59	326	30	29	47	47	55	69	151	292	465	509	RAZIN
32.22	290	9	359	38	70	8	16	18	23	24	24	27	28	49	81	TILL
73	584	8	584	11	0	0	0	22	22	38	45	47	49	139	222	JENSEN

We have also assessed that A index is not complete in itself rather has many shortcomings which need to mended.

Calculation and Comparison of R-index with H-index

No doubt the R index works under the advisory of h index but gives due credit to the work of authors as per their citation count. As evident from the results and cases analysed from table-3 R-index is highly reflective of authors citations intensity.

Case 1: Authors Blackburn, Capechi, Takiechichi, and Ruvkun have citation count of 19337, 15904, 18345 & 22833 respectively but h-index puts them on the same scale i.e 68 which is not justifiable. Ruvkun has 22833 citations while as Capeichi have only 13716 but H index have ranked them same which is unfair. R index has been able to demarcate between the two, thus R-Index has given due credit to the citation count of authors.

Case 2: Mosmann & Cedar with H index of 49 & 48 but there citations are 31976 & 10542 showing the difference of more than 20000 citations while R-index (176.13 & 99.33) is clearly giving due credit to the author with high citation count.

Case 3: Analysing Hartl and Mosmann, former is at 12 and latter is standing on 3rd rank as per h-index. R-index is stresses on the impact of work rather than quantity. R-index of Mosmann & Hartl is **176.13** & **173.74** respectively. H-index ranks as per their no. of publications ignoring the impact of the work, analysing their first 10 papers Mossman is way ahead than Hartl as the latter has published more quality work than former.

We can call R *as an variant to h index overcoming some of the flaws of h index but it's not a complete index as the divisors of the index are of the opinion that the ranking as per* R*-index is not convincing and have welcomed further research on the same. (Hirsch 2007).*

Calculation and comparison of M-quotient with H-index

Although M-Quotient is reliant on h-index but it is considered to be totally independent of the citation distribution in the h-core. M-quotient goes a step ahead by taking career length of an author.

Case 1: Analysing the citation laureates, Blackburn, Capecchi and Ruvkun having the same h-index 68 and same number of years since publishing i.e., 26 years, are having the same m-quotient.

Case 2: Assessing the rank of the citation laureates according to h-index, we found that each citation laureate are having same rank in m-index.

Greater the h-index, greater will be the m-quotient and vice-versa. An organised descending order of ranking is followed same as that of h-index. Thus m-quotient more closely reflects the H-index pattern

Calculation and Comparison of M-index with H-index

M-Index entirely depends on the Hirsch Core contents and the rest of the publications not belonging to the h-core. M-Index is the median number of citations received by papers in the Hirsch core. Based on the median value, H-core contents may increase the attention to the success publications of such author.

Case 1: Allis ranked at first position with h-index of 119 and "Hynes" ranked at the second position with h index of 93 are ranked at the first and fifth position respectively by m-index.

Case 2: The citation laureates Blackburn, Capecchi, Takiechi and Ruvkun are having same H-index (68) but their citation count varies (19337, 15904, 18345 & 22833 respectively) which means not justifying their total citation count. While as m-index (127.5, 152.5, 142 & 188 respectively) gives due credit to them.

m-index gives an appropriate picture of citation laureates. Furthermore, the value of m-index may alter if there is some addition in the citations in the paper pertaining to the h-core; however h-index remains same.

Comparison of selected Indices

Here the focus is on the citations per paper and more specifically average citation per paper. Since citations have been linked to the repayments of intellectual debts.

Table 6 is a comparative analysis of the selected indices. Here the emphasis is on the average citation per paper rather than illogical connection between number of citations and publication sequence propounded by the h-index. The authors are ranked on the bases of h-index in the above table. The table also discloses a strong correlation between h-index and other selected indices except A-index. As all the indices ranked except A-index ranked Allis as top Author in the list. Further R-index is most closely following the h pattern in ranking the authors followed by m-Quotient where authors are ranked same instead of having different citation count and average

Table 3: Calculation and Comparison of R-index with H-index

R-Index	SUM OF H-CORE	H-NDEX	TNC	TNP	CUMM. CITA. OF 11-LAST CITED PAPER	10	9	8	7	6	5	4	3	2	1	PAPER ID
224.24	50286	119	57251	306	39895	760	774	936	941	997	1039	1089	1457	4277	5086	ALLIS
199.02	39609	93	44514	278	24427	609	727	801	812	828	1101	1101	1389	4076	8643	HYNES
173.74	30186	93	33936	246	22991	655	677	684	700	771	796	933	1338	1895	2496	HARTL
116.65	27773	86	32213	336	19974	706	766	868	879	916	1230	1374	1576	1785	2139	KLIONS
177.03	31340	77	34573	234	17744	700	702	776	814	943	1023	1198	1349	3423	5901	COFFM
129.46	16761	68	19337	223	10647	310	502	543	559	634	679	967	1046	1162	2288	BLACKBURN
117.03	13716	68	15904	193	10441	330	337	371	375	400	444	481	691	695	1339	CAPECCHI
131.49	17291	68	18345	86	9780	405	400	454	477	537	561	775	1075	1073	2808	TAKIECHI
144.5	20881	68	22833	160	12588	483	530	549	779	1089	1038	1032	1185	1690	1870	RUVKUN
126	15863	63	18712	217	10361	385	425	429	516	522	536	583	647	664	3644	SZOSTAK
121.1	14666	57	15784	134	8427	339	363	401	512	517	677	771	796	1037	1944	HORWICH
176.13	31021	49	31976	127	10495	932	1013	1185	1585	1859	2120	2168	2258	2582	5779	MOSMAN
99.33	9868	48	10542	91	5688	298	322	340	441	472	522	542	570	653	694	CEDAR
148.68	22107	43	22541	82	5648	632	633	786	820	874	911	1630	1862	3828	4925	AMBROS
89.73	8052	43	8652	113	4132	237	237	238	277	299	319	436	504	519	1454	MILLER
122.24	3229	43	15557	81	544	378	409	419	438	456	462	537	750	2110	4154	NISHI
91.36	8347	37	8525	57	3025	299	305	359	372	442	471	497	548	1039	1168	BIRD
64.4	4148	26	4426	92	1138	118	120	120	177	180	185	201	290	632	1265	LANGER
56.6	3229	26	3413	53	973	93	93	114	129	149	250	236	266	433	677	KNUDSON
46.31	1902	19	2020	59	326	30	29	47	47	55	69	151	292	465	509	RAZIN
17.02	290	9	359	38	70	8	16	18	23	24	24	27	28	49	81	TILL
24.16	584	8	584	11	0	0	0	22	22	38	45	47	49	139	222	JENSEN

Table 4: Calculation and comparison of M-quotient with H-index

M QUOTIENT	SUM OF H-CORE	H-INDEX	TNC	TNP	CUMM. CITA. OF 11-LAST CITED PAPER	10	9	8	7	6	5	4	3	2	1	PAPER ID
4.57	50286	119	57251	306	39895	760	774	936	941	997	1039	1089	1457	4277	5086	ALLIS
3.57	39609	93	44514	278	24427	609	727	801	812	828	1101	1101	1389	4076	8643	HYNES
3.57	30186	93	33936	246	22991	655	677	684	700	771	796	933	1338	1895	2496	HARTL
3.3	27773	86	32213	336	19974	706	766	868	879	916	1230	1374	1576	1785	2139	KLIONSKY
2.96	31340	77	34573	234	17744	700	702	776	814	943	1023	1198	1349	3423	5901	COFFMA
2.72	17291	68	18345	86	9780	405	400	454	477	537	561	775	1075	1073	2808	TAKIECHICHI
2.61	16761	68	19337	223	10647	310	502	543	559	634	679	967	1046	1162	2288	BLACKBURN
2.61	13716	68	15904	193	10441	330	337	371	375	400	444	481	691	695	1339	CAPECCH
2.61	20881	68	22833	160	12588	483	530	549	779	1089	1038	1032	1185	1690	1870	RUVKUN
2.42	15863	63	18712	217	10361	385	425	429	516	522	536	583	647	664	3644	SZOSTAK
2.19	14666	57	15784	134	8427	339	363	401	512	517	677	771	796	1037	1944	HORWICH
1.96	31021	49	31976	127	10495	932	1013	1185	1585	1859	2120	2168	2258	2582	5779	MOSM
1.84	9868	48	10542	91	5688	298	322	340	441	472	522	542	570	653	694	CEDAR
1.65	22107	43	22541	82	5648	632	633	786	820	874	911	1630	1862	3828	4925	AMBROS
1.65	8052	43	8652	113	4132	237	237	238	277	299	319	436	504	519	1454	MILLER
1.65	3229	43	15557	81	544	378	409	419	438	456	462	537	750	2110	4154	NISHIO
1.42	8347	37	8525	57	3025	299	305	359	372	442	471	497	548	1039	1168	BIRD
1	4148	26	4426	92	1138	118	120	120	177	180	185	201	290	632	1265	LANGER
1	3229	26	3413	53	973	93	93	114	129	149	250	236	266	433	677	KNUDSON
0.73	1902	19	2020	59	326	30	29	47	47	55	69	151	292	465	509	RAZIN
0.34	290	9	359	38	70	8	16	18	23	24	24	27	28	49	81	TILL
0.30	584	8	584	11	0	0	0	22	22	38	45	47	49	139	222	JENSEN

Table 5: Calculation and Comparison of M-index with H-index

M-INDEX	SUM OF H-CORE	H-INDEX	TNC	TNP	CUMM. CIT. OF 11-LAST CITED PAPER	10	9	8	7	6	5	4	3	2	1	
295	50286	119	57251	306	39895	760	774	936	941	997	1039	1089	1457	4277	5086	ALLIS
180	39609	93	44514	278	24427	609	727	801	812	828	1101	1101	1389	4076	8643	HYNES
221	30186	93	33936	246	22991	655	677	684	700	771	796	933	1338	1895	2496	HARTL
172.5	27773	86	32213	336	19974	706	766	868	879	916	1230	1374	1576	1785	2139	KLIONS
177	31340	77	34573	234	17744	700	702	776	814	943	1023	1198	1349	3423	5901	COFFM
142	17291	68	18345	86	9780	405	400	454	477	537	561	775	1075	1073	2808	TAKIECHI
127.5	16761	68	19337	223	10647	310	502	543	559	634	679	967	1046	1162	2288	BLACKBURN
152.5	13716	68	15904	193	10441	330	337	371	375	400	444	481	691	695	1339	CAPECCHI
188	20881	68	22833	160	12588	483	530	549	779	1089	1038	1032	1185	1690	1870	RUVKUN
126	15863	63	18712	217	10361	385	425	429	516	522	536	583	647	664	3644	SZOSTAK
164	14666	57	15784	134	8427	339	363	401	512	517	677	771	796	1037	1944	HORWICH
275	31021	49	31976	127	10495	932	1013	1185	1585	1859	2120	2168	2258	2582	5779	MOSMAN
154	9868	48	10542	91	5688	298	322	340	441	472	522	542	570	653	694	CEDAR
139	22107	43	22541	82	5648	632	633	786	820	874	911	1630	1862	3828	4925	AMBROS
120	8052	43	8652	113	4132	237	237	238	277	299	319	436	504	519	1454	MILLER
152	3229	43	15557	81	544	378	409	419	438	456	462	537	750	2110	4154	NISHI
125	8347	37	8525	57	3025	299	305	359	372	442	471	497	548	1039	1168	BIRD
86	4148	26	4426	92	1138	118	120	120	177	180	185	201	290	632	1265	LANGER
71	3229	26	3413	53	973	93	93	114	129	149	250	236	266	433	677	KNUDSON
29	1902	19	2020	59	326	30	29	47	47	55	69	151	292	465	509	RAZIN
24	290	9	359	38	70	8	16	18	23	24	24	27	28	49	81	TILL
38	584	8	584	11	0	0	0	22	22	38	45	47	49	139	222	JENSEN

Table 6: Comparison of selected Indices

M-INDEX	M QUOTIENT	A-INDEX	R-Index	H-NDEX	Average citation per paper	TNC	TNP	Paper ID
295	5	423	224	119	187	57251	306	ALLIS
180	4	426	199	93	160	44514	278	HYNES
221	4	325	174	93	138	33936	246	HARTL
173	3	323	117	86	96	32213	336	KLIONS
177	3	407	177	77	147	34573	234	COFFM
142	3	246	129	68	87	19337	223	BLACKBURN
128	3	202	117	68	82	15904	193	CAPECCHI
153	3	254	131	68	213	18345	86	TAKIECHI
188	3	307	145	68	143	22833	160	RUVKUN
126	2	251	126	63	86	18712	217	SZOSTAK
164	2	257	121	57	117	15784	134	HORWICH
275	2	633	176	49	251	31976	127	MOSMAN
154	2	206	99	48	115	10542	91	CEDAR
139	2	514	149	43	274	22541	82	AMBROS
120	2	187	90	43	77	8652	113	MILLER
152	2	348	122	43	192	15557	81	NISHI
125	1	226	91	37	150	8525	57	BIRD
86	1	160	64	26	48	4426	92	LANGER
71	1	124	57	26	64	3413	53	KNUDSON
29	0.73	100	46	19	34	2020	59	RAZIN
24	0.34	32	17	9	9	359	38	TILL
38	0.30	73	24	8	53	584	11	JENSEN

citation/ paper. Observing the column Average citation/ paper the highest number is gained by the citation laureate Ambros with 274 citations per paper followed by Mosmann (251) and Nishi (192). A-index ranks Mosmann as top author in the list followed by Ambros and Hynes instead of Nishi and Allis. Thus A-index looks beyond the h-core and could be regarded as justifiable index with few intrinsic limitations.

Findings and Conclusion

Numerous studies in the past three decades have shown a strong correlation between citations in the literature and the peer esteem. Eugene Garfield founder of Science Citation Index database studied the correlation between high citation frequency and the receipt of prestigious prizes especially the Nobel price. In this paper a survey of selected citation indices is carried for evaluating the

impact factor and determining the rank of citation laureates based on the h-index and its select variants. Using examples, the limitations of indices are shown particularly the limitations of h-index are focused in the paper. Among the studied indices m-quotient and R-index is more closes following the h-pattern in ranking the authors. While as A-index gives credit on the basis of citation count not on the basis of the combination of no. of citations and publication sequence. Thus author having more hit papers and more ACPP is ranked accordingly and nearly by A-index not exactly. Thus it can be concluded that the proposed variants of h-index are not complete in itself and are in growing stage as they are not displaying the clear picture of the authors. So the future window is kept open in order to devise a complete index so that ranking will be accurate and can be trusted.

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