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A Decade of Gender-based Violence (GBV) Research Productivity in South Africa 2009-2018

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Abstract

South Africa has not only been identified with high records of gender-based violence (GBV), but that, it takes a complex toll on young people than does transport accidents. Therefore, two methods: Pao's Least Squared (LS) and Sen's methods were used to determine the validity of GBV research output vis-a-vis Lotka's law of scientific productivity over a ten-year window 2009-2018. Data on GBV scientific publications in South Africa was harvested from the EBSCO Discovery Service Database. The study revealed an acute dearth of research on GBV, given the fact that 300 publications were produced by 617 researchers which translated to less than 1 publication per a researcher and an average of 30 journal publications per annum. Moreover, this study discovered that, although, GBV scientific productivity did not accurately conform to the statistical proportions stated by Lotka's law, however, Sen's method validated with t-test statistical analysis produced an outcome that concurred with the general patterns of the law. Least squared method and K-S goodness-of-fit test however out rightly opposed Lotka's law. The implication is that Gender-based violence (GBV), is not yet a subject specialty in its own right but rather a topic embedded within medical education. This is evidenced by the seemingly large number of transitory authors with few publications and a clear indication of the commitment of few researchers and institutions to the course of GBV.

Key Words: Informetrics, Lotka's law, Gender-based violence (GBV), South Africa.

Introduction

The Dictionary of Bibliometrics defines Law as "Eponymic statements in Bibliometrics, Informetrics, and Scientometrics"(Diodato, 1994:99). The laws are explanations or premises of patterns that are clearly seen in the publication and usage of information. The well- noted laws are three, namely: Lotka's law (used to measure author's productivity), Bradford's law or the law of dispersal of publications (commonly used to study the distribution of journal literature and describes how literature in a particular field is scattered or found in many journals) and Zipf's law of word occurrence. These laws are aimed at fortifying the status of informetrics from a technique to a scientific theory, but different from the conventional laws of physical sciences (Egghe and Rousseau, 1990). The commonest feature of these laws is that their data are mostly skewed towards their upper tails (Chen and Leimkuhler,1986) . The authors further accentuated that given certain conditions, the three laws are mathematically similar; thus implying that the three laws model the distribution of information phenomena from different perspectives.

Lotka (1926) came up with a hypothesis following a research conducted on two samples drawn from the Chemical Abstracts between 1907 and 1916 that the number of persons making n

contributions was about $1/n^2$ of those making one and the totality of all single contribution was about 60%. Therefore, he called the discovery the "inverse square law of scientific productivity" because he discovered a sharp contrast between the quantities of publications and the number of authors on such documents (Coile, 1978; Nicholls, 1989 and Potter 1981). Lotka's article came to limelight in 1941 when it received its first citation, and the hypothesis distribution was adjudged "Lotka's law" in 1949. However, attempt to test the fittingness of Lotka's law in scientific disciplines started in 1973 (Potter, 1981). Since then, Lotka's law had variously been undertaken across many disciplines despite the notable shortcomings inherent in the formulation of the law.

Gender-based violence in South Africa

GBV is a widely known public health, human rights and human continuity issue that has attracted global outcry at many fora. It happens across the world, irrespective of culture, race, age, and social class (Mcquaid, 2017; Naciri, 2018). Recent estimates reveal that globally, almost one quarter of adults (23%) experienced physical abuse as a child and about one third (35%) of women had at one time suffered from physical and/or intimate partner sexual violence or non- partner sexual violence (World Health Organisation, 2013).

GBV has severe consequences on the victims, families, communities and nations. For instance, studies have shown that children who were exposed to violence are most likely to grow up with abusive tendencies that could produce lifelong impacts on the health and well-being of other children. Likewise, violence against women could result in life-threatening short or long-term physical disability, mental illness, sexual and reproductive health complications. It impinges on their children's well-being, and eventually culminate in loss of potential social and economic gains for the women, their families and societies.

It is often assumed that the greatest perpetrators of violence are largely men (the advantaged) who directed violence primarily towards the disadvantaged (largely women) due to the patriarchal power relations that customs and culture bestow on them by virtue of their masculinity (Walby *et. al.* 2014; Hillis *et. al.*, 2016, UN Women, n.d.???)). Nonetheless, recent evidences point to the fact that men also experience gender-based violence. However, the level of violence is more severe on women and girl children than men because it is the common source of injury to women (Garcia-Moreno et al 2015; Maquibar *et al.,* 2018; Naciri, 2018).

South Africa's estimates of GBV is one of the highest in the world, in that, women that get killed by their intimate partners were appraised six times the global average (Davis and Meerkotter 2017). According to the Report of Statistics South Africa (Stats SA) in the *Crime against women in South Africa* (2018), an estimate of 138 per 100 000 women were raped in 2016/17. Mills *et al.* (2015) Evidence Report revealed that 39 per cent of South African women have suffered one form of SGBV in their lifetime. Even, the community of lesbian, gay, bisexual, transgender, queer and intersex (LGBTQI) are violated as well. The authors hinged the cause of the various forms of violence on the socio-economic inequalities that pervaded the long era of apartheid in the country. Although, South Africa is one of the few countries in Africa that have instituted laws and policies

against GBV, such promulgation of policies, laws and national strategies have not curbed the prevalence of GBV crisis (Meyiwa, Williamson, Maseti, & Ntabanyane 2017).

Literature Review

Lotka's study being a mere hypothesis model that was not grounded on an empirical law (Nicholls 1989; Wagner-Döbler and Berg 1995) generated a lot of controversies in a bid to empirically confirm its validity. The debates are largely on issues pertaining to: the population of authors; methods of data collection; calculation of the two constants (*α and c*) and problem with the validity of the observed data to the theoretical distribution. Thus, if the above mentioned issues are not well resolved in the course of applying Lotka's law on any scientific literature, the implication of such lackadaisical assessment on scientists' research performance could belittle their productivity. To that end, early works of scholars such as Chen and Leimkuhler (1986); Pao (1985), Pao (1986); Potter (1981) proffered suggestions to some of the methodological deficiencies so as to make its application more scientific.

For instance, the choice of community of authors that will form the population of the study has been largely controversial. Whereas, Lotka's general and theoretical estimate of productivity was based solely on the first authors, probably because, co-authorship was not common then. Many years thereafter, co-authorship became an acceptable measure of scientific productivity (Potter 1981). Hence, Pao (1986), recommended that complete count, that is, giving equal credit to all authors who contributed is ideal so as not to eliminate a substantial portion of authors. According to her, bestowing "full productivity" of authorship on first authors alone, would significantly impair the contributions of other authors. She further suggested that the two constants in Lotka's formulation, the slope α and the constant C, should be derived from the observed data distribution.

Nicholls (1989) suggested different views on how best to resolve these issues. For instance, Nicholls (1986), stressed that a robust testing methodology is an essential prerequisite to the validation and generalization of Lotka's law. In his opinion, Nicholls (1989) was not surprised at the uproar that trailed the validity of Lotka's law. The author cross examined the results of 30 validity studies conducted on Lotka's law from 1973 and found that these studies' were grossly inconsistent in their methodological approach. According to him, half of the studies tested the validity of another type of model, while a lot of others misconstrued the model, and so, such studies cannot offer robust validity on Lotka's law.

Potter (1981:37) on the other hand, viewed the use of standard bibliographic databases as an improvement in the methods of data collection. Yablonsky (1980:4) opine that Lotka's scientific productivity can be determined through direct statistical counting of frequency and ranking approach; Pao (1985), maintained the need to test the conformity of the observed distribution vis-à-vis the theoretical distribution function with a suitable statistical test of goodness-of-fit, at a specified level of significance. Gupta (1987:45) concluded that Lotka's law should only be treated as estimates of general and theoretical productivity rather than precise statistical distribution. Wagner-Döbler and Berg (1995), considered the effect of time on Lotka's distribution as a demonstration of inequality in scientists contributions towards the growth of science. According

to the authors, it is unethical to match authors just setting out on their scientific activity with authors who have gotten longer periods of scientific activity. They argued that the computations of Lotka distribution should be based on researchers' length of scientific activity. The authors' highlighted number of years spent in scientific activity, phases of development scientific areas or authors cumulative publications as prerequisite for measuring authors' productivity distributions rather than ascribing an arbitrary starting point over a period of time for the authors.

Some of the recent studies that have confirmed Lotka's law include: Shenton (2017), who applied Lotka's law to investigate the authorship of original "Doctor Who library" a novelization series from a small number of writers, while many authors had no more than one contribution each. Nonetheless, there was no evidence that a statistical test for goodness of fit was performed to determine the fitness of Lotka's law to the objects of research.

Tsay and Lai (2018) conducted a Scientometrics study on the literature of Heat transfer from 1900 to 2017 based on the 120,628 data harvested from Web of Science. The findings followed Lotka's law, in that 61.3%, (79,655) out of 130,037 authors contributed one article only, while 15.9% of the authors had two articles to their credit; authors of three articles contributed 7.0%, and four articles 4.0%. The outcome of the least squared method showed the value of the exponent α in a slope of -2.15, which was also near to Lotkas exponent α value of -2. However, contrary to the suggestion that applicability of Lotka's law to a set of data must be subjected to a statistical test, these values were not subjected to any test-of-goodness to determine the conformity of the data.

Parry (2019), did a scientometric investigation on computing research in South Africa with data accessed from the Scopus bibliographic database. He found that scientific distribution of computing authorship followed an inverse power law ($\alpha = 2.27$), with 9936 authors contributing one paper each. He confirmed the authorship patterns with two-sample Kolmogorov-Smirnov goodness-of-fit. Result validated Lotka's law with 68.50% of authors' single publication, 14.50% authors have two publications, 5.45% have three publications, and 3.02% have four publications while only three authors were accountable for 429 (3.84%) publications.

Similarly, there are several fields of studies wherein Lotka's law of distribution did not hold sway. In other words, some disciplines do not fit into empirical frequency distributions of scientific productivity. Such studies include:

Lemoine (1992) studied CSIR India' scientists research papers and patents. He grouped the population of authors into two: authors with 10 articles, and authors with 11 and above research publications. He applied two tests of goodness: Kolmogorov-Smirnov (K-S) test and a t-test to determine their conformity to the inverse power relationship. His findings reveal that the scientific productivity of researchers with 11 or more publications conceded to an inverse square relationship. He further discovered that the productivity distribution of both males and females' scientists who have contributed 11 and more research papers conform to an inverse square power relationship.

Moreover, Savanur (2013) applied three methods i.e.: Sen's method, Pao's Least Squared method, and Maximum likelihood method along with Kolmogorov-Smirnov (KS) test-of-goodness to measure validity of Lotka's law in cloud computing research. He discovered that, the values of exponent (α) and constant (C) based on the three methods contradicted Lotka's law on pattern of authorship productivity in the field of Cloud computing research.

Research Objectives

1. This paper seeks to test whether the frequency distribution of the GBV research output in South Africa follows Lotka's law using authors' "full productivity" based on Pao's least Squared (LS) and Sen's methods.
2. Undertake Kolmogorov-Smirnov (K-S) and T- test- analysis as goodness-of-fit tests to confirm the results.

8.2. Research Questions

Arising from the above objective, the study shall provide answers to the following questions:

1. To examine the conformity of Lotka's law on the research productivity of GBV scientific publications in South Africa based on Least Squared (LS) and Sen's methods.
2. Does Kolmogorov-Smirnov (K-S) and T-test analysis as goodness-of-fit tests to confirm Lotka's law on GBV literature?

Methodology

This study was based on bibliometrics. Therefore, data used in this study was downloaded from EBSCO Discovery Service (EDS), because its services cover a pool of databases. Only peer reviewed journals articles were considered owing to the fact that they are the most acceptable and easily measurable source of research (Alcaide and Gorraiz 2018). GBV publications over a ten-year window from 2009-2018 were considered relatively new. Search terms included "gender-based violence' OR 'gender violence' OR 'gender inequality' OR"women abuse", OR 'women trafficking' OR 'domestic violence, OR intimate partner violence, OR 'sexual violence, OR 'child abuse, OR 'child trafficking, OR homosexuals OR 'same sex, OR lesbians OR gay. The LGBT were included in the search because they often get abused on the basis of their gender identity. All these terms were searched along with individual country; e.g …. AND South Africa from seven databases housed in EBSCO Discovery Service (EDS). The databases were: Business economic, Communication/media, Education, Health Sciences, History, and Life Sciences and Psychology/Sociology. The study employed ENDNote, SPSS and Microsoft Excel Spreadsheets to capture, clean up and analyse data. EndNote was used to export data from EBSCO to get the bibliographic details for easy counting of the publications and the authors. SPSS and Microsoft Excel Spreadsheet on the other hand were used to obtain the t-test result and calculations of other values. A total of 300 journal articles were found useful for the study.

Scientists have applied a number of methods to determine the applicability of Lotka's law in many fields of research. However, the notable methods are: Least Squared (LS) Method along with Kolmogorov-Smirnov (KS) goodness-of-fit test suggested by Pao (1986); Maximum Likelihood (ML) method through a computer program named **LOTKA** (Ahmed and Rahman 2009; Rousseau

and Rousseau 2000); and Sen's method in conjunction with t-test for goodness-of-fit (Roy, 2019). Notable scholars (Pao 1985; Savanur 2015; Torbati and Chakoli 2013) reiterated preference for Kolmogorov-Smirnov test (K-S test) as the most suitable test for fitting Lotka's law. This study will employ Least squared (LS) and Sen's methods to examine the conformity of Lotka's law on the research productivity of GBV in South Africa and thereafter validated its applicability through KS goodness-of-fit test and t-test analysis.

Findings

Table 1 Distribution of GBV Research Publication

Year	No	%
2009	29	9.67
2010	29	9.67
2011	32	10.66
2012	30	10.00
2013	27	9.00
2014	35	11.67
2015	34	11.33
2016	34	11.33
2017	26	8.67
2018	24	8.00
Total No of Authors	300	100

Source: Research data

Table 2 Distribution of Authors' Contributions

Number of Contributions (x)	No of authors (y)	% of Authors
1	488	79.09
2	71	11.51
3	24	3.89
4	10	1.62
5	13	2.11
6	6	0.97
8	3	0.49
9	1	0.16
22	1	0.16
Total	617	100

Source: Research data

Table 3 **Least square Method**:

X	Y	X	Y	XY	X^2
1	488	0	2.68842	0	0
2	71	0.301029996	1.851258	0.557284	0.090619
3	24	0.477121255	1.380211	0.658528	0.227645
4	10	0.602059991	1	0.60206	0.362476
5	13	0.698970004	1.113943	0.778613	0.488559
6	6	0.77815125	0.778151	0.605519	0.605519
8	3	0.903089987	0.477121	0.430883	0.815572
9	1	0.954242509	0	0	0.910579
22	1	1.342422681	0	0	1.802099
	617	6.057088	9.289105	3.632888	5.303067

$$\frac{N\sum XY - \Sigma X \Sigma Y}{N\Sigma X^2 - (\Sigma X)^2}$$

$$\frac{9*3.632888 - 6.057088*9.289105}{9*5.303067 - (6.057088)^2}$$

n= -2.14

(b) Calculation of value 'c'

Table 4

X	x^{α}	$\frac{1}{x^{\alpha}}$
1	1	1
2	0.226879789	4.407620464
3	0.095270954	10.49637855
4	0.051474439	19.42711815
5	0.031930388	31.31812905
6	0.021615054	46.26405289
8	0.01167851	85.62736351
9	0.009076555	110.1739627
22	0.001340341	746.0785206
		1054.793146

$$C = \frac{1}{1054.793146}$$

=0.0009

Table 5 KS Test of goodness of fit

x	Y	FOF	CFOF	FEF =c/x^α	CFEF	DOECF
1	488	0.790923825	0.79092382	0.000948053	0.000948053	0.789975772
2	71	0.115072934	0.90599676	0.004178659	0.005126712	**0.900870047**
3	24	0.038897893	0.15397083	0.009951125	0.015077837	0.13889299
4	10	0.016207455	0.05510535	0.018417941	0.033495778	0.02160957
5	13	0.021069692	0.03727715	0.029691252	0.06318703	-0.025909883
6	6	0.009724473	0.03079417	36.59134167	36.6545287	-36.62373454
8	3	0.004862237	0.01458671	9.853391911	46.50792061	-46.4933339
9	1	0.001620746	0.00648298	4.285535015	50.79345563	-50.78697265
22	1	0.001620746	0.00324149	12.09203437	62.88549	-62.88224851
	617					

The above Table**,** the difference between the cumulative values of the observed and the expected number of authors are shown in column 7 of the Table 5. D-max is the highest value on column 7, which is 0.90

The critical value:

$$1.63 \Big/ \sqrt{\Sigma y + \sqrt{\Sigma y/10}}$$

$$1.63 \Big/ \sqrt{624.8549}$$

$$CV = 0.07$$

From the foregoing calculations, it is clearly seen that CV (0.07) is less than D-max (0.90), it follows therefore, that using Least squared (LS) method, Lotka's law does not apply to GBV scientific distribution.

Application of Sen's method

Sen (2010), wrote a short communication in Annals of Library and Information studies; he demonstrated how parameter values of c and α could be determined with less tabular columns compared to Pao's Least Squared Method (LSM). Sen's method is thus represented

$$x^{á} y = c \qquad \text{[Eqn. 1]}$$

Y is the number of authors credited with X (1, 2, 3, 4, 5, 6, 8, 9……) papers C is the number of authors contributing one paper. From the above equation

X=1; Y=488

1^{α}*488=C

To determine the value of α apply the data of the second row

2^{α}*71=488

Divide both sides by 71

$\frac{2^{\alpha}*71}{71} = \frac{488}{71}$

$2^{\alpha} = \frac{488}{71}$

2^{α}=6.87

Take the log of both sides

α*log2 = log 6.87

α*.3010 = 0.837

$\alpha = \frac{0.837}{.3010}$

α= 2.78

Given the values of exponential α =2.78 and c= 488, we calculate the number of the expected authors with these values.

E.g. Authors contributing 2 papers: $Y = \frac{488}{2\text{^}2.78}$

$= \frac{488}{6.87}$

= 71.03

Table 6: Verification of Lotka's law using Pao's LM & Sen's methods

Papers (x)	No of authors (y) Observed	% of Observed Authors	**Pao's Least squared Method**		**Sen's Method**	
			Expected Authors with α -2.14	% of Expected Authors	Expected Authors with α 2.78	% of Expected Authors
1	488	79.09	488	0.09	488	80.79
2	71	11.51	2, 151	0.42	71 .05	11.76
3	24	3.89	5, 122	1	23.02	3.8
4	10	1.62	9, 480	1.84	10	1.66
5	13	2.11	15, 283	2.97	6	0.99
6	6	0.97	22, 576	4.39	3 .35	0.55
8	3	0.49	41, 786	8.12	1.5	0.25
9	1	0.16	53, 765	10.44	1.09	0.18
22	1	0.16	36, 4086	70.73	0.09	0.02
Total	**617**	**100**	**51, 4737**	**100**	**604.1**	**100**

Pao's least squared method has α=-2.14, c= 0.009 with K-S fitness value of D-Max 0.09, higher than CV 0.07. **Sen's method calculated values α=2.78, c=** 488 close to Lotka's theoretical law.

Table 7: Result of the T-test analysis

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
NoAuthors	Equal variances assumed	.000	.991	.019	16	.985	1.43333	75.00868	-157.57795	160.44462
	Equal variances not assumed			.019	16.000	.985	1.43333	75.00868	-157.57814	160.44481

Source: Research data

To further ascertain the credibility of the Sen's method, a Two-tailed analysis was carried out on the data set. Table 7 above confirmed that there is no statistical significant difference between the observed number of GBV authors and the expected number of GBV authors in South Africa. Thus the above mentioned results signifies that, if Sen's method is used, scientific productivity of GBV literature conforms to Lotka's Inverse Square Law with the exponent á=2.78 and C= 488 respectively.

Discussions and Conclusions

This study explores the productivity of researchers in the field of GBV, with a view to using Pao's Least Squared (LS) and Sen's methods along with KS and T-test analysis as goodness -of -fit tests to verify the application of Lotka's law of scientific productivity. The study harvested 300 publications on GBV from EBSCO Discovery Service (EDS) published between 2009 and 2018 in South Africa. Pao's least squared method and Sen's method were used to determine the validity of Lotka's law on GBV literature.

Table 1 above shows a discontinuous trend of GBV research publications with an average of 10 publications per year and 2.5 publications per month over the ten years' period. 2009 and 2010 witnessed neither increase nor decrease in the GBV publication output; same scenario played out in 2015 and 2016 respectively. However, it can be deduced that GBV attracted much attention in 2014, 2015 and 2016 as publications for the three successive years summed up to 34.3% of the total publications though the momentum was lost in the subsequent years. These publications increased turn over may be connected to the growing outcry against GBV across the world which could have prompted scientific enquiries. For instance, WHO (2013) stunning findings that one out of every three women had experienced violence in her life time could have aroused further research. This multi-country study on global and regional estimates of violence against women was really an eye opener on the magnitude of gender-based violence against womenAll the 617 authors were assigned full authorship of the 300 GBV publication using full-count method. That is, each author was giving full credit per publication. A look at 300 GBV publications vis-à-vis 617 authors gives an average of less than 1 (0.5) publication per author. This is a clear indication of the dearth of research on GBV for a nation that is plagued by Gender-based violence.

About 488 authors (79.09%) contributed one article each, a larger percentage of authors contributed one article. A single author contributed 22-the largest number of articles per author in this study. The second highest was 9 articles by one author and the third highest was 8 articles each contributed by three authors. In all, these 5 (0.81%) researchers contributed 18% of the total publications and 11 publications on the average.

Furthermore, the results show that **Pao's least squared method** has α=**-2.14, c= 0.009.** Application of Goodness-of-fit test by Kolmogorov-Sminov (K-S) to ascertain the fitness of Lotka's law further showed that value of D-Max 0.09 was higher than CV 0.07. Therefore, Kolmogorov-Sminov (K-S) does not fit the theoretical distribution of Lotka's law. However, **Sen's method calculated values on the other hand, has α=2.78, c=** 488 respectively were very close to the Lotka's theoretical law.

The use of Sen's method on GBV scientific output adheres to Lotkas's law of productivity distribution both in generalized form and in inverse square law using "full productivity" of authorship. When the data set was further subjected to Two-tailed test with 16 Degree of freedom (df), the result for equality of means (p=0.985) still, reveals that there is no statistical significant difference between the observed and the expected number of authors. Furthermore, this result concurs with a number of studies whose findings correlate positively with Lotka's law of scientific productivity. For instance, Roy (2019), replicated Sen's method with a two-tailed goodness-of-fit tests on the contributions of Indian researchers in the field of Biological Science over a period of 45 years. He discovered that the Biological science literature followed Lotka's law of scientific productivity with C and α parameters values of 714 and 1.884 respectively.
Likewise, in the field of Dentistry, Batcha (2018), showed that the authorship frequency distribution follows Lotka's Inverse Law accurately with the exponent á=2, and further discovered that with K-S test of goodness, parameters α and C 2.49 and 0.7433 for dentistry literature, Lotka's law fits global dentistry research output

Recommendation

This study found low productivity in GBV research arising from the fact that average number of GBV publication per author is less than 1; moreover, an average of 30 GBV research journal articles per annum over a ten-year window, is an indication of dearth of GBV research in South Africa. Therefore, the government of South Africa needs to provide incentives that would drive GBV scientific investigations to boost researchers' interest in GBV subject domain. In addition, South Africa Government should commission specialized institutes to undertake research on GBV; which would solve the menace of GBV in the country.

This study admits its limitations on the scope of GBV research publications in South Africa, in that, only EBSCO Discovery Service (EDS) Database was searched. Thus other Databases could have housed more GBV publications than were found in EDS. Therefore, it is recommended that Lotka's law be tested on GBV publications from South Africa through other databases.

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