Biomedical Research Collaboration Patterns of academic staff at the University of Zambia School of Medicine

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Abstract

The objective of the study was to explore research collaboration (RC) patterns in a university environment. Bibliometrics, a quantitative methodology was adopted for the study. Data was extracted from PubMed/Medline database, with a total of 281 articles retained for use in the study and then analysed quantitatively. It was found that, except in 1997 and 2000, most of the papers were authored by more than five researchers. The years 1998, 2004-2006, and 2011-2014 recorded 100% collaboration. As there were a total of 281 papers during the period under study (256 multi-authored plus 25 single authored papers) divided into 256 multi authored papers, the DIC for the School of Medicine over the whole period under study was 0.91; indicating a high degree of collaboration.Its major contribution to knowledge is the illumination of health research collaboration at the University of Zambia School of Medicine. Further studies on subject field research collaboration at the University school of Medicine are recommended.

Keywords
Academic staff; Collaboration; Collaboration patterns; Knowledge collaboration patterns; Universities, University of Zambia; Zambia.

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INTRODUCTION

In academia, interest in research collaboration has grown over the years (Subramanyam, 1983) and this interest has tremendously peaked today (Cheng et al., 2020), perhaps spurred on by the digital age. Research collaboration is a relationship arising out of working together on scientific projects. This type of collaboration has been called various things; research collaboration, collaborative research, scholarly collaboration, scientific collaboration or collaboration science. However, at the core of its ethos is the idea of working together towards a common goal. Scientific collaboration is "research involving coordination between the researchers, institutions, organisations, and/or communities" (Bansal et al., 2019, p. 137). Collaboration relates to two or more people working together to achieve a concrete output. The people collaborating may be in one organisation and working in different departments or they can be based in different institutions and, sometimes, located in different countries. Collaboration can happen between individuals, groups, departments, schools or faculties, universities, sectors, regions and nations (Katz & Martin, 1997). Sometimes, it becomes imperative to measure how much collaboration is taking place in an institution or indeed in whatever circumstances. This measurement can be done through articles authored by multiple persons. Using bibliometric techniques, "multiple-author publication, frequently referred to as a co-authored publication, has been used as a basic counting unit to measure collaborative activity" (Katz & Martin, 1997, p. 2). There is enough evidence of the measurement of collaborative research, even the methodologies of how to do it (Eriksen & Frandsen, 2018; C.W. Kanyengo et al., 2019; M. & J., 2002; Philbin, 2008; Thomson et al., 2009; Tigges et al., 2019).

At the University of Zambia (UNZA), research collaboration is recognised as an important aspect of research as well as its contribution to the University's motto of 'service and excellence' in teaching, research and public service. Research is not just valued by the institution but is rewarded through academic promotions; when lecturers seek promotions. Further, the recognition of the importance of research collaboration can be seen in various policy documents of the University. For instance, the University of Zambia Strategic Plan 2018-2022 says it aims to "enhance local and international collaboration through beneficial partnerships" (University of Zambia, 2018, p. 72). Likewise, the UNZA Research Policy and Intellectual

Property Rights states that it will encourage: "university staff to explore and innovate [in] ways of establishing such alliances, networks and partnerships with relevant public, private and other research institutions for mutual gain. The University of Zambia must, in this regard, co-operate and collaborate with individuals, institutions and agencies" (University of Zambia, 2009, p. 4). This is an indication that at UNZA, collaboration is an important aspect of research and that is why it is important to know the nature of this collaboration.

STATEMENT OF THE PROBLEM

There have been studies on collaboration as part of research output in Zambia (Ahmed et al., 2010; Akakandelwa, Makondo, et al., 2016a, 2016b); however there seems to be a gap on studies delving deeply into scientific collaboration alone, and none specifically targeting biomedical and health related research. This is an attempt to fill this knowledge gap.

Objective of the study

The objective of the study was to examine collaborative patterns of academic staff (lecturers) at the School of Medicine (SOM)[1], University of Zambia during the period 1995-2015.

Rationale of the Study

This study's significance lies in the fact that it provides an understanding of knowledge collaboration patterns of SOM, UNZA. Although the study is confined to SOM, its findings may be relevant to other schools within UNZA and other higher education institutions worldwide.

LITERATURE REVIEW

In Science, authorship patterns are closely linked to collaboration. A few characteristics of scientific collaboration are important to highlight. For instance, the study by (Kamalski, 2009, p. 7) where her analysis of data on collaborative article output by country, revealed that smaller countries proportionally conduct more international collaborative research than larger countries. The World Bank has, similarly, established that many countries in Eastern and Southern Africa rely heavily on international collaboration for their research output. In 2012 this represented 79% and 70% of all research conducted in these regions. South Africa was excluded from their analysis of trends in Sub-Saharan Africa (Bank, 2014, pp. 3–4). They further established that research collaboration is characterised by research capacity fragmentation across the regions; with very little collaboration between the countries; and that a large proportion of World Bank researchers were visiting researchers themselves. The World Bank, while encouraging international collaboration, also further expresses concern regarding the high reliance on such collaboration, in these regions, as this to their mind indicates lack of internal research capacity. The United Nations Educational, Scientific and Cultural Organisation (UNESCO) further indicates that South Africa, regionally, is a key research partner for most countries within the Southern Africa Development Community (SADC) (United Nations Educational Scientific and Cultural Organisation, 2015, p. 545).

Observations have been made about some of the characteristics of research collaboration:

a) it improves the quality and quantity of research output among the participating partners (Jonathan et al., 2013),
b) Can measure individual contributions to research (Jonathan et al., 2013),
c) Patterns of collaboration may vary between subjects (Newman, 2004),
d) Interdisciplinary of research (Mäkinen et al., 2020; van Rijnsoever & Hessels, 2011),
e) "Internal cohesion, productivity, the ability to communicate openly and learn each other's languages, setting shared expectations, defining roles and responsibilities, and challenging each other without it becoming personal" (Bennett & Gadlin, 2012, p. 12),
f) Long term collaboration with high achieving scientists can lead to high productivity and impact (Maeki et al., 2020).

Some of RC characteristics have been summed as: "better utilisation of resources; quality improvement; and expanding production and knowledge dissemination…increasing knowledge about subjects studied, there are numerous aspects learned: work with diversity and collaboration; valorize national researchers; plan and record activities of the group; humility"(Odelius & Ono, 2019, p. 114). As concluded "collaborations are essential — *we need diverse teams to tackle global problems such as pandemics, and to help navigate social and*

[1] *Data was collected before the SOM was split into four schools of: Health Sciences, Nursing Sciences, Public Health and SOM.*

geopolitical challenges"(Nature, 2021, p. 2). RC enables society to work "across borders, cultures and disciplines" (Nature, 2021, p. 1), as demonstrated in the COVID-19 pandemic where RC brought enormous rewards to mankind in finding solutions to pandemic problem.

METHODOLOGY

The main sampling design adopted by the researchers was purposive sampling, a form of non-probability sampling (Hungler & Polit, 1999, p. 284) of the University of Zambia first, and then the School of Medicine second, as the study unit based on the fact that it is one of the oldest schools in the university, having been established in 1966. Further, purposive and availability sampling was used to select the PubMed/Medline database as it is freely available online. The study was limited to PubMed/Medline database for it only indexes biomedical and health related research. The sample size that was selected for the study were citations published from 1st January 1995 to December 31st, 2015. A search was conducted on PubMed with the search string: *University of Zambia [ad] AND ("1995/01/01"[PDAT!]: "2015/12/31"[PDAT])*[2]. A number of bibliometric research studies have used the author's address field as a delimiter in their citation searches (Nico Cloete et al., 2015; R. R. Ettarh, 2015; Remare Ettarh, 2016; Hofman et al., 2009). For example, Rehn et al. (2014, p. 4) have argued that the author's address field "can identify prolific countries, universities or other organisations and give an overview of the co-publication patterns".

Data Extraction and Analysis

Those articles that were retrieved with the University of Zambia affiliation but belonging to another school other than the School of Medicine, for example School of Veterinary Medicine, or other units of the University of Zambia, or the University Teaching Hospital were excluded. After carefully analysing each citation and making exclusions, a total of 281 usable citations were retained for the study. These citations were then imported into SPSS for further analysis. Since we are interested in RC, it is important to measure it, and according to Subramanyam (1983, p. 37), the Degree of Collaboration (DIC) is defined "as the ratio of the number of collaborative research papers to the total number of research papers published in the discipline during a certain period of time". Further, Subramanyam's formula, which defines the degree of collaboration as "the ratio of the number of collaborative research papers to the total number of research papers in the discipline during a certain period of time" (Subramanyam, 1983, p. 37) was used to calculate the degree of collaboration.

FINDINGS

The number of authors[3] per paper was calculated using the formula: x (x=1, 2, 3…) authors. Table 1 and Figure 1 provide the number of publications that were authored by more than one author. Papers authored by more than five researchers were the majority and totaled 143, followed by papers authored by three authors (40), five-author papers (31), one author-author papers and four-author papers (25 each). Two-author papers were the least (17). Several publications were authored by an unusually high number of authors; for instance, two papers were authored by 24 authors each while one paper was authored by 23 authors.

Table 1. Number of Authors per Publication – (1995-2015)

Number of authors	*Frequency*	*Percent*	*Cumulative Percent*
1	25	8.9	8.9
2	17	6.0	14.9
4	25	8.9	38.1
3	40	14.2	29.2
5	31	11.0	49.1
>5	143	50.9	100.0
Total	**281**	**100.0**	

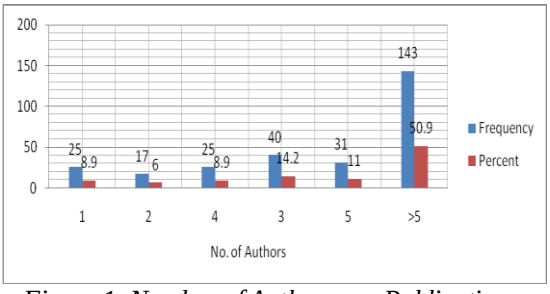


Figure 1. Number of Authors per Publication – (1995-2015)

[2] *[ad] refers to author address field; and! PDAT refers to publication date.*

[3] *In this instance, at least 1 author is from UNZA*

Figure 2 further shows that the period under review (1995-2015) has been dominated by multi-authored publications, except in 1997 and 2000 when there was only one publication recorded in PubMed/Medline in each year. In these two years, both the papers were single authored; while the years 1998, 2004-2006, and 2011-2014 recorded no single authored paper. Interestingly, out of the 80 papers published in the year 2015 only one was single authored.

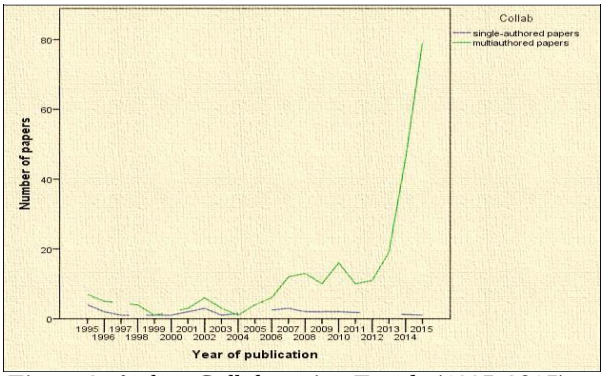


Figure 2. Author Collaboration Trends (1995-2015)

Year wise Degree of Collaboration of the Academic staff

The formula suggested by Subramanyam (1983) to measure DIC is widely used worldwide (Akakandelwa, 2009; Akakandelwa, Makondo, et al., 2016a; Jeyasekar & Saravanan, 2015, p. 138; Khaparde & Pawar, 2013, p. 53; Velmurugan, 2013, p. 20; Verma & Singh, 2017, p. 4; Zafrunnisha & Pullareddy, 2009, p. 257) to measure the degree of collaboration in knowledge production studies. This is the formula used in this study to measure the DIC of the School of Medicine academic staff. In the formula below, the Degree of collaboration is obtained by dividing Nm = (Number of Multiple authored papers) with the value obtained after adding Nm (Number of Multiple authored papers with Ns = Number of Single author papers) where C = Nm/Nm+Ns, as suggested by Subramanyam (1983, p. 37). See Tables 2 and 3.

Table 2. Degree of Collaboration **Calculation Formula**

$$DC = \frac{Nm}{Nm+Ns}$$

DC =	Degree of collaboration in a discipline
Nm =	Number of multiple-authored research papers in the discipline in a year
Ns =	Number of single papers in the discipline in a year
Total Nm	256
Total Ns	25
Total Papers	281

Table 3. Total Degree of Collaboration (1995 -2015)

DC =	Total number of multi authored papers	256
	Total number of papers	256 + 25

Total DIC = 0.91

An examination of the degree of collaboration (DIC) in Table 4 reveals that there is generally a high DIC over the whole period, with a few exceptional cases when the DIC was 0.00 (1997 and 2000). The years 1998, 2004-2006, and 2011-2014 recorded 100% collaboration. During the period under study, there were a total of **281** papers (**256** multi-authored plus **25** single authored papers) divided into **256** multi authored papers, therefore the DIC for the School of Medicine over the whole period under study was 0.91.

Table 4. Year wise Degree of collaboration (1995-2015)

Year of Publication	*Single-authored papers*	*Multi-authored papers*	*Total*	*DIC*
1995	4	7	11	0.64
1996	2	5	7	0.71

1997	1	0	1	0.00
1998	0	4	4	1.00
1999	1	1	2	0.50
2000	1	0	1	0.00
2001	2	3	5	0.60
2002	3	6	9	0.67
2003	1	3	4	0.75
2004	0	1	1	1.00
2005	0	4	4	1.00
2006	0	6	6	1.00
2007	3	12	15	0.80
2008	2	13	15	0.87
2009	2	10	12	0.83
2010	2	16	18	0.89
2011	0	10	10	1.00
2012	0	11	11	1.00
2013	0	19	19	1.00
2014	0	46	46	1.00
2015	1	79	80	0.99
Total	**25**	**256**	**281**	**0.91**

Institutions that Collaborated with the UNZA School of Medicine (1995-2015)

Researchers from one thousand, three hundred and twenty-eight (1328) institutions collaborated with UNZA SOM staff to produce the 256 co-published publications. Table 5 shows the top twenty (20) institutions with whom the UNZA SOM academic staff collaborated with most frequently. These are the University of London, United Kingdom (294, 24.14%), University Teaching Hospital (UTH), Zambia (147, 11.07%), University of Malawi, Malawi (35, 2.64%), Centre for Infectious Disease Research in Zambia (CIRDZ) (33, 2.48%), Ministry of Health, Zambia (26, 1.96%), University of Alabama at Birmingham, United States of America (25, 1.88%) and the University of North Carolina at Chapel Hill, United States of America (24, 1.81%). Together these institutions contributed (771, 58.06%) of the publications co-authored with the UNZA Medical School staff. It is not surprising that the UTH is one of the primary local institutions with which the School of Medicine collaborates with as every medical school must relate to a teaching hospital to provide clinical practice for its students and staff; and to conduct clinical research (Table 5).

Table 5. Top 20 Institutions Collaborating with UNZA School of Medicine

S/N	Name of Institution	Country	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	University of London	UK	294	22.14	294	0.22
2	University Teaching Hospital	Zambia	147	11.07	441	0.33
3	University of Malawi	Malawi	35	2.64	476	0.36
4	Centre for Infectious Disease Research in Zambia	Zambia	33	2.48	509	0.38
5	Ministry of Health (Zambia)	Zambia	26	1.96	535	0.40
6	University of Alabama at Birmingham	USA	25	1.88	560	0.42
7	University of North Carolina at Chapel Hill	USA	24	1.81	584	0.44
8	Vanderbilt University	USA	24	1.81	608	0.46
9	University of Bergen	Norway	21	1.58	629	0.47
10	Imperial College London	UK	16	1.20	645	0.49
11	Karolinska Institute	Sweden	16	1.20	661	0.50
12	University of Cape Town	SA	15	1.13	676	0.51
13	Emory University	USA	13	0.98	689	0.52
14	Stellenbosch University	SA	13	0.98	702	0.53
15	University of Miami	USA	13	0.98	715	0.54
16	University College London Hospitals	UK	12	0.90	727	0.55
17	Centers of Disease Control and Prevention	USA	11	0.83	738	0.56
18	National Institutes of Health	USA	11	0.83	749	0.56
19	University of Washington	USA	11	0.83	760	0.57
20	World Health Organisation	Zambia	11	0.83	771	0.58

Table 6 reveals the top fifteen countries collaborated with UNZA School of Medicine in research during the period under review. These countries are the

United States of America (66, 28.09%), the United Kingdom (31. 13.19%), Canada (14, 5.96%), South Africa (14, 5.96%), Uganda (9, 3.83%), Nigeria (8, 3.40%), Tanzania (8. 3.40%) and Sweden (7, 2.98%). France and Kenya, Malawi and Switzerland had five publications, with a percentage of 2.13% each. The United States of America is the leading collaborator, followed by the United Kingdom and Canada.

Table 6. Top 20 Countries Collaborating with UNZA School of Medicine

S/N	*Country*	*Frequency*	*Percent*	*Cumulative Count*	*Cumulative Percent*
1	United States of America	66	28.09	66	28.09
2	United Kingdom	31	13.19	97	41.28
3	Canada	14	5.96	111	47.23
4	South Africa	14	5.96	125	53.19
5	Uganda	9	3.83	134	57.02
6	Nigeria	8	3.40	142	60.43
7	Tanzania	8	3.40	150	63.83
8	Sweden	7	2.98	157	66.81
9	France	5	2.13	162	68.94
10	Kenya	5	2.13	167	71.06
11	Malawi	5	2.13	172	73.19
12	Switzerland	5	2.13	177	75.32
13	Germany	4	1.70	181	77.02
14	India	4	1.70	185	78.72
15	Zimbabwe	4	1.70	189	80.43
16	Australia	3	1.28	192	81.70
17	Saudi Arabia	3	1.28	195	82.98
18	Sudan	3	1.28	198	84.26
19	Belgium	2	0.85	200	85.11
20	Botswana	2	0.85	202	85.96

DISCUSSION OF THE FINDINGS

Collaboration Patterns of the Academic Staff at the UNZA SOM seems to be following in the footsteps of other researchers in the knowledge production field of academia, which is predominantly dominated by multiple authorships. This multiple authorship has mainly been motivated by various factors such as funding patterns of the funder where they prefer proposals from across disciplines and even from different countries.

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In another study of published journals in South Africa; with a predominance of the Arts and Humanities fields, collaborative publishing accounted for a quarter of all the papers with 15% of those collaborations occurring with institutions that are outside the university system, meaning people were collaborating with non-university actors, with co-authorship being more prevalent in agriculture, chemical sciences and the biological sciences (Academy of Science of South Africa (ASSAf), 2019, p. 69). This shows a growing trend in RC in various disciplines (Akakandelwa & Rousseau, 2016; Falagas et al., 2006; Hoidn, 2010; Christine Wamunyima Kanyengo, 2020; Logan et al., 2017; Rotich & Onyancha, 2017; Tijssen, 2015; van Rijnsoever & Hessels, 2011).

It is also important to note that there is diversity in the institutions that the UNZA SOM was collaborating with, both local and international. However, what was not very prominent is the collaboration with regional and African institutions, and this confirms the general lack of cooperation and interaction, in general amongst African countries especially, where there is a lack of linkages in terms of air transport, road transportation, trade and economic linkages. Even though these linkages exist, most of them are insufficiently linked as well as being inconvenient to the citizens of Africa. The results agree with those of Ettarh (2016, p. 194) who in his study found that "the number of publications involving multiple [Sub Saharan Africa] SSA countries over this period accounted for less than 10% of the total number of multi-country publications including at least one SSA country. Collaboration patterns reflected dominance by countries in Europe and North America, with South Africa accounting for the bulk of scientific collaboration in [cardiovascular Research] CVR within SSA". In a study on 'Mapping the health research landscape in Sub-Saharan Africa: a study of trends in biomedical publications' it was established that South African institutions were collaborating more with the European counterparts when compared to their regional counterparts (Hofman et al., 2009); again, this is similar to the situation with the UNZA SOM. It is similar to the findings of Sooryamoorthy (2021, p. 371) apart from North America and Europe dominating the partnerships with Africa such as Brazil, China and India are slowly coming on board. It is for this reason, that Tijssen (2015, p. 63) has argued that "university-specific growth trajectories are at least also partly driven by international

collaboration and the increased production of internationally co-authored publications". This really speaks to the issues of those institutions that depend so much on international funding for all their research (as there is no local funding); the drivers of the subject areas for research may be decided by the interests of the funder and not really the needs of the local institution or country; an assertion confirmed by the findings of (Pan et al., 2021)

Incidentally, studies further elucidates that collaboration with African countries is minimal, even if it has been steadily increasing (Onyancha & Maluleka, 2011; Tijssen, 2015). This goes for collaboration between African countries themselves. A study by Boshoff (2009, p. 426) in Central Africa found a significant number of "regionally co-authored papers involve a non-African country address (85% of all papers and 71%–89% of field-based papers). Only 26% of regionally co-authored papers involve collaboration by another African country although the figure is higher in the health sciences (37%). European countries participate in 77% of regionally co-authored papers and the colonial powers in 57% of cases". A Zambian study found there was more collaboration with researchers from outside, with the USA leading a country of origin for the collaborating researchers followed by, UK, South Africa, Malawi, Zimbabwe and Botswana (Akakandelwa, Kanyengo, et al., 2016). It is interesting to note that four African countries were among the top ten collaborators. Others studies have found that their African institutions are increasingly getting in RC and also increasing their research partnerships with fellow African universities and research institutions (Pan et al., 2021).

However, some have argued that these are not collaborations that Africa should be satisfied with; for the collaboration levels between developed and developing countries are not equitable. In this vein Owusu-Nimo and Boshoff (2017, p. 1099) in a study in Ghana on collaboration have argued that "collaborators within Ghana were largely involved in the collection of data or fieldwork. Collaborators from outside Africa played instrumental roles in providing resources and securing research funds". In the words of former President Kenneth Kaunda, this is a relationship of a rider and a horse. Anamela-Gundersen (2002) quotes the former President repeating the same statement at an Open Forum in Oslo, Norway in 2002 where he reiterated this unbalanced relationship between developed countries and countries in the South that the "current system of globalisation can only be seen in terms of a slave and master relationship, horse and rider" where the horse does all the work and the credit goes to the rider. The rider makes all the decisions, whilst the Africans do minimum work on the RC (it is akin to doing menial jobs) and even go further by writing the manuscripts for their African partners who become Ghost authors on the papers. Still, others have argued that this type of collaboration is the reason why African authors are not visible as most often they are only involved in the data collection and therefore not credited as contributor to knowledge generation. That is why there is an argument being advanced for African scientists to be involved in RC that are "truly lateral with all collaborators involved from the design phase of the project to completion"(Maswime et al., 2020, p. 2).

Certainly, over the years, the University of Zambia has been collaborating with a number of institutions both locally, regionally and the world over. Among some of the notable research collaboration programmes and partnerships that UNZA SOM has had over the years are the following; 1) the Medical Education Partnership Initiative (MEPI) -- a programme led by the the United States of America (USA) Office of the Global AIDS Coordinator (OGAC) and supported by the USA National Institutes of Health (NIH); 2) the Norwegian Programme for Development, Research and Education (NORHED) through a partnership with the University of Norway; 3) the USA Centres of Disease Control and Prevention (CDC) under the President's Emergency Plan For AIDS Relief (PEPFAR/Emergency Plan); 4) United Kingdom (UK's) Wellcome Trust; 5) Japan International Cooperation Agency (JICA); 6) Swedish International Development Cooperation Agency (SIDA); 7) the Department for International Development (DFID); 8) United Nations Population Fund (UNFPA); and 9) the World Health Organisation (WHO), amongst many others. Additionally, in this process of research collaboration, they have worked with several institutions both locally and internationally, such as: the University of Alabama at Birmingham, the University of Miami, the University of Nebraska, Vanderbilt University, University of North Carolina, University College of London Medical School (UCLM), University Teaching Hospital- Lusaka (UTH), the Centre for Infectious Disease Research in Zambia (CIDRZ), Zambia AIDS Related Tuberculosis (ZAMBART), Emory University and London School of Hygiene & Tropical Medicine

(LSHTM). Some of the top collaborative countries have been the USA, UK, Japan, South Africa, Malawi, France, Nigeria, Canada, Tanzania, Botswana, Central African Republic, Mozambique, Norway, Sweden and Uganda. The collaborative partnerships that UNZA SOM has had are at several levels; individual, programme, institution and country.

Although UNZA collaboration patterns are impressive, they confirm other findings that there is more collaboration with authors from outside the continent when compared to authors within the continent, within country or institutions (Akakandelwa, 2009; Boshoff, 2009, 2010; Ocholla et al., 2013; Onyancha, 2009; Onyancha & Maluleka, 2011; Onyancha & Ocholla, 2007). In a study tracing UNZA's Research Outputs from 1966 to 2015, it was found that "**co-authorship patterns and collaboration trends" were increasing, arguing that "the first 25 years of UNZA's publications were dominated by single-authorship, the last 25 years were dominated by multi-authored publications with more and more publications being authored by more than five authors [with] UNZA researchers also collaborates with foreign funding agencies" (Akakandelwa, Makondo, et al., 2016a, p. 138).**

CONCLUSION

The study's overall conclusion is that the research output at the School of Medicine has seen a growth in multiple authorship patterns as well as research collaborations. The study established that papers authored[4] by more than five researchers were the majority followed by papers authored by three authors; as revealed by the increase in multiple authorships over the study period. In this regard, overall authorship patterns showed that there was also increased collaboration which tended to increase the research output. These increased research collaboration patterns might have been driven by funding patterns and the general shift in authorship patterns in the scientific fields where knowledge production is increasing and becoming much more of a collaborative venture than a sole process.

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