

# Five decades lead in biomedical research: University of Khartoum tops Sudanese universities in PubMed articles

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## Author's summary

The University of Khartoum has always been the leader of Sudanese universities. The quality of academic and para-academic environment has always set the bar for local and regional higher education institutions. Here, we describe a compelling evidence for this prowess in yet another field where this deeply rooted prestigious institution takes the lead: Biomedical Research. In this article, we present a trend of figures from the famous and gold-standard biomedical research online database “PubMed” dating as early as 1966. The worldwide online library maintained by the National Center for Biotechnology Information (of the National Institutes of Health, United States) is leading and most comprehensive – biomedical research repositories and indexes. The number of articles indexed in PubMed is one widely accepted measure of research advancement both on institutional and personal levels. As expected, the University of Khartoum shows an all-time lead based on number of PubMed-indexed research articles. It shows as well a promising rising trend of PubMed articles, reflecting the growing attention to biomedical research. At the end, we present the reader with practical yet simple tips to increase the visibility and improve the tracking of research articles.

**Abstract:**

Introduction: University of Khartoum (U of K) is the largest and oldest university in Sudan (1). The recent rankings of international and local universities made by Webometrics Ranking of world Universities initiative in 2017 have placed University of Khartoum as number one University in Sudan and 1970 in rank Worldwide. This ranking system is based mainly on research activity and publications. Using PubMed we obtained data on all PubMed-indexed articles (from 1966 to 2016) affiliated to the four oldest and most established Sudanese universities: University of Khartoum, University of Gezira, Omdurman Islamic University, and Al-Neelain University.

Methods: Using R Statistical environment, we compiled a unified dataset from multiple resources including PubMed data and impact factor data. This unified dataset was then used to calculate multiple article and authorship metrics including total number of articles and annual averages. We also applied text mining techniques to from indexed abstracts in order to explore the prevailing trends and research focus of some the most prolific authors and to visualize this trends though word clouds.

Results: Since the earliest date of PubMed indexing in 1966, the University of Khartoum is by far the most affiliated Sudanese university in PubMed. Approaching 300 articles in 2016, the number of PubMed indexed articles has shown a promising rising trend over the past decade. Our results clearly indicate lead of University of Khartoum in published biomedical research. This trend is promising and shows the attention shift towards research activities among the major Sudanese universities in general and University of Khartoum in particular.

**Key words:**

*University of Khartoum, PubMed, research, Sudan*

## **Introduction:**

University of Khartoum (U of K) is the largest and most established university in Sudan. It was founded in 1902 first as Gordon Memorial College and turned later into University of Khartoum after Sudan's independence in 1956 (1). Since its establishment, University of Khartoum was the top university in both academic excellence and research activities in all Sudan and one of the top universities in Africa (2). The recent rankings of international and local universities made by Webometrics Ranking of world Universities initiative in 2017 have placed University of Khartoum as number one University in Sudan and 1970 in rank Worldwide (3). This ranking system is based mainly on research activity and publications. The number of research articles published in credited international journals is indeed a rough estimate of the activity of research done in academic institutions (4). However till now no study objectively compared the number of articles published in International journals between University of Khartoum and other Sudanese universities.

Using a state-of-the-art method for retrieving indexing and citation metrics based on the contemporary and leading statistical language R, we present here a comparison of the quantity and quality -measured by impact factor- of PubMed-indexed articles affiliated to four public Sudanese universities: University of Khartoum, University of Gezira, Al-Neelain University, and Omdurman Islamic University. We chose these four universities based on their long academic and research history, and large number of admissions and academic staff. They are the earliest universities to offer biomedical education. Through “Word Clouds” - a standard visualization method to highlight key tags and words following data mining – we explore the major keywords associated with these PubMed articles, giving an overview on the areas of interest approached by published research efforts.

## **Methods:**

We downloaded and compiled metadata about published papers by the top four public universities in Sudan including Khartoum University, University of Gezira, Al-Neelain University, and Omdurman Islamic University from PubMed. R statistical Software was used to merge the different datasets into one dataset, and to extract, and compute various measures from the unified data including number of authors per article. The final data table included: titles of articles, complete lists of authors, journals and journal abbreviations, PMIDs, PMCsIDs for open-access articles, and indexed abstracts, etc. The publication time frame ranges from 1966 till the end of 2016. The resulting data frame was subset for different analysis purposes as explained hereafter.

**Number of articles and timelines:** We used multiple R base functions and packages to sort and subset the tabulated meta-data per university and visualize the total and annual number of articles. We constructed bar charts featuring the number of published articles per university (R script available upon request). Trends were visualized in line graphs as well to allow ease of comparison.

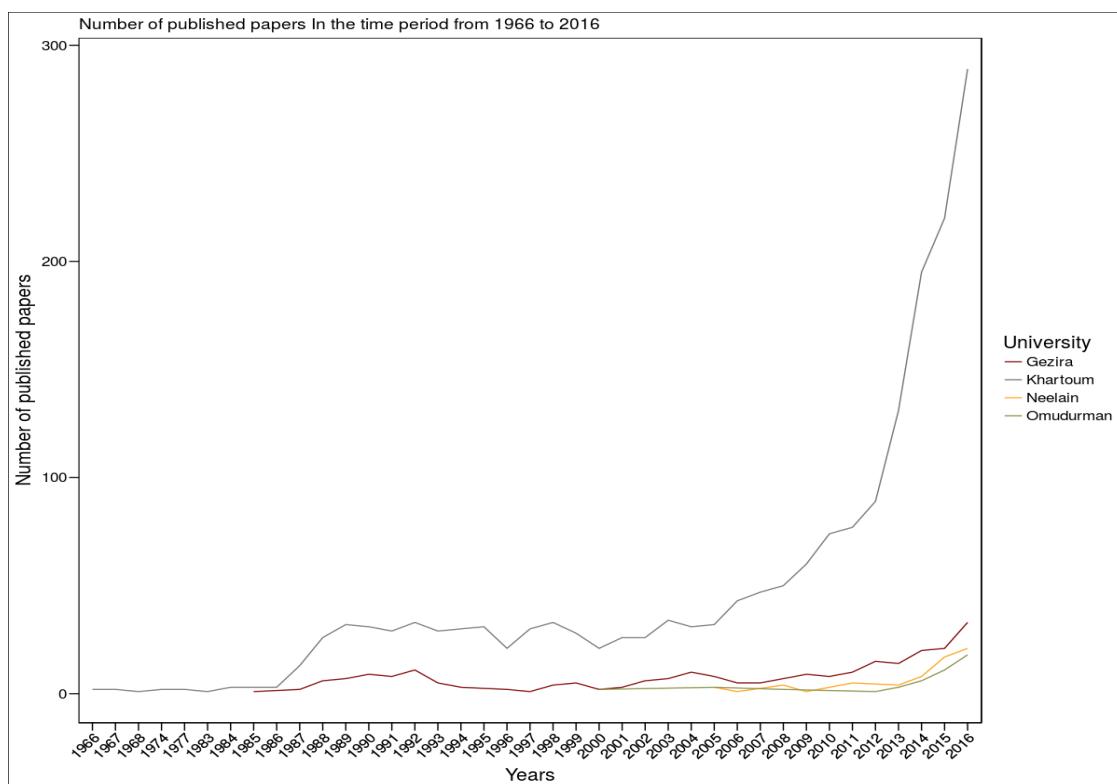
**Authorship metrics:** average number of authors per article was calculated for each university per annum. Tabular data was then visualized in line graphs.

Word Clouds: Text mining for tags was performed on indexed abstracts texts and authors lists. Afterwards, Word Clouds were constructed to reflect the frequency and density of tag words. The data was tabulated for Khartoum University and the most prolific authors.

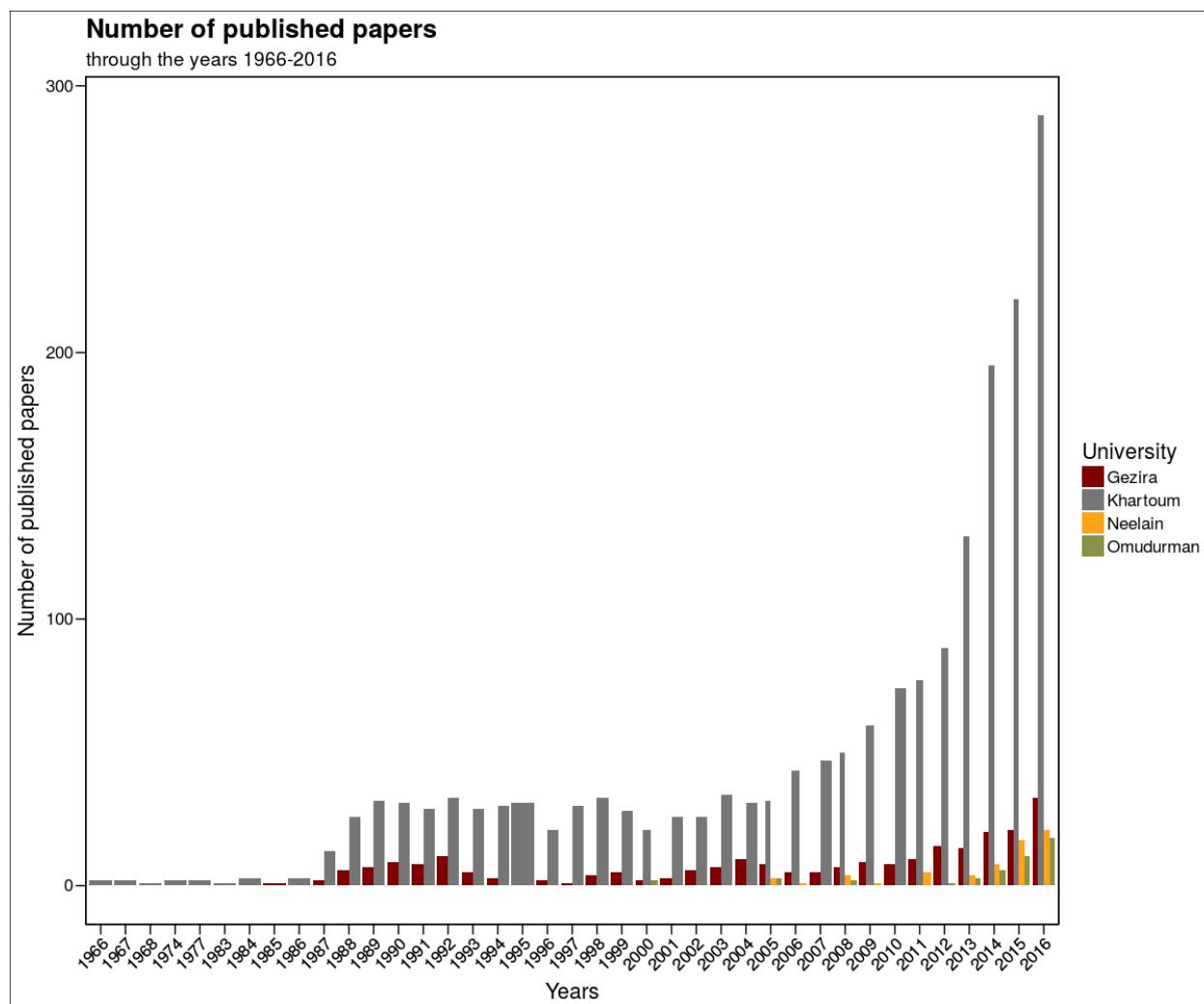
## Results:

The total number of PubMed Articles published by the four mentioned Sudanese universities between 1966 and 2016 was 2228. The main publishing Sudanese universities were: University of Khartoum: 1864 (84%) articles, University of Gezira: 253 (11%) articles, Al-Neelain University: 65 (3%) articles and Omdurman Islamic university: 46 (2%) articles.

The articles citing University of Khartoum as the researcher affiliation date back to the earliest records presented by the PubMed in 1966. It has been then joined by Gezira University in the early eighties. Despite featuring a first appearance of indexed articles in the nineteen nineties, Omdurman Islamic University showed a steep decline in the nineties followed by a prominent rise since the year 2000. The first indexed article citing Al-Neelain University dates to the year 2005. These time trends are shown in figure 1. After an apparent plateau between the 1980s and 2005, University of Khartoum articles showed an exponential rise in number. This number jumped from around 30 paper in the year 2005 to around than 300 papers in 2016 (figure 2).

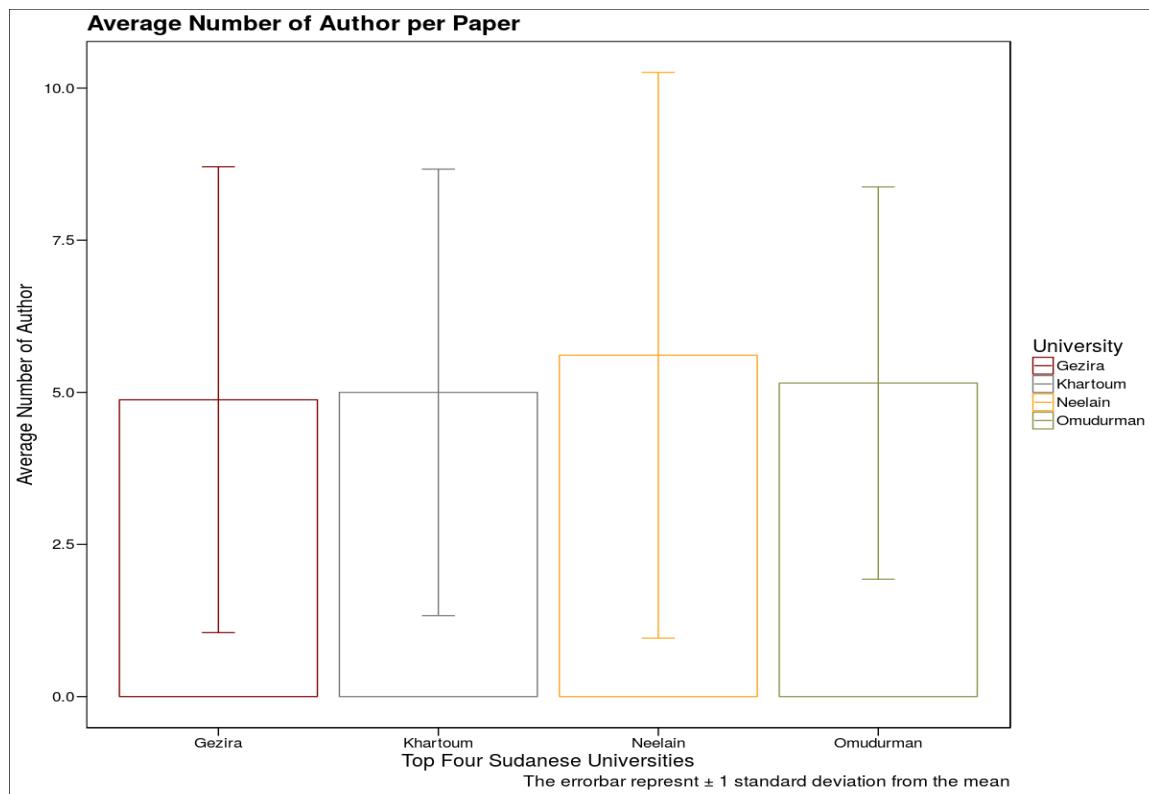


**Figure 1.** Line plot shows the number of articles published in PubMed indexed journals from the year 1966 to 2016 by four Sudanese universities (Gezira, Khartoum, Al-Neelain and Omdurman Islamic university).



**Figure 2.** Bar plot shows the number of articles published in PubMed indexed journals from the year 1966 to 2016 by four Sudanese universities (Gezira, Khartoum, Al-Neelain and Omdurman Islamic university).

The average number of authors per published article in all four universities also witnessed an increase in the last forty years. This rise is more dramatic for Al-Neelain and Omdurman universities reaching 10 and 8 authors per article respectively. The average number of authors per article in University of Khartoum and Gezira University 5 and 3 authors/article respectively, although these numbers are on the increase, Supplementary Figure 1.

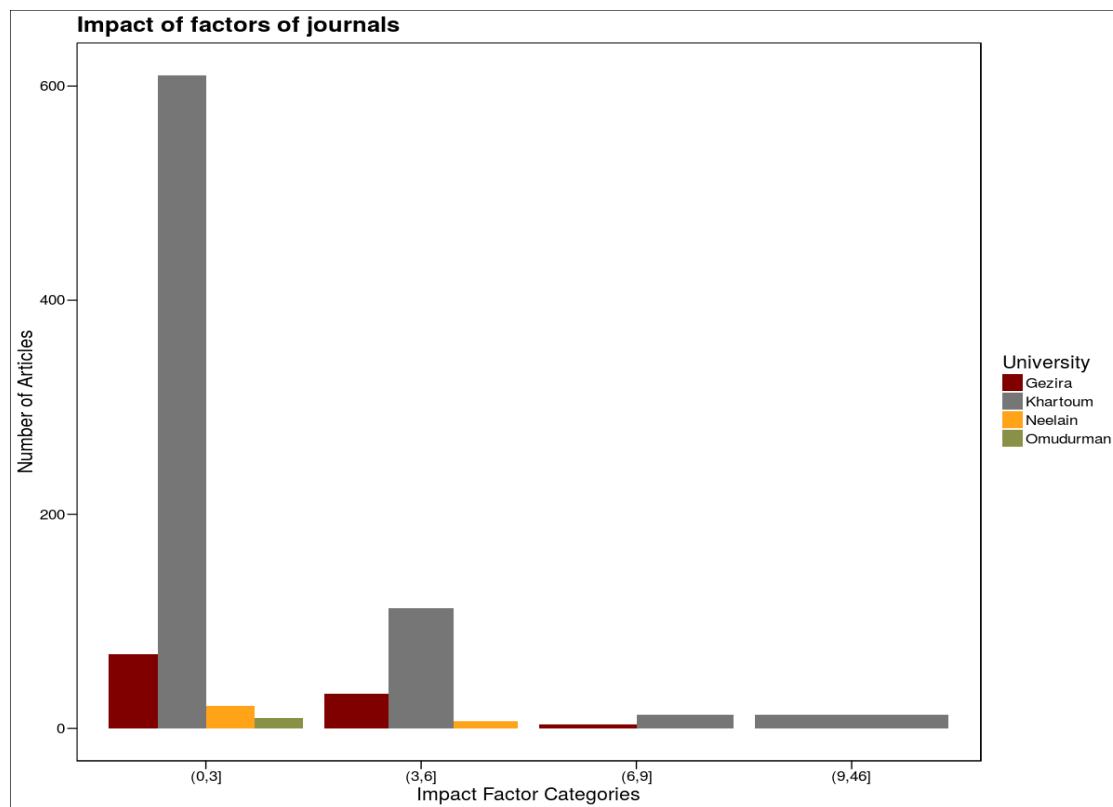


**Figure 3.** Average number of authors per article published in PubMed indexed journals from the year 1966 to 2016 by four Sudanese universities (Gezira, Khartoum, Al-Neelain and Omdurman Islamic university).

The highest number of articles was first-authored by Fahal AH (24), Ahmed AA (22) Ahmed AM (22), Adam I (21), Ahmed ME (19) and Salih ME (18), all from Khartoum University, Table 1. The most published in journals were Sudan journal of pediatrics (70 articles) followed by Transactions of Royal society of Tropical medicine and hygiene (64), Saudi medical journal (63), East Mediterranean health journal (59) and East Africa medical journal (56). The majority of research articles were published in journals with impact factor less than 3. Only University of Khartoum had authors published in journals with impact factor above 9, Figure 4.

**Table 1.** The top 10 publishing authors in PubMed indexed journals from the year 1966 to 2016 among four Sudanese universities (Gezira, Khartoum, Al-Neelain and Omdurman Islamic university).

Author	No. of articles	University
Fahal AH	24	University of Khartoum
Adam I	21	University of Khartoum
Ahmed AA	21	University of Khartoum
Ahmed AM	21	University of Khartoum
Salih MA	18	University of Khartoum
Ahmed ME	16	University of Khartoum
Elamin A	16	University of Khartoum
Ahmed HG	15	University of Khartoum
Elbashir AA	15	University of Khartoum



**Figure 4.** Number of research articles in four impact factor groups (group 1:impact factor 0-3, group 2:impact factor 3-6, group 3:impact factor 6-9, group 4: impact factor 9-46) published in PubMed indexed journals from the year 1966 to 2016 by four Sudanese universities (Gezira, Khartoum, Al-Neelain and Omdurman Islamic university).

The top 400 keywords of articles published by University of Khartoum generally varied but showed a trend towards infectious diseases and other health related problems, Figure 5.

Figure 5 A



Figure 5 B



**Figure 5.** A Word cloud of the top 400 keywords for Khartoum University. B an example Word cloud from Professor Mudawi HM research

## Discussion:

From the results seen in the accompanying figures, it is easy to get a clear perception of the lead of University of Khartoum in published biomedical research. This trend is promising and shows the attention shift towards research activities for all Sudanese universities in general and University of Khartoum in particular. In this article we have clearly shown that there is a marked difference in number of published research articles from University of Khartoum and other Sudanese Universities. Every year, the University of Khartoum's published articles outnumber all researches from all other Sudanese universities put together. However in this regard it's noteworthy that we counted only research articles stored in PubMed database and not all journals are indexed in PubMed. Sadly, the vast majority of our Sudanese medical journals are not yet indexed in PubMed, probably for financial reasons. However, The Sudanese journal of pediatrics is well indexed in PubMed, which opens the door for the rest of our local journals to follow suit. It is worth noting that, despite the fact we relied in our analysis only on PubMed, it is still the most comprehensive biomedical database worldwide. Moreover, it employs the most restrictive policy and quality assurance criteria for published biomedical research, that why is it does not suffer from the many shortcomings of the more contemporary and social network inclined

resources like ResearchGate and more importantly, it boasts a unique open-access policy that makes obtaining biomedical data and metadata very easy.

The relative lower number of research articles published by University of Khartoum compared to international universities and for other Sudanese universities is caused by the obstacles of research found in Sudan most importantly lack of funds and the difficulty of finding international collaborations. This is clearly seen in the low impact factor of the most published journals which indicates limits in research methodologies. Facilitating the research in Sudan through funding and international collaboration will push the already rising trend of research even further and hopefully will motivate other Sudanese universities to join the race towards international recognition.

**Interests disclosure:**

All authors declare no conflicts of interest.

**Supplementary information:**

Complete data sets and detailed methods used in analysis are available upon request through contact with the corresponding author.

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