

# Can informetrics shape biomedical research? A case study of the HIV/AIDS research in sub-Saharan Africa<sup>1</sup>

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## Abstract

*Biomedical research is burgeoning as new dangerous diseases and healing methods emerge. Informetrics defined as methods or a research field that uses mathematical and statistical techniques and/or models to examine patterns that show up not only in publications but also in many aspects of life, as long as the patterns deal with information, are widely applied in the evaluation of research performance, among others. Informetrics measures can be divided into descriptive and evaluative measures, commonly referred to as production (publications) count and citation analysis respectively. Whereas the former has continued to gain popularity in sub-Saharan Africa, especially with regard to the assessment of research output of researchers, the latter is rarely applied.*

*The paper focuses on the research evaluation, methods of research evaluation, and the pros and cons of using informetrics techniques to evaluate research performance. Further, the paper addresses the application of informetrics to examine whether or not informetrics can be used to shape biomedical research, with special reference to HIV/AIDS research in sub-Saharan Africa. In that regard, the paper reports on an informetrics perspective of the relatedness of opportunistic diseases and other factors (i.e. risk factors, pre-disposing factors, other sexually transmitted diseases, and the other tropical diseases) to:*

- *Demonstrate the use of informetrics techniques in assessing the relatedness of a disease to the pathogens that are associated with it.*
- *Reveal that informetrics can be used to support and/or inform medical opinions regarding the relationship/influence of certain factors/diseases with/on a given disease, e.g. HIV/AIDS.*

*This paper concludes that the application of informetrics, using various techniques or methodologies associated with it, to shape research in different fields/disciplines, is feasible.*

**Keywords:** HIV/AIDS, Informetrics, Bibliometrics, Research evaluation

## Introduction

The role that research plays in economic and societal development cannot be overemphasised. There is an enormous amount of literature that has been published on the role or importance of research (e.g. Rantanen 1999). Research is increasingly seen as a solution to most socio-economic and political problems humanity faces. It is therefore not surprising to see research being conducted in all disciplines including arts and humanities, social sciences, natural sciences, pure or formal sciences and applied sciences. According to Rantanen (1999: 473), the role of research in society is (i) to increase our knowledge of nature and society, (ii) to increase our understanding of these three components of life, and (iii) to provide a scientific basis for actions to make a better world through the prevention and control of adverse trends (e.g. global warming, technology hazards, poverty, emerging new and old diseases) through amplifying and facilitating positive developments (e.g. new methods for agricultural and food production, clean technologies, ensuring decent work for all, and the promotion of economic and societal development in the least developed countries).

It is widely acknowledged that research is a cyclical process. It begins with the identification of a research problem or need and culminates (or so, it is thought) in the dissemination or reporting of the findings. The reporting can take the form of publishing the findings as journal articles, full length refereed conference papers, authored books and chapters in books that are research-based, awarded patents, software, design artefacts, materials, devices, and multimedia and video research outputs (National Research Foundation [NRF] 2012). According to the National Research Foundation of South Africa (NRF 2012), the recognition of a particular item as a research output differs from one discipline to another. For instance, the Foundation states that "it is admissible to list technical reports as "additional research outputs" inasmuch as such reports are based on contract research" (NRF 2012: 3). That notwithstanding, an analysis of the research cycle models reveals that most research activities are seen as complete once the findings have been published, despite the research process being considered cyclic. One aspect that is missing in most of the models is the evaluation or assessment

1. This article is based on this authors inaugural lecture for promotion to professor at UNISA, on the various informetrics studies that have been conducted by the writer over a period of time on HIV/AIDS research.

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of the 'completed research'. This step in the research cycle is being driven by the increasing demand for accountability, especially in circumstances wherein the research was funded using public funds. Governments and other institutions (such as universities, research councils, funding organizations, etc) around the world are facing increased demand of accountability of their investments made into research using public funds (Cox, Cozzens, van Ark, McAuley & Borbey 2010). The increasing demand for research evaluation can be attributed to an increased emphasis on governance and accountability in both the public and private sectors. Guthrie, Wamae, Diepeveen, Wooding & Grant (2013) summarize the justification for research evaluation by outlining the following broad purposes:

- **Analysis:** for example, what funding is most effective in terms of different outputs and outcomes, including the impact of research?
- **Accountability:** for example, for those distributing public funds who need to show they are doing the right thing. Likewise, funding organisations need to demonstrate impact to donors.
- **Advocacy:** for example, how the research benefits society; this would help funders wanting evidence to support their decisions, or advocates seeking evidence for their cause.
- **Allocation:** for example, to prioritise which projects, people and institutions are given funding.

As a result of this increased demand for research evaluation and contrary to the widely held view that research is complete upon its publication, we believe that research is not really complete until its impact has been assessed. We use the term impact to cover a broad spectrum of terms such as research relevance, cost-effective analysis of research investments, research influence, worthiness of research findings, and so on. It is at this stage of the 'research cycle' that, we believe, **informetrics** comes into play.

### What is informetrics?

Diodato (1994:ix) defines informetrics as methodologies that examine “*patterns that show up not only in publications but also in many aspects of life, as long as the patterns deal with information*”. According to Egghe & Rousseau (1990:1), informetrics deals with the measurement, mathematical theory and modeling of all aspects of information. The authors argue that informetrics largely “*borrow tools (techniques, models, analogues) from mathematics, physics, computer science and other metrics*”. Informetrics is used and/or applied across many disciplines, which include library management, the sociology of science, history of science, information retrieval, and biometrics, econometrics, chemometrics, sociometrics, and quantitative linguistics. Its popularity is reflected in several studies that have recently proliferated, and the formation of the International Society for Scientometrics and Informetrics (ISSI), in addition to the publication of specialized journals in the subject domain (e.g. Journal of Cybermetrics – the online journal of Scientometrics and Informetrics; Journal of Informetrics; and Scientometrics). Although informetrics is sometimes used interchangeably with bibliometrics and scientometrics, the three terms have similarities as well as differences. The relationship between the three terms, including the more recent related metrics, namely cybermetrics and webometrics, is provided in Figure 1.

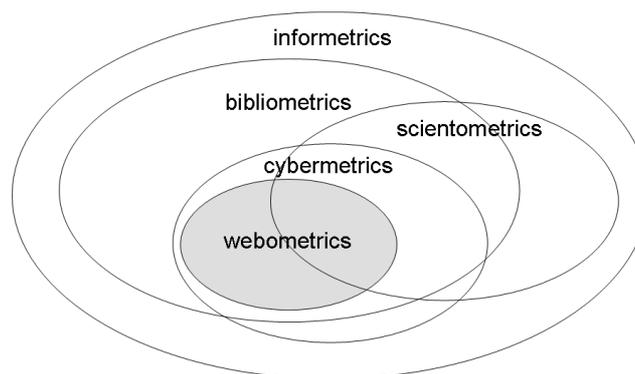


Fig 1: The overlaps between Informetrics, bibliometrics, scientometrics, cybermetrics and Webometrics (Björneborn & Ingwersen 2004).

Figure 1 presents an illustration indicating the overlaps between informetrics, bibliometrics, scientometrics, cybermetrics and webometrics. We have modified Fig 1, which was originally proposed by Björneborn & Ingwersen (2004) to include the most recent of the metrics (i.e. Altmetrics) in Fig 2. The following can be deduced from the illustrations:

- That all webometric and altmetrics studies are cybermetric, bibliometric and informetrics in nature and some of the webometric and altmetrics studies are scientometric studies;
- Some cybermetric studies use bibliometric and scientometric approaches while they utilize all informetrics

methodologies;

- Scientometrics studies are partly bibliometric and vice-versa, and all bibliometric and scientometric studies are informetric in nature;
- Finally, and most importantly, informetric studies can be webometric, altmetric, cybermetric, scientometric or bibliometric in nature. That is, informetrics is a general term that covers webometrics, altmetrics cybermetrics, bibliometrics, and scientometrics.

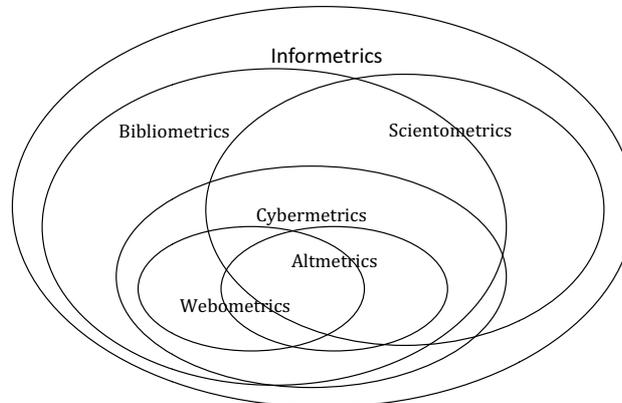


Fig 2: The overlaps between Informetrics, bibliometrics, scientometrics, cybermetrics Webometrics, and Altmetrics

Indeed, Björneborn & Ingwersen (2004) concur with Brookes in Wolfram (2000) that both bibliometrics and scientometrics are part of informetrics. Likewise, Egghe (2005) uses the term informetrics as a broad term consisting of all metrics studies related to information science, including bibliometrics (bibliographies, libraries, etc.), scientometrics (science policy, citation analysis, research evaluation, etc.), and webometrics (metrics of the web, the Internet or other social networks such as citation or collaboration networks). The most recently introduced informetrics-related concept of altmetrics (see Haustein *et al.* 2013 and Piwowar 2013;) is seen as an alternative means of measuring scholarly impact (Priem 2010; Priem *et al.* 2010). This metrics has emerged to gain popularity among the evaluators of research performance due to the shortcomings associated with the traditional methods of research evaluation such as peer-review, citation analysis and journal impact factor analysis (Priem *et al.* 2010). Altmetrics is concerned with the measurement of the impact of a paper (although it can be applied on other units of analysis, e.g. people, journals, books, data sets, presentations, videos, source code repositories, web pages, etc.) through the counting of not only citations, how many data and knowledge bases refer to it, article views, downloads, or mentions in the social media such as Twitter, Facebook, Blogs, etc. and news media (McFedries 2012; Galligan & Dyas-Correia, 2013). Broadly, the metrics that may comprise altmetrics can be categorized as follows (see ImpactStory Blog 2012; Lin & Fenner 2013):

- Viewed – HTML views and PDF downloads
- Discussed – journal comments, science blogs, Wikipedia, Twitter, Facebook and other social media
- Saved – Mendeley, CiteULike and other social bookmarks
- Cited – citations in the scholarly literature, tracked by Web of Science, Scopus, CrossRef and others
- Recommended – for example used by F1000Prime.

### How does published research offer grounds for informetrics studies?

The use of bibliometrics/informetrics as proxy for the measurement of research volume and quality is based on the following central assumptions:

- Scholars who have to say something important do publish their findings
- Scholars refer, in their own work, earlier works of other scholars to acknowledge intellectual debt and to witness the use of information.

Simply put, “bibliometric [or informetrics] assessments are based on the assumption that most scientific discoveries and research results eventually are published in international scientific journals where they can be read and cited by other researchers” (Karolinska Institute 2008: 2). Hence, the assessment of research volume and quality uses certain elements in the published literature.

As Stefaniak (1987: 150) states, “there are various searchable elements that describe the bibliographic characteristics of the items included in data bases.” She further explains that some of these elements are “subject oriented such as

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classification codes, descriptors, key words, words in the title, while other features point out the type of publication (e.g. journal paper, conference paper, book, patent, report), source (e.g. journal title, country of its editor, CODEN, ISSN number, patent number, and year of publication, volume, number of issue, pages), language of publication, name and corporate affiliation of the authors (name of organization, city, country), as well as data on secondary source (year, volume and number of the abstract (Stefaniak 1987: 151)”. Some of these items or elements reflect certain elements of research. The table below provides a reflection of each of the bibliographic data or elements in research and the purpose to which the elements can be put in informetrics analysis.

Bibliographic element	Equivalent elements in research	Informetrics application or measurement
Author	Researcher	Research productivity and impact per individual researchers
Author's institutional affiliation	Researcher's institutional affiliation	Research productivity and impact per institution
Author's country of origin	Researcher's country of affiliation	Research productivity and impact per country or geographic region
Journal name	Journal in which research was published	Impact factor of journals (to measure prestige, popularity, influence, quality etc)
Title of document	Topic of research	Analysis of subject focus of the research using title words
Keywords	Topic of research	Analysis of subject focus of the research using title words
Indexing subject terms	Topic of research	Analysis of subject/discipline focus of the research using title words
Year of publication	Year when research was published	Trend (i.e. growth) of research per individual researcher, institution or country
Language of publication	Language in which research is disseminated	Language in which research is disseminated/communicated
Patent number	Patented research	Research productivity and impact per individual researcher, institution or country
Citations	Use of research	Influence, relevance, importance, impact or quality of research

It should be noted, however, that the table is not exhaustive, as various scholars are still investigating other elements that can be used in informetrics to reflect certain aspects of research performance. The provision of relevant informetrics data differs from one database to another. While some of the databases provide data that can be used for descriptive informetrics (e.g. EBSCOHost databases), others such as Scopus and Thomson Reuters citation indexes specialise in the provision of data that can be used for evaluative informetrics studies.

### Informetrics measures of research

Informetric measures can be divided into descriptive and evaluative (or behavioural) measures, commonly referred to as production (publications) count and citation analysis respectively. As mentioned in Section 2 above, a third metric known as altmetrics has emerged to complement the two methods, which are mostly applied in informetrics. We will deal with publications count and citations analysis in this paper as time and space will not allow us to delve into altmetrics.

#### Publications count

Publications count is used to study publication or research output in different countries, the amount produced during different periods, or the amount produced in different subdivisions of the field (Hertzal 1987; Sengupta 1992). Nicholas & Ritchie (1978) observe that studies using publications count normally describe the characteristics or features of the literature. A study conducted on 4,000 researchers to identify appropriate bibliometric indicators for research performance measurement in their disciplines found that publications (i.e. publication of research results in refereed journals) ranked as the most important performance indicator (Kostoff, 2001). Other performance indicators, according to the same study, include peer reviewed books, keynote addresses, conference proceedings, citation impact, chapters in books, and competitive grants.

Examples of questions that publications count is designed to answer are:

1. How many publications, citations, books, patents, etc. has a particular author, group of authors, institutions and/or countries/geographic regions, produced?
2. How much has been produced on a given topical issue, discipline, country, regional area, etc.?
3. How many publications have each been authored by how many authors?

4. How many publications were published in a given source (journal, magazine, etc?)
5. In how many languages are documents published?
6. How often does a particular word appear in a text?

Results from such analyses may then be used to measure and compare research productivity and collaboration among authors, institutions, journals, and countries/regional areas, to name a few. Although commonly applied in assessing research output, publications count should be used cautiously, particularly when used as a proxy of research productivity because of the limitations associated with it. Objections have been raised in the following areas as outlined in King (1987:262) and Kostoff (2001 Section IV-B-5-ii, para. 1):

1. Publications count does not provide any indication as to the quality of the work performed.
2. Informal and formal non-journal methods of communication in science are ignored.
3. Publication practices vary across fields and between journals.
4. Social and political pressures on a group to publish vary according to country, to the publication practices of the employing institution, and to the emphasis placed on number of publications for obtaining tenure, promotion, grants, etc.
5. The choice of the right database is problematic and therefore makes it very difficult to retrieve all the papers for a particular field.
6. An awareness of the use of publications count for assessment may encourage undesirable publishing practices such as the production of very brief papers.
7. Very few active researchers produce heavily cited papers.
8. Biases favoring publications of established authors.

Despite all these shortcomings, publications count still remains a valuable tool for information and other social scientists interested in measuring research productivity. A few, if not all, of the aforementioned drawbacks in the use of publications count could, however, be resolved if the method was used together with citation analysis.

#### Citation analysis

Citation analysis is one of the research areas of bibliometrics. A citation is defined as an “acknowledgement that one document receives from another” (Smith 1981:83). Citation analysis involves counting the number of citations of a particular paper for a period of years after its publication (Hertzal 1987). Citation-based indicators include the citation age, citation factor, cited half life, citing half life, citation behaviour, biased citation, citation type, consumption factor, citation rate, citation density, citation impact, citation frequency, and citation function, etc. while citation-based measurement techniques include co-citation analysis, and bibliographic coupling. Citation-based studies may focus not only on the documents, but also the authors, sources in which the documents are contained (i.e. journals, books, magazines, databases, web pages, etc.), the organizations or countries in which the documents are produced, and the purpose of the citations (Diodato 1994:33). In specific terms, Wallace (1989:18) demonstrates that the focus areas of citation studies would include:

- what motivates an author to cite a particular work;
- the relationship between a citing work and the works cited by it;
- works cited long after their publication and works cited while relatively new;
- heavily cited works, infrequently cited works and those that have not been cited at all;
- how citation practices and patterns differ throughout disciplines or families of disciplines;
- how citation practices and patterns can be used in the evaluation of information sources;
- how citation practices and patterns can be used to enhance information retrieval systems.

He further enumerates the fundamental assumptions associated with citation studies, namely:

- That the citing author has actually used the cited work and has cited all works used;
- That the citation of an information source is an indicator of its quality;
- That the citing author has provided references to the best possible works;
- That the content of the citing work is significantly related to the content of the cited works; and
- That all citations are of equal value (Wallace 1989:18).

It is in these assumptions that many have found fault with citation analysis. Above all, these assumptions are not universally true, although they may be true under given circumstances (Wallace 1989). Secondly, there are several factors that motivate authors to cite others, some of which include the following:

- a desire to give the appearance of being in touch with the most recent literature;
- the need to provide support for a methodology or tool;
- attempts to persuade the reader of the correctness and importance of the ideas presented in the study;
- providing appropriate credit for the origins of ideas;

- alerting the reader to important publications;
- establishing evidence of a consensus of opinion amongst researchers; and
- refuting the claims of other researchers (Wallace 1989:18-19; King 1987).

While agreeing with Wallace(1989), Cronin (in King1987:96) outlines 10 different reasons for citing, which include 'hat-tipping', over-elaborate reporting, and citing the most popular research trends in order to curry favour with editors, or grant-awarding bodies, etc." (King 1987:263). Turnbull (2000) and Garfield (in Smith 1981:84) provide a fairly comprehensive list of reasons why authors cite others, e.g. paying homage to pioneers; giving credit for related work; identifying methodology, equipment, etc; background reading; correcting one's own work; correcting the work of others; criticizing previous work; substantiating claims; alerting others to forthcoming work; providing leads to poorly disseminated, poorly indexed, or un-cited work; authenticating data and classes of fact-physical constants, etc; identifying original publications in which an idea or concept was discussed; identifying an original publication or other work describing an eponymic concept or term; disclaiming the work or ideas of others; and disputing the priority claims of others. King (1987) observes that a work that is incorrect tends to be highly cited; methodological papers similarly attract numerous citations; and self citations, more often than not, inflate citation rates. Other limitations of citation analysis include those associated with the databases used to collect data, and field-dependant factors.

These drawbacks notwithstanding, Cronin (in King, 1987) considers citation analysis to be a useful analytic tool given that citations give substantive expression to the process of innovation, and, if properly marshaled, potentially provide the researcher with a forensic tool of seductive power and versatility. Wallace (1989:19) also observes that the "notion that citation represents a rather constant indication of the relationship between one information source and another lies at the heart of most citation studies, and plays a key role in the practical application of citation analysis". Nevertheless, even with its wide application in evaluative studies, Wallace (1989) advises that citation analysis should be treated with caution. His argument first lies in the fact that an author's contribution to a field is likely to be misjudged given that it is not easy to obtain all his/her publications. Secondly, citation counts represent only citations from journals covered in citation indexes. Furthermore, errors may accrue from assigning individual authors' citation counts, given that citation indexes provide only the author's last name and initials, and are subject to virtually no authority control. Finally, Wallace warns that "the uneducated use of citation counts for evaluative purposes of any kind can have disastrous results, and a very real problem of citation analysis is application of results by individuals who are not capable of effectively interpreting them" (Wallace 1989:19).

### **Theoretical basis of informetrics**

The theoretical basis of informetrics rests on three empirical laws and models of bibliometrics. Ikpaahindi (1985:169) defines informetric laws as "statistical expressions, which seek to describe the working of science by mathematical means". According to Diodato (1994:99), informetric laws are "descriptions or hypotheses about patterns that seem to be common in the publication and use of information". These laws of informetrics include Booth's, Bradford's, Brooke's, Estroup's, Leimkuhler's, Lotka's, Pareto's, Price's, Willis', and Zipf's laws. Of all these laws, only three have been extensively used in bibliometric/informetrics studies (particularly as they relate to LIS), notably Bradford's law of scattering, Lotka's inverse square law of author productivity, and Zipf's law of word frequency in a text.

#### **Bradford's Law**

Samuel C. Bradford (1878-1948) is well known for his empirical study on the scatter of relevant articles within a subject domain in source publications. He started off by noticing that indexers and abstracters could miss up to 67% of published journal articles each year, leading to engineers and scientists missing highly important information. In the words of Kellerman (1997:8), Bradford was concerned that "scientists and engineers were missing important information because the abstracting and indexing services could not include every journal that might have articles of possible relevance". He attributed this anomaly to the manner in which literature on a given subject field is distributed among the periodicals.

In his study, conducted in 1934 on geophysics, Bradford analyzed 326 journals and discovered that 9 journals contained 429 articles, 59 contained 499 articles, and 258 contained 404 articles. Upon ranking the journals according to the number of records, Bradford noticed that it took 9 journals to contribute one-third of the articles, 45 to produce the next third, and 225 to produce the final third. He concluded that journals in any given field could be divided into three zones, each containing the same number of articles, as follows:

*Zone one:* a core of journals on the subject, relatively few in number, that produce approximately one-third of all the articles

*Zone two:* containing the same number of articles as the first, but a greater number of journals, and

*Zone three:* containing the same number of articles as the second, but a still greater number of journals (Palmquist 2001).

Bradford's law simply states that:

If scientific journals are arranged in order of decreasing productivity of articles on a given subject, they may be divided into a nucleus of periodicals more particularly devoted to the subject and several groups or zones containing the same number of articles as the nucleus, when the number of periodicals in the nucleus and succeeding zones will be as 1: k: k<sup>2</sup> where the constant k is known as Bradford's constant or multiplier (Ungern-Sternberg 2000).

#### Lotka's Law of author productivity

In 1926, Alfred J. Lotka (1880-1949), an insurance company statistician (Ikpaahindi 1985), and a man who has since been credited with founding the mathematical pattern known as Lotka's law (Lotka's inverse square law), studied author productivity in Chemistry And Physics and noted that "there are a few researchers who publish a great deal and many who publish very little or nothing at all" (Ikpaahindi 1985:171). Lotka observed that:

for any body of literature, there will be a substantial number of authors who have each contributed only one publication, a smaller number of authors who have each contributed a small number of publications, and a very small group of authors who have each contributed a substantial number of publications (Wallace 1989:10).

The mathematical expression states that in any given field the proportion of authors making a contribution of one article or publication each out of the total number of publications is 60% (0.60) (Rao 1983; Ikpaahindi 1985). Ikpaahindi (1985:171) expresses the formula thus: "the productivity of scientists adhered to an inverse square law such that for every 100 authors contributing one article, 25 will contribute two articles, about 11 will contribute 3 articles and 6 will contribute 4 articles". Therefore, as Diodato (1994:105) explains, "there is an inverse relation between the number of documents produced and the number of authors producing the documents."

#### Zipf's Law

Zipf's Law is the least used of the three empirical laws of informetrics. Named after the philologist George Kingsley (1902-1950), the law is based on the fact that people tend to use a "small part of their available vocabulary for most communication" (Wallace 1989). The law relies on the occurrence of words in a long text. According to Diodato (1994), Zipf's law is expressed in two ways. Zipf's first law concerns words of high frequency, while Zipf's second law holds for words with low frequencies.

In his description of Zipf's law, Potter (as cited in Palmquist 2001, Zipf's Law section, para. 1) explains that if one "lists the words occurring within a text in order of decreasing frequency, the rank r of a word on that list multiplied by its frequency f will equal a constant C". Zipf's law thus "approximates the relationship between rank r and the frequency f for any actual corpus" and works well for the middle ranks whose corpus should consist of at "least 5000 words in order for the product rf to be reasonably constant, even in the middle ranks" (Wyllis 1981:55).

### **Application of informetrics in biomedical research**

Worldwide, informetric studies have been reported in many fields of research, including biomedicine. The evaluation of the results of biomedical research, particularly various epidemic human diseases and other related subjects using publications count and citation analysis, is increasingly taking center stage in informetric research. Informetrics studies have been conducted on subject areas such as onchocerciasis (Afolabi 1989), cardio-vascular diseases (Rodrigues, Fonseca, & Chaimovich 2000; Arunachalam & Gunasekaran 2001) and general biomedicine (Lewison 2001; Lewison, Rippon & de Francisco 2004; Steynberg, & Rossouw 1995; Sodha 1993). Others include cancer (Rodrigues, Fonseca, & Chaimovich 2000), malaria (Rodrigues, Fonseca, & Chaimovich 2000; Beattie, Renshaw & Davis 1999; Lewison, Lipworth, de Francisco n.d.; MacLean, Anderson, & Davis 1997; Anderson, MacLean & Davis 1996), alternative medicine (Yitzhaki & Shahar 2000), diabetes (Krishnamoorthy & Ramakrishnan 2009), tuberculosis (Ramos, Padilla & Masia 2008), to name only a few.

A quick search through the Google Scholar for HIV/AIDS AND bibliometrics OR informetrics yielded a total of 948 results that reflected the number of bibliometrics/informetrics studies that have been conducted on HIV/AIDS research. The majority of these studies are descriptive in nature, i.e. they have applied publications count to describe the literature of HIV/AIDS. This author has conducted a total of 11 bibliometric/informetrics studies on HIV/AIDS research, either singly or in collaboration with other researchers. The following is a summary of each of the studies to elucidate the application of informetrics in biomedical research and more so in HIV/AIDS research.

#### (a). A comparative study of the literature on HIV/AIDS in Kenya and Uganda: a bibliometric study

Using the publications count method, this study examined and compared the trends of HIV/AIDS literature for Kenya and Uganda and specifically sought to explore the following questions: What is the overall performance in HIV/AIDS research on Uganda and Kenya? What is the nature of those publications? What are the nature of and trends in collaboration?

Which institutions/organizations are behind HIV/AIDS research on Uganda and Kenya? And, which is the predominant source of information on HIV/AIDS in Kenya and Uganda?

The study concluded that although Uganda has, for a long time, been unstable politically from the persistent conflicts – a situation that could have hindered effective research – research activities regarding HIV/AIDS were focused in the country more than they were in Kenya. One would have expected more HIV/AIDS research in Kenya, throughout the entire period of study, considering Kenya's continued increase in HIV infections besides the country's favourable research environment. The government of Kenya and other stakeholders involved in the formulation of policies on research in HIV/AIDS should vigorously campaign for more research funds and other resources that have made Uganda's case a success. Collaborative links with foreign researchers should also be strengthened.

(b). Empowering the South African community in the AIDS war: an informetric-case study of HIV/AIDS research projects, with special reference to masters and doctoral dissertations and theses

The purpose of this study was to generally assess the role that is being played by various institutions of higher learning in South Africa in graduate preparedness as a means of empowering the country's HIV/AIDS intervention workforce. Using publication count, the study analysed research publications indexed in SABINET's Current and Completed Research and the Union Catalog of Theses and Dissertations databases. The study found that the number of research projects had continued to increase over time; universities were the most active; projects conducted towards masters qualifications were in the majority, reflecting the level of focus in terms of training; publications outputs included other formats such as reports, journal articles, conference papers, books and book chapters, databases and computer software.

(c). Country-wise collaborations in HIV/AIDS research in Kenya and South Africa

This study used co-word and factor analyses to identify and measure country collaborations between Kenya and South Africa and their respective country collaborators. Using the widely accepted indicator of research collaboration, i.e. the coauthorship of papers, the study used three measurement indicators, namely, the Eigenvectors/scores, the collaboration coefficients (CC) and the strengths (**S**) of term association to identify key collaborators and evaluate their degree and strengths of collaboration over time. The influence of research collaboration on research impact in Kenya and South Africa was also explored. Results indicated that the two countries largely collaborated with foreign countries, with the USA emerging as the strongest collaborator. Kenya exhibited stronger links with foreign countries while South Africa had much of its papers published through internal collaborations. There have been shifts in research partnerships in the two countries. From the standpoint of impact, Kenya's papers produced a higher average impact than South Africa's papers. Co-authored papers yielded a higher average impact than single-authored papers, thereby providing a strong argument for encouraging research collaboration not only within the countries but internationally.

(d). Productivity, and scientific impact of sources of HIV/AIDS research in eastern and southern Africa, 1980-2005

As channels of communicating HIV/AIDS research information, serial publications and particularly journals are increasingly used in response to the pandemic. The last few decades have witnessed a proliferation of sources of HIV/AIDS-related information, bringing many challenges to collection-development librarians as well as to researchers. This study uses an informetrics approach to examine the growth, productivity and scientific impact of these sources, and especially to measure performance in the publication and dissemination of HIV/AIDS research about or from eastern or southern Africa. The study concluded that the coverage of HIV/AIDS sources published in Africa in the MEDLINE and ISI databases is minimal. Whether or not this is attributable to indexing bias on the part of the indexing services, or the poor quality of African sources, could not be derived from the data analysed. However, since the indexing services highly regard those journals with high international impact (see Onyancha & Ocholla 2004; Thomson Scientific 2004; National Institutes of Health 2005), it can be inferred that journals that are published on the African continent do not yet meet the quality standards set by the indexing services. This calls for a reassessment of the journals' editorial policies, among other issues. Most journals that are gaining in popularity are ones that are electronically available; this perhaps explains why some African journals, which are largely available only in print, are not easily internationally visible – thus affecting their impact. To achieve wider circulation, visibility and impact, I recommend that such journals be published online. Thus, we concur with Rosenberg (2002 summary, para. 1) as she advises that in order for African journals to “compete successfully with journals published elsewhere, they need to offer access to full text online.”

(e). Authorship patterns of the literature on HIV/AIDS in eastern and southern Africa: an exposition of the responsible authors, institutions and countries, 1980-2005

This study assessed the HIV/AIDS literature published by and on eastern and southern Africa in order to establish the number of countries engaged in the publication of HIV/AIDS literature; the most productive authors, institutions and

countries; and the countries in which the literature is published. A comparison is made between regional (i.e. African) and foreign (or international) productivity. Among the results was that foreign authorship dominated the scene and that the majority of the publications were published in foreign countries. It was also noted that a large percentage of research findings were published in foreign countries. Although this pattern is healthy as far as international visibility and the impact of HIV/AIDS research conducted in and about Africa is concerned, it nevertheless denies policy and decision makers in Africa free access to the research findings that were specifically meant to improve health standards in their respective countries. In order to allow international visibility and impact, as well as provide free access to the findings, the study highly recommended that authors/researchers be encouraged by way of incentives to present the findings at regionalised conferences, and publish them in both print and electronic conference proceedings while publishing the papers in foreign sources. Another option is to publish their papers through Open Access (OA) platforms.

(f). Changing patterns and trends in author co-authorship networks of HIV/AIDS research in eastern and southern Africa

This study argues that social networks play an important role in the analysis and tracking of relationships between the participating entities (i.e. words, individuals, institutions, and countries, etc.). Social networks are likely to play an even greater role now and in the future than before due to the complex nature of unresolved issues such as HIV/AIDS. The proliferation of local and international conferences has opened new avenues for 'networking', a term that is increasingly becoming common amongst researchers. This study examined collaboration networks amongst HIV/AIDS researchers in eastern and southern Africa, aiming to provide a better understanding of the nature and composition of HIV/AIDS research networks; the changing patterns of the networks; and the geographic regions of study for each network. It was found that a number of collaborative networks have recently emerged, while several others that previously existed have disappeared, or are on the verge of disappearing, from the most active author networks. It would be interesting to investigate the factors that cause or might have caused such patterns. We speculate that this phenomenon could be caused by the completion of a project, which would mean that researchers do not have reason for continued cooperation, unless they register new projects. This includes post-graduate students' projects which are largely conducted jointly with their supervisors. Once the students complete their studies, they are likely to discontinue their research collaboration with their supervisors.

(g). Subject content analysis of the HIV/AIDS research in eastern and southern Africa, 1981-2005

This study used content analysis to assess HIV/AIDS research in eastern and southern Africa as indexed in the MEDLINE database, with a view to assisting in the identification of HIV/AIDS indexing terms which can be used to access HIV/AIDS literature. Results indicate that the number of keywords/terms used to index HIV/AIDS research outputs has grown exponentially, thus providing a number of options for accessing HIV/AIDS research findings. The ranking of main subject headings was initially unstable, especially in the 1980s, but had stabilised by the mid-1990s and thereafter. Concerning the sub-fields of HIV/AIDS, it was noted that most research is conducted on epidemiology, prevention and control, transmission, complications, and drug therapy. Drug therapy and antiretrovirals are rapidly emerging as the main areas of HIV/AIDS research, implying that research has shifted from the causal factors and diagnosis (which were the major areas of concern in the 1990s) to the care of those with HIV.

**Table I** The writer's informetrics studies on HIV/AIDS research

Author/s	Year	Title	Journal	Vol	No.	Pages
...with Ocholla, DN	2004	A Comparative Study of the Literature on HIV/AIDS in Kenya and Uganda: A Bibliometric Study	Library & Information Science Research	26		434-447
...with Ocholla, DN	2005	An Informetric Investigation of the Relatedness of Opportunistic Infections to HIV/AIDS	Information Processing and Management	41		1573-1588
	2006	Empowering the South African community in the AIDS war: an informetric-case study of HIV/AIDS research projects, with special reference to masters and doctoral dissertations and theses	South African Journal of Libraries and Information Science	71	2	56-71
...with Ocholla, DN	2006	HIV/AIDS Research and the youths: an informetric analysis of the literature	South African Journal of Libraries and Information Science	72		85-97
...with Ocholla, DN	2007	Country-wise collaborations in HIV/AIDS research in Kenya and South Africa	LIBRI	57	4	239-254
	2008	Productivity, and Scientific Impact of Sources of HIV/AIDS Research in Eastern and Southern Africa, 1980-2005	African Journal of AIDS Research	7	1	55-70

	2008	Authorship patterns of the literature on HIV/AIDS in Eastern and Southern Africa: an exposition of the responsible authors, institutions and countries, 1980-2005	South African Journal of Libraries and Information Science	74	1	9-22
	2008	Changing patterns and trends in author co-authorship networks of HIV/AIDS research in Eastern and Southern Africa	Mousaion	26	2	59-78
...with Ocholla, DN	2009	Is HIV/AIDS in Africa Distinct? What Can We Learn from an Analysis of the Literature?	Scientometrics	79	2	277-296
	2009	Towards global partnerships in research in Sub-Saharan Africa: an informetric study of the national, regional and international country collaboration in HIV/AIDS literature in eastern and southern Africa	South African Journal of Libraries and Information Science	75	1	84-97
...with Ocholla, DN	2009	Subject content analysis of the HIV/AIDS research in eastern and southern Africa, 1981-2005	Mousaion	28	2	89-109

(h). Is HIV/AIDS in Africa distinct? What can we learn from an analysis of the literature?

This study was of particular interest and is the main focus of this lecture. It sought to answer the question: is HIV/AIDS in Africa distinct? What can we learn from the literature? The study stemmed from South Africa's former president Thabo Mbeki's argument that "it is obvious that whatever lessons we have to, and may draw from, the West about the grave issue of HIV/AIDS, a simple superimposition of Western experience on African reality would be absurd and illogical" (as cited in Cohen 2000). Indeed, it has been observed that not only do the manifestations of the AIDS disease in Africa differ from those in the West but, as Cohen (2000) observes, AIDS-related diseases, and possibly disease progression itself, differ on the continent (i.e from region to region) that is home to about 71% of the global population infected with HIV. In turn, this difference is said to be clinical. Cohen reports that while tuberculosis amongst AIDS patients is rare in the west – especially the USA and Europe – it is the most common disease afflicting HIV-positive people in Africa. He further notes that Kaposi's Sarcoma, a cancer that causes purple skin blotching, commonly afflicts both HIV uninfected and infected persons in Africa, while in industrialised nations the disease is largely restricted to HIV-infected gay men. The same applies to *pneumocysts carinii*, a strain of pneumonia predominant in HIV-infected persons in developed countries. These arguments are based on clinical diagnoses of various diseases in HIV infected persons. Further observations point various factors aggravating the spread of HIV/AIDS in developing countries, hence the argument that the impact of HIV/AIDS in these countries is different from that felt in developed countries.

In view of the above, this study posed the question: what can we learn from an analysis of the published literature on HIV/AIDS? Which of these known diseases/infections and factors are most commonly associated with HIV/AIDS in Africa? Given that scientific research is often mirrored in published literature, is the above description of the uniqueness of HIV/AIDS in Africa reflected in published literature? The study's aim was to establish whether or not HIV/AIDS in Africa is a distinct disease by identifying the opportunistic infections, pre-disposing factors, risk factors, sexually transmitted diseases, and other tropical diseases most commonly associated with HIV/AIDS in Africa as a whole, and eastern and southern Africa in particular.

The study employed a co-word analysis technique to assess the associatedness of HIV/AIDS to various opportunistic infections, pre-disposing factors, risk factors, sexually transmitted diseases, and other tropical diseases most commonly associated with HIV/AIDS in Africa. Co-word analysis is a content analysis technique that "reveals patterns and trends in technical discourse by measuring the association strengths of terms representative of relevant publications or other texts produced in a technical field" (Coulter, Monarch & Konda 1998:1206). The method is meant to identify associations between publication descriptors in order to determine themes and trends in a discipline (Kostoff 2001). Co-word analysis provides a set of terms or descriptors that not only occur together regularly in a text or record, but also [may be used to] measure the regularity with which events occur (Jacobs 2002). Thus, the process "measures the strength of association between two or more documents by the co-occurrence of the same 'words' (phrases, descriptors, classification codes, etc.) in a chosen field".

An analysis of HIV/AIDS and the opportunistic diseases (see also Fig 3) produced patterns that could be said to support arguments that some of the opportunistic infections' associations with HIV/AIDS in Africa are stronger than they could be in industrialised nations or any other geographic region (especially when compared to findings in previously conducted studies (e.g. Cohen 2000). Results revealed that HIV/AIDS was associated with 21 opportunistic infections, led by tuberculosis, followed by pneumonia, mycobacterium avium complex, cancer and kaposi's sarcoma. Fig 3 clearly shows a huge cluster of the diseases/infections that are closely associated with HIV/AIDS, in the middle of the MDS map. This revelation supports claims that tuberculosis is the most common ailment in HIV-infected persons in Africa.

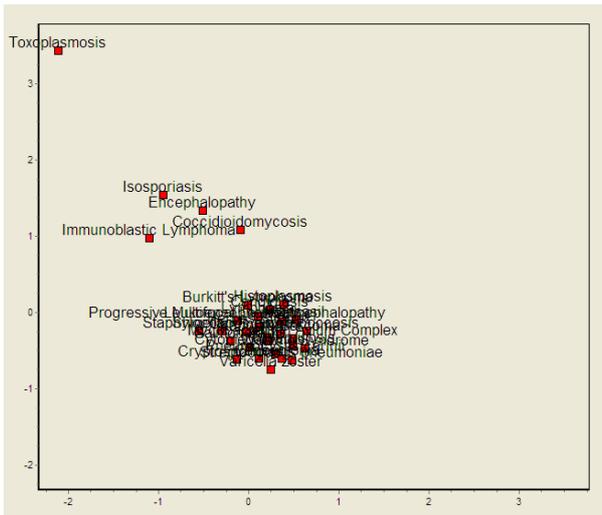


Fig. 3: Non-metric MDS mapping of HIV/AIDS and Opportunistic Infections (stress = 0.028)

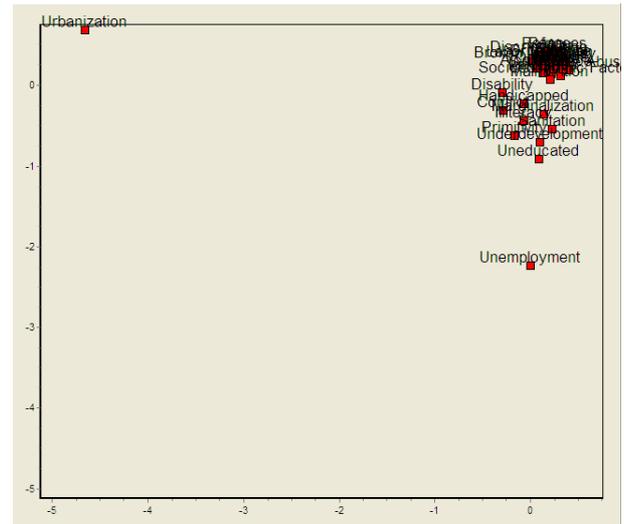


Fig. 4: Non-metric MDS mapping of HIV/AIDS and Pre-Disposing factors (stress = 0.008)

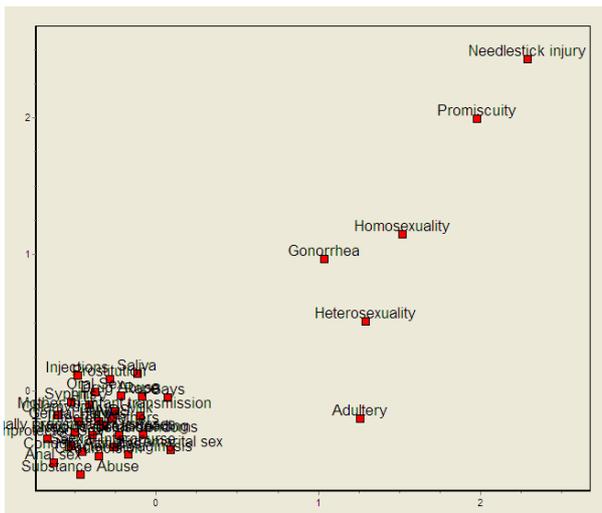


Fig. 5: Non-metric MDS mapping of HIV/AIDS and risk factors (stress = 0.024)

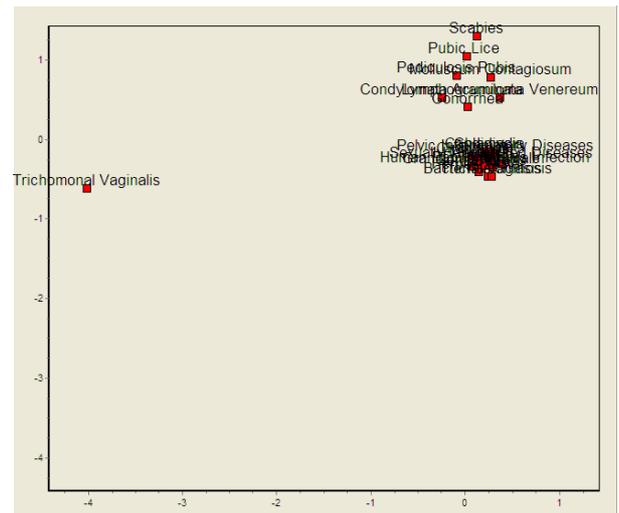


Fig. 6: Non-metric MDS mapping of HIV/AIDS and sexually transmitted diseases/infections (stress = 0.008)

Cohen (2000) states that tuberculosis kills more HIV-infected persons in Africa than any other AIDS-related disease. He further notes that the disease is rare in AIDS patients in the United States and Europe, reporting that one neurologist and pathologist found no TB in all 390 autopsies that were performed on people who had died from AIDS. Other opportunistic infections such as *pneumocystis carinii* pneumonia (PCP) are more common in HIV-infected persons in developed countries. Cohen (2000b) claims that PCP infected more than 80% of the AIDS patients in developed countries in the 1980s, while only 8% of the HIV-infected people autopsied in Africa were found to have had PCP. A few diseases did not have any connection with HIV/AIDS in Africa. These were toxoplasmosis, isosporiasis, encephalopathy, immunoblastic lymphoma, and coccidiodomycosis. Some of the opportunistic infections that were closely associated with HIV/AIDS in this study are missing from the list of the most commonly associated OIs with HIV/AIDS in Onyancha & Ocholla's (2005) study, a pattern that perhaps can be attributable to the international nature of that study. Furthermore, Onyancha & Ocholla (2005) used subject keywords to conduct a co-word analysis of HIV/AIDS records. The dissimilarity between these two studies might probably also support the view that HIV/AIDS differs from one geographic region to another.

Concerning predisposing factors, the findings illustrated some association between several factors and HIV/AIDS in E&S Africa as illustrated in Fig 4. Fig 4 provides two major clusters that are adjacent to each other. The clusters contain closely associated descriptors of HIV/AIDS pre-disposing factors. Their strength of closeness with each other, on the one hand, and HIV/AIDS on the other, is reflected in the density of the clusters. The cluster in the upper right hand corner consists of terms that were closely associated with HIV/AIDS, while the one immediately below it provides terms that did not co-occur with HIV/AIDS. Generally, it was found that the factors that could be influencing the spread of HIV/AIDS in the region include culture, substance or drug abuse, malnutrition, rural-related factors and activities, violence, rape, labour migration, ignorance, broken marriages, war, poverty, inequality, socio-economic factors, refugees and war. Of these, the most influencing factors are rural and drug or substance abuse related, as illustrated by their high frequency and strength of co-occurrence and association with HIV/AIDS. Most of these factors should be subjects of concern in the HIV/AIDS intervention programs. Most of the listed factors are common in Africa and tend to be associated with marginalization (e.g. poverty, ignorance, poor health and hygiene and proximity to social amenities). Substance and drug abuse was not expected to feature strongly as an influencing factor in the region.

Another factor that this study considered in investigating the uniqueness of HIV/AIDS in Africa is the co-occurrence of AIDS-related risk factors with HIV/AIDS descriptors within the titles of HIV/AIDS papers. Terms that did not have any co-occurrence with HIV/AIDS were adultery, gonorrhoea, heterosexuality, promiscuity, and needlestick injuries. The scatter graph depicted in Fig 5 places these terms far away from the rest of the terms, which recorded high normalized counts. The non-co-occurrence of the aforementioned terms with HIV/AIDS should not be misconstrued, however, to mean that the risk factors are not related to HIV/AIDS. Most likely, the authors used related terms or their variants. Notably, most of the risk factors are sex-related. Perhaps this is attributable to the fact that HIV/AIDS is mainly contracted through sexual intercourse, especially between different sexes (i.e. largely heterosexually) in the case of Africa, as observed by Cohen (2000). Overall, the most common HIV/AIDS-associated risk factors constitute sexual intercourse, vertical transmission (mother to child during birth), blood transfusions and contaminated needles (intravenous drug use, needle stick injuries). According to the findings of this study as shown in Fig 5, several AIDS-related risk factors, including the above, were associated with HIV/AIDS in E&S Africa. The highest co-occurrence between HIV/AIDS and the risk factors was recorded by “infected mothers”, followed closely by a related descriptor, “mother-to-infant transmission”. Sexual intercourse and sexually transmitted diseases also ranked highly. The descriptor “Contaminated needles” was less common. It should be noted however that the cluster that describes this pattern (in Fig 5) is not as dense as the one that describes the co-occurrence of HIV/AIDS and opportunistic diseases. Fig 5 shows a more dispersed pattern among the descriptors that co-occurred with HIV/AIDS, which implies a loose relationship.

One of the risk factors (and sometimes a pre-disposing factor) is the sexually transmitted diseases. Amuyunzu-Nyamongo (2001) argues that individuals with ulcerative sexually transmitted infections (STIs) have an increased risk of transfer of HIV infection by factors of two to four. Of all the sexually transmitted diseases, papillomavirus infection was the most common in HIV/AIDS titles. Respectively, it recorded a co-occurrence frequency and strength of association of 144 and  $S=0.09$  with HIV, and 13 and  $S=0.03$  with AIDS. There were other high co-occurrence frequencies from genital warts, hepatitis B, syphilis, bacterial vaginosis, and herpes zoster. Fig 6 provides a scatter graph that describes this pattern of co-occurrence of HIV/AIDS and the other STDs. The non-metric MDS analysis produced two large clusters. The denser one shows the relationship between HIV/AIDS and other STDs, while the rest of the terms had little or no co-occurrence at all with HIV/AIDS. Seemingly, HIV/AIDS is mostly associated with un-curable STDs. For instance, the human papilloma virus is thought to be one of the main causes of cervical cancer and has been linked to other types of cancers of the female reproductive system. While this virus can be treated to reduce signs and symptoms, it does not yet have a cure. Both herpes and hepatitis B are other examples of STDs that do not yet have cures. Diseases or viruses that have cures co-occurred less frequently with HIV/AIDS.

The effect of the other diseases on HIV-infected persons was also considered by analysing the relationship between HIV/AIDS and the selected diseases through term-co-occurrence analysis. It has long been observed that HIV/AIDS does not actually kill; rather it is the opportunistic infections/diseases (or other diseases) that kill AIDS patients (Médecins Sans Frontières, 2003). This study sought to identify the most common HIV/AIDS-associated diseases, especially tropical diseases. Out of the total 24 diseases, slightly over one-half ( $\frac{1}{2}$ ) co-occurred with HIV/AIDS as shown in Fig 7.

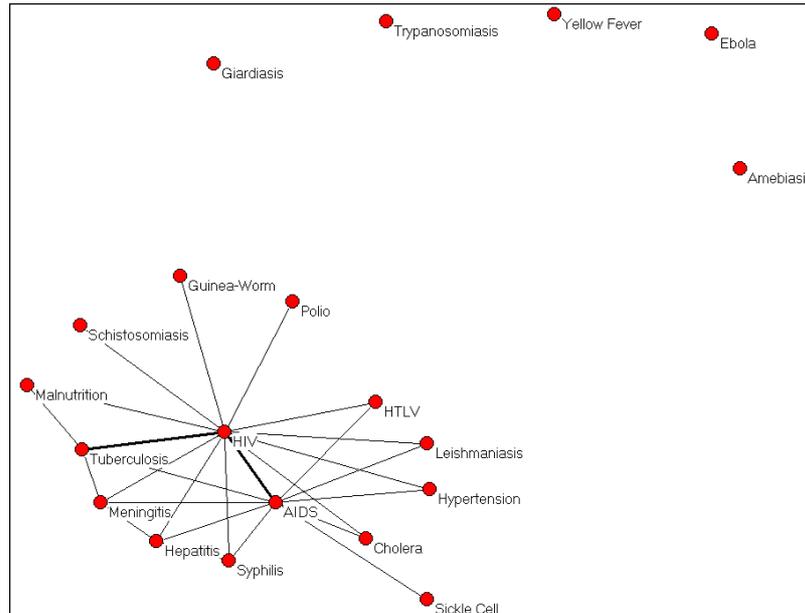


Fig 7: Normalized co-occurrence of HIV/AIDS and other diseases

The highest frequency of co-occurrence was recorded by tuberculosis ( $S=0.17$ ), which is said to be killing more HIV-infected persons in Africa than any other disease (Cohen 2000). Other terms that were linked to HIV/AIDS descriptors include cholera ( $S=0.01$ ), hepatitis ( $S=0.04$ ), hypertension ( $S=0.01$ ), leishmaniasis ( $S=0.02$ ), malaria ( $S=0.08$ ), malnutrition ( $S=0.03$ ), meningitis ( $S=0.02$ ), polio ( $S=0.02$ ), schistosomiasis ( $S=0.01$ ), sickle cell ( $S=0.05$ ), and syphilis ( $S=0.01$ ). Although most of these diseases have no direct link with HIV/AIDS, it is common knowledge that most have an equally (if not greater) negative impact on the economies of E&S Africa and its peoples. For instance, malaria is said to be killing millions of people in the region. The World Health Organization (2013) estimates that half of the world's population is at risk of malaria. The WHO states that

People living in the poorest countries are the most vulnerable to malaria. In 2010, 90% of all malaria deaths occurred in the WHO African Region, mostly among children under five years of age.

Again, it has been observed that HIV infection increases the incidence and severity of clinical malaria and although the effect of malaria on HIV is not well documented, UNICEF (2003) states that acute malaria infection increases viral load. The relatedness of other diseases such as cholera and polio to HIV/AIDS may be attributed to the fact that all are diseases of poverty, which is a common factor in sub-Saharan Africa. The reasons for the co-occurrence of HIV/AIDS and some of the diseases were, however, not very clear. Perhaps researchers were curious to discover the relationships between these diseases, or simply wanted to find out the impact the diseases have in E&S Africa.

In conclusion, the following diseases and factors produced high/strong co-occurrence patterns with HIV/AIDS:

- Opportunistic infections: tuberculosis, pneumonia, kaposi's sarcoma, herpes simplex, candidiasis, and mycobacterium avium complex.
- Pre-disposing factors: rural-related issues, drug abuse, orphans, gender, and violence.
- Risk factors: infected mothers, mother-to-infant transmission, sexual intercourse, drug abuse, oral sex, and breastfeeding
- Sexually transmitted diseases (infections): human papillomavirus infection, sexually transmitted diseases, genital warts, hepatitis b, syphilis, and bacterial vaginosis.
- Other diseases: tuberculosis, malaria, hepatitis, syphilis, and meningitis.

### Can informetrics shape biomedical research?

It should be noted, from the onset, that informetrics data is applied differently in various disciplines for different purposes. As Debackere & Glanzel (2004: 261) argue, "bibliometric information may serve highly different objectives simultaneously". The authors have vividly captured the different purposes for which informetrics studies are conducted or are meant to serve as follows:

- Bibliometricians (or informetricians) as well as information scientists may focus on publications in the context of

information management and retrieval systems. They are mainly concerned with methodological issues relating to the management, the measurement and the retrieval of bibliometric information

- Sociologists of science use them to study the professional and the communal behaviour of scientists.
- Scientists (in natural sciences), on the other hand, rely on bibliometric data for monitoring and mapping the state-of-the-art in their respective and highly diverse fields of enquiry and occasionally to trace and track individual (or group) scientific performance.
- In science policy, bibliometric data are mainly used to underpin the accountability and the justification of research funding allocations, on the one hand, and to allow for the comparison of scientific input and output, on the other hand. This is the most common view among scholars of bibliometrics/informetrics studies (e.g. Russell & Rousseau nd).

According to Gauthier (1998), informetrics methods serve three main functions, namely description, evaluation, and scientific and technological monitoring. In her explanation of the three main functions of bibliometrics, Gauthier (1998: 9) states:

As a descriptive tool, bibliometrics provides an account of publishing activities at the level of countries, provinces, cities or institutions, and is used for comparative analyses of productivity. The data can then be used to assess the performance of research units, as a complement to standard evaluation procedures. Bibliometric data are also used as a benchmark for the monitoring of science and technology, since longitudinal studies of scientific output help identify areas of research that are developing or regressing.

These two examples of the different scholars' perceptions of the application of informetrics imply that, if well applied, informetrics can shape research in any given field or discipline, including biomedical research. Indeed, each of the studies reviewed in section 6 above produced very interesting results which can be used to shape research in HIV/AIDS research in sub-Saharan Africa. Not only have the studies demonstrated that informetrics can assist in policy-making decisions on such matters as funding, but also the findings can lead to the identification of possible research collaborators; predict or forecast changes; the identification of influential journals through which biomedical research can be disseminated as well as obtained; and the identification, recruitment, tenure, and/or promotion of researchers. Onyancha and Ocholla's (2009) study on the distinctiveness of HIV/AIDS in Africa revealed that an informetrics study of the published literature can produce results that are congruent with the viewpoints held by knowledgeable biomedical (or HIV/AIDS) researchers. This revelation is not new. As early as 1989, when they conducted a co-citation analysis of AIDS research, Small & Greenlee (1989: 664) concluded that changes in bibliometric structure can be correlated to changes in scientific knowledge and understanding. Russell & Rousseau (nd), too, have observed that "most bibliometric evaluations of papers, journals and institutions correlate well with peer review appraisals suggesting that bibliometric indicators are generally accordant with the intuitive notions of knowledgeable scientists, as well as with the cognitive state of the art of particular research fields".

Nevertheless, Russell & Rousseau (nd) advise that, "rather than bibliometrics being championed as a cheap alternative to peer review, the two methods offering different viewpoints on a common problem, should be considered complementary and, wherever possible, used concurrently, especially in small scale evaluations". We concur with Debackere & Glazel (2004), who, like Russell & Rousseau (nd), observe that bibliometrics is not designed to correct or even substitute peer reviews or evaluation by experts. The authors, too, advise that qualitative and quantitative methods in science studies should complement each other. We add that, for informetrics to have the desired role in the evaluation of research performance and therefore inform biomedical decision making processes, a high regard for professionalism as well as ethical research has to be exercised by those charged with conducting informetrics studies. The choice of the electronic database from which data would be extracted or mined as well as the informetrics method/technique that would be applied to conduct the studies has to be made wisely.

We conclude by reiterating Wormell's (2000: 133) argument:

Access to information itself today does not signify either competitive advantage or guarantee the feeling of being informed, neither in the research nor the business environment. The sophisticated value of online information provision is not to use the databases only for finding facts and accessing documents, but to tap the unique items of useful information, the nuggets of knowledge and (by synthesis and/or analysis) extract the 'searched pattern' in the raw data.

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