ORIGINAL ARTICLE

Hypertension Research Productivity from Saudi Arabia: A Scientometric Analysis for the Last Two Decades (2001-2020)

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Abstract

Background: Hypertension (HTN) is one of the most prevalent chronic diseases and important global morbidity and mortality, along with other prevalent cardiovascular risk factors. Nonetheless, there has been little data on publication trends and performance evaluation from the Middle East region, including from the Kingdom of Saudi Arabia (KSA).

Objective: This study analysed KSA's hypertension-related research output over the last two decades (2001-2020).

Methods: The Web of Science (WoS) platform was used to extract HTN-related data, and then scientometric analysis was done utilizing the "R-Bibliometrix' package. An extensive array of indicators was studied to determine the quality and quantity of HTN-related publications from KSA.

Results: A total of 3129 research publications from 1274 sources were extracted using WoS over 20 years (2001-2020). Most of the documents (2617) were articles. After 2012, there was a substantial increase in research articles, which peaked in 2020. Among 21343 total authors from 131 countries, two authors had > 40 publications and five had > 2500 total citations. King Saud University (KSU) was the major contributing affiliation, followed by King Abdulaziz University (KAU). Saudi Medical Journal (SMJ) was the leading and most consistent source, while Hypertension, blood pressure, and Saudi Arabia were the most frequently used keywords.

Conclusion: Our study provides an in-depth overview of hypertension-related research productivity from KSA. Some characteristic trends were observed regarding contributions by top authors, productivity, impact, international collaborations, and organizational affiliations. Related stakeholders can find the study findings very useful in precisely interpreting trends and performance of hypertension-related regional work.

Keywords: *Hypertension, research, Saudi Arabia, bibliometry, web of science.*

INTRODUCTION

Hypertension (HTN) is a chronic illness that has become extremely prevalent, reaching a pandemic phase and resulting in substantial health costs, morbidity, and mortality. It is one of the leading causes of cerebrovascular accidents, aneurysms, cardiac failure, coronary artery disease, kidney dysfunction, and peripheral arterial disease. It is a silent killer since it can gradually damage target organs without producing symptoms.

According to WHO, around 1.28 billion adults aged 30-79 have HTN worldwide. An estimated 46% of these individuals are unaware that they have HTN and less than half of the hypertensive adults are diagnosed and treated. From 1990 to 2019, there was minimal change in the global rate of HTN, but the burden has transferred from wealthy nations to low- and middle-income countries. In 2019, more than one billion hypertensive people (82% of all hypertensive people worldwide) lived in low- and middle-income countries [1]. In 2018, however, the American College of Cardiology estimated the prevalence of HTN to range from 4 to 78% in 71 countries worldwide [2].

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Increased prevalence of HTN always leads to a significant increase in the incidence of cardiovascular diseases and their repercussions, potentially overwhelming healthcare systems [3]. It also has financial implications for national drug plans because there is growing evidence that most hypertensive patients require two or more medications to manage blood pressure [4].

Attempts have been made to analyse HTN trends in Arab countries in recent years. A critical appraisal of HTN-related literature from ten Arab countries reported the overall crude prevalence of HTN (BP ≥ 140/90 mmHg and/or use of antihypertensive medication) was 29.5% in 11 studies (n = 45,379) [5]. However, another study conducted in four Middle Eastern countries (Iran, Occupied Palestinian Territory, KSA, and the United Arab Emirates) in 2016-17 found a collective prevalence of HTN at 33%, a 3.5% increase in three years [6].

The prevalence of HTN is increasing in KSA's neighbouring countries. HTN was reported to be 38.2% prevalent in rural parts of Egypt [7]. Whereas, in Jordan, 33.8% of men and 29.4% of women were hypertensive [8]. In KSA, overall mortality from HTN increased from 1.88% in 1990 to 2.37% in 2005 and 2010. It is also a leading contributor to disability-adjusted life years, rising from 5.91% in 1990 to 7.83% in 2010 [9].

According to a 2010 national survey, the prevalence of HTN was 25.5%, with only 44.7% of hypertensives being

aware, 71.8% receiving medications, and 37% being controlled [10]. However, a similar survey conducted in 2014 showed a different picture, with 15.2% of the Saudis being hypertensive, while around 40.6% had borderline HTN and 57.8% of the cases were undiagnosed. Most participants with HTN (78.9%) reported taking medication to treat their condition, and about 45% of participants on HTN medication had their blood pressure controlled [11]. Since then, no significant research on HTN was conducted until 2016, when the African Middle East Cardiovascular Epidemiological (ACE) study investigated the prevalence of various cardiovascular risk factors and found that HTN was present in 47.5% of Saudi adult patients attending various clinics [12]. The Ministry of Health released HTN prevalence statistics in 2018. According to their findings, HTN affects 3.2% of those aged 15-24, 51.2% of those aged 55-64, and up to 70% of those aged 65 years and older [13].

A scientometric analysis is a newly emerging division of information theory that quantitatively analyses previously recorded research properties and behaviour. This has led to research based on quantitative measurements and unbiased data analysis. This innovative analysis technique provides objective data on scientific output in a disciplinary field, a medical specialty, or a disease area. Indicators are used in scientometrics to compare countries, institutions, and disciplines, allowing for the determination of temporal trends. It can play a significant role in providing meaningful data to assist nations in improving their research policies. There has been a rapid expansion in research productivity in this domain over the last two decades.

Many scientometric studies on medicine have been published recently, but very few on HTN. Only three studies analyzed data from HTN-related publications in the global context. One study examined the top 100 most frequently cited articles essentially focused on HTN from all countries over a period covering the whole 20th century (1900-2013) [14]. Devos and Menard conducted a descriptive scientometric study of HTN research output published worldwide over 20 years (1999-2018) [15]. This study was a step up from the previous work, which analysed HTN-related output globally but focused more on the research productivity from European Union countries and compared it with other developed counties like the United States (US), albeit with some limitations [16].

To our knowledge, no Asian researcher has undertaken a similar bibliometric analysis on HTN. Moreover, there is no detailed analysis available for HTN-related research in KSA. The present study investigated the various dimensions of HTN publications published in KSA over the last 20 years (2001-2020) and analysed its multiple trends in-depth.

MATERIALS AND METHODS

The World Bank estimates the population of KSA to be around 32.94 million and categorizes it into a group of high-income countries. The Kingdom has a gross domestic product (GDP) of $683.8 billion and gross national income (GNI) per capita of $20,080 [17]. The country has made considerable investments in research and development, resulting in increased publications in the last few years. Numerous databases are available for researchers and academicians, including Scopus, EBSCO, Science Direct, ProQuest, and PubMed. WoS, the most relevant and widely used database, was chosen, along with appropriate criteria, search topics, and identified keywords from the literature, to retrieve relevant documents. WoS is a Clarivate Analytics (formerly Thomson Reuters) maintained platform. It is considered the most precise and comprehensive scientific exploration source, with the highest quality indexing. It is also assumed to be more appropriate for evaluating the research output of different regions, authors, or organizations [18]. It encompasses a search across major search databases, disciplines, and document types and over one billion searchable cited references [19].

A variety of indicators have been used in the study to measure the quantity and quality of the publications and provide a critical picture of KSA's national and international contributions to HTN literature. The online library and digital resources of KAU were used to access information. This study used scientometric techniques to ensure data quality during the initial extraction and later processing phases. The study examined all published articles in WoS between 2000 and 2020 that specifically addressed HTN.

The following search strategy was used: TS=(Hypertens* OR Blood pressure OR HTN), refined by CU=SAUDI ARABIA, timespan (2000–2020), Indexes (SCI Expanded, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI). The use of "hypertens*" in the above strategy implies that all relevant derivatives of the HTN research term, such as hypertension and hypertensive, are also assessed, and the records retrieved. In total, 3129 documents were found from 1293 sources. The search was conducted on a single day (November 25th, 2021), to avoid inconsistencies with no language restrictions and all types of publications (total = 3129) included.

Data was extracted from WoS in plain text files, and later bibliometric analysis was performed using the "R-Bibliometrix" package at the author, source, and document levels [20]. The information from the retrieved documents was analysed using various bibliometric metrics, such as journals, publication year, authors, citation reports, institutions, and countries/regions.

RESULTS

A total of 3129 research publications were extracted from 1274 sources over the last 20 years (2001-2020), with 2707 (86.5%) published in the last decade. The average number of documents per year for the study period was 156.45. The total number of citations from all

Table 1: Summary table.

Description	2001-2010	2011-2020	2001-2020
Sources (Journals, Books, *etc.*).	208	1170	1274
Documents, count	422	2707	3129
Average years from publication	14.5	4.05	5.46
Average citations per document	30.32	13.53	15.79
Average citations per year per doc	2.019	2.35	2.305
References, count	11775	89623	99595
Document Contents			
Keywords Plus (ID), count	1509	6143	6839
Author's Keywords (DE), count	841	5744	6220
Authors, count	4657	17085	21343
Author Appearances, count	5148	28367	33515
Authors of single-authored documents, count	56	161	210
Authors of multi-authored documents, count	4601	16924	21133
Authors Collaboration			
Single-authored documents, count	68	180	248
Documents per author, average	0.0906	0.158	0.147
Authors per document, average	11	6.31	6.82
Co-Authors per Documents, average	12.2	10.5	10.7
Collaboration Index	13	6.7	7.34
Document Types			
Articles, count	355	2262	2617
Editorials, count	5	18	23
Letters/Correspondences, count	3	16	19
Reviews, count	33	281	314
Others, count	26	130	156

documents was 49413. The average number of citations per document was 15.79, but it nearly doubled (30.32) in the first decade. The total references used were 99595, of which 89623 were used between 2011 and 2020. The total research participating authors were 21343 from 131 countries, with a total of 33515 author appearances. The number of authors of single-authored documents was 210, while the number of authors of multi-authored documents was 2113. On average, there were 6.82 authors and 10.7 co-authors per document. Most of the documents, 2617 (83.6%), were articles, followed by 314 reviews, 156 other categories, 23 editorials, and 19 letters/correspondences (**Table 1**).

The year-wise distribution of hypertension-related research documents showed the lowest number (18) in 2001 and the highest number (509) in 2020. The number of documents produced remained in the double digits until 2012, after which there was a sharp increase in the number of research articles published annually, reaching a peak in 2020. However, the mean total citations (TC) per year showed an undefined pattern, with the highest score in the year 2006 (69.1) and the lowest mean TCs in the previous three years (**Fig. 1**).

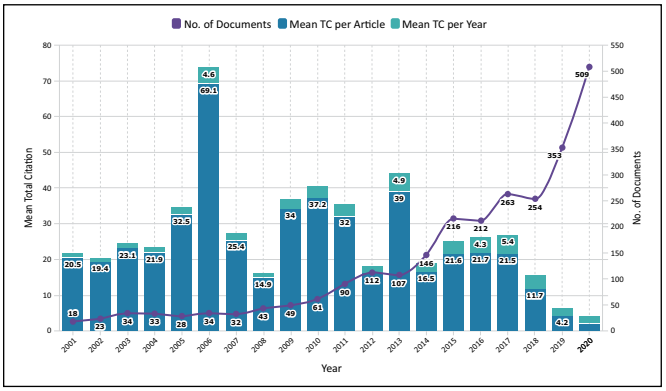

Fig. (1): Year-wise distribution of documents and mean total citations.

Analysis of the top ten most prominent affiliations and funding sources for research projects on HTN showed KSU and KAU contributed the most research documents from KSA, with 1191 and 552, respectively. The foreign affiliations that stood out the most were Helsinki University, Cairo University, and Washington University. The leading funding source was KSU's Deanship of Scientific Research while the National Institute of Health (NIH), USA, and the US Department of Human Health Services were prominent among foreign funding organizations (**Table 2**).

Table 2: Top 10 most frequent affiliations and funding sources.

Affiliations	Count	Funding Organizations	Count
King Saud Univ	1191	King Saud University	145
King Abdulaziz Univ	552	National Institutes of Health NIH USA	117
King Faisal Specialist Hosp And Res Ctr	292	United States Department of Health Human Services	117
King Saud Bin Abdulaziz Univ Hlth Sci	207	European Commission	71
Univ Helsinki	123	UK Research Innovation UKRI	55
Cairo Univ	118	NIH National Heart Lung Blood Institute NHLBI	49
Univ Washington	110	Medical Research Council UK MRC	46
King Khalid Univ	107	British Heart Foundation	45
Imperial Coll London	100	NIH National Institute of Diabetes Digestive Kidney Diseases NIDDK	33
Univ Oxford	100	Canadian Institutes of Health Research CIHR	32

The top 20 most productive countries, authors, and organizations inferred from the three-field analysis indicated that KSA, Qatar, USA, and Oman were the main contributors, while KSU, KAU, and Zagazig University

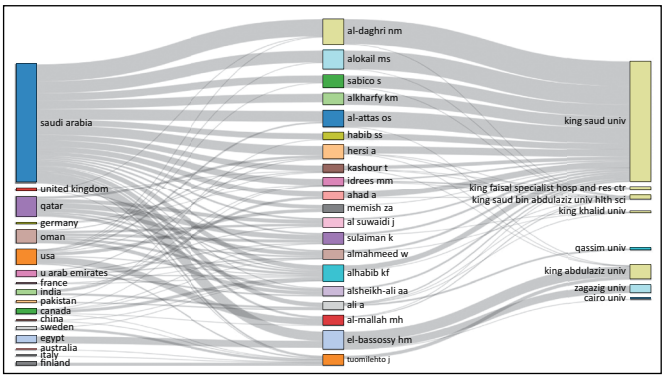

Fig. (2): Three Field Plot for the top 20 most productive countries, authors and organizations.

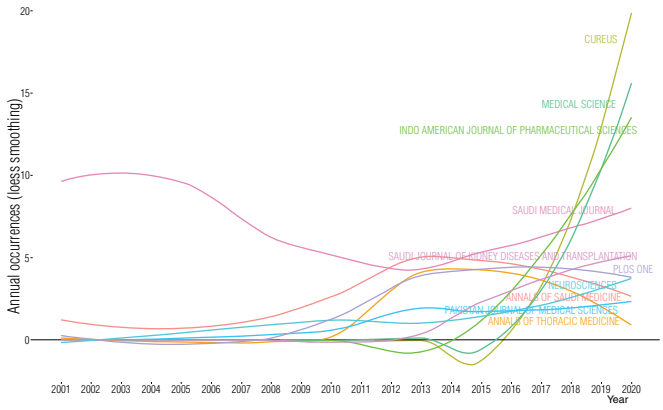

Fig. (3): Year-wise growth of the 10 most productive sources.

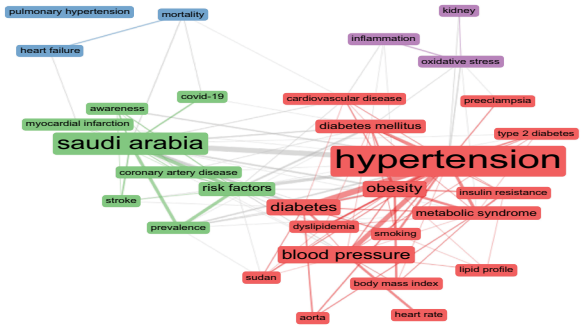

Fig. (4): Most frequent keywords' network groups.

were the chief organizational contributors. The authors, Al-Daghri NM (KSU) and Alokali (KSU), El bassossy HM (KAU), and Tuomilehto J (KAU) demonstrated a maximum collaborative curve for these countries and organizations (**Fig. 2**).

The yearly progress of the ten most productive sources revealed that "SMJ" was a relatively consistent contributor over the last 20 years. "Saudi Journal of Kidney Disease and Transplantations" showed relative growth trends in the last 3-4 years. "Cureus," "Medical Science" and "Indo-Pak Journal of Pharmaceutical Sciences" experienced sudden exponential growth in the last few years. In contrast, two sources, "ASM" and "Annals of Thoracic Medicine," showed a decreasing trend in recent years (**Fig. 3**).

Analysis of the co-occurrence network based on the 30 most frequently used keywords demonstrated that among the four highlighted networks, the most commonly used keyword in the most prominent network was 'HTN' and 'blood pressure', forming a mesh with search words mainly related to other co-morbid health conditions and cardiovascular risk factors like diabetes mellitus, obesity, dyslipidaemia, and smoking. The second largest network was formed by the keyword 'Saudi Arabia' in conjunction with other keywords mostly related to epidemiological or observational research studies such as risk factors, prevalence, awareness, and so on. Search for COVID-19 can also be seen in the same mesh. (**Fig. 4**).

The top 20 most cited publications are shown in Table **3**. With regards to local citations, 4 publications achieved more than 50 citations all to the credit of Al-Nozha MM (2004, 2007, 2005x2) all published in Saudi Med Journal. His 2004 article achieved the maximum local citations (96). Analysing for global citations as shown in WoS, 5 publications got >100 citations, with the highest rank achieved by Al-Nozha MM (2005, SAUDI MED J-a). The same achieved the highest overall citation score of 268. According to IC/GC ratio figures, the highest score

Table 3: Top 20 highly cited documents.

Document	Year	Local Citations (count)	Global Citations (count)	LC/GC Ratio (%)	Normalized Local Citations	Normalized Global Citations
AL-NOZHA MM, 2004, SAUDI MED J	2004	96	112	85.71	25.34	5.11
AL-NOZHA MM, 2007, SAUDI MED J	2007	79	147	53.74	25.28	5.79
AL-NOZHA MM, 2005, SAUDI MED J	2005	62	93	66.67	9.86	2.86
AL-NOZHA MM, 2005, SAUDI MED J-a	2005	62	206	30.1	9.86	6.33
AL-DAGHRI NM, 2011, BMC MED	2011	34	149	22.82	28.33	4.65
ALQURASHI KA, 2011, ANN SAUDI MED	2011	28	198	14.14	23.33	6.18
EL-BASSOSSY HM, 2012, VASC PHARMACOL	2012	21	58	36.21	31.78	3.6
EL BCHERAOUI C, 2014, INT J PUBLIC HEALTH	2014	17	47	36.17	13.42	2.85
EL-BASSOSSY HM, 2013, BRIT J PHARMACOL	2013	15	46	32.61	14.08	1.18
HASSAN N, 2013, N-S ARCH PHARMACOL	2013	15	32	46.88	14.08	0.82
MEMISH ZA, 2014, PREV CHRONIC DIS-a	2014	15	52	28.85	11.84	3.15
AHMED AM, 2017, J SAUDI HEART ASSOC	2017	14	40	35	35.4	1.86
AL-QAHTANI DA, 2005, SAUDI MED J	2005	13	35	37.14	2.07	1.08
AL-QAHTANI DA, 2005, SAUDI MED J-a	2005	13	12	108.33	2.07	0.37
AL-DAGHRI NM, 2010, PLOS ONE	2010	13	34	38.24	12.39	0.91
HASSAN NA, 2014, CHEM-BIOL INTERACT	2014	13	33	39.39	10.26	2
EL-BASSOSSY HM, 2014, TOXICOL MECH METHOD	2014	12	24	50	9.47	1.45
MEMISH ZA, 2014, PREV CHRONIC DIS	2014	12	45	26.67	9.47	2.73
AL-RUBEAAN K, 2015, J DIABETES	2015	12	57	21.05	22.54	2.64
ALHABIB KF, 2009, CAN J CARDIOL	2009	11	37	29.73	14.18	1.09

IC - Internal Citation (Citations within study selected documents), GC - Global Citation (Citation in Web of Science)

was seen for Al Qahtani DA, 2005, (Saudi Med J-a) with 108.33 while the lowest score was achieved by Al Qurashi KA, 2011, (Ann Saudi Med) with only 14.14. 12 (60%) of these articles were published in the last decade (2011-2020).

DISCUSSION

Hypertension is a prevalent chronic disease in KSA; hence more attention is expected to be placed in the research domains on various aspects of the disease and its management in this region. According to the current study, the total number of publications output from KSA in the last 20 years was 3129, with research articles accounting for most of them. However, this number of published articles is much lower when compared to other countries, including the US, Japan, China, the UK, and many European countries [15]. An in-depth analysis of HTN research publications revealed some intriguing trends. First, the quantity of research output related to HTN has soared exponentially over the last decade; between 2010 and 2018, the number of publications steadily increased, but between 2018-2020, they astonishingly doubled. In the last 20 years, the same trend was observed in HTN publications contributed by Asian countries, particularly China [15, 16]. A variety of factors could stimulate this trend. Firstly, in recent years, chronic diseases have captured the interest of the medical research fraternity due to their rising prevalence and heavy toll on morbidity and mortality. Secondly, cardiac risk factors have received much attention as preventive cardiology is gaining more importance. Lastly, many new drugs have recently been developed to treat HTN and numerous clinical trials have been conducted to determine their efficacy and adverse effects.

Among the most frequently affiliated academic institutes, KSU was on the top by a huge margin with 1191 affiliations, almost double the number of affiliations held by KAU, which ranked second. Overall, five Saudi Universities were among the top 10 affiliated institutes. Other universities with many affiliations were the University of Helsinki, Cairo University, Washington University, Imperial College London, and Oxford University. According to the latest statistics, the last three are among the top 30 universities in the world [21]. Organizations and institutes from the US and UK significantly contributed to funding HTN research in KSA. This clearly showed that other than KSU, there was no major local funding body for supporting HTN research and there is a need for other Saudi institutes to increase their funding contributions for HTN research in KSA.

KSA was found to be the most significant contributor to HTN research, trailed by Qatar, the USA, Oman, and Egypt. Most of the authors were from KSA and had affiliations with KSU. Only two Saudi universities, KSU and KAU, were prominently contributing to the country's HTN research. Other local universities' faculties, such as King Khalid and King Saud bin Abdulaziz Universities, need to enhance their research on the important aspects of HTN.

Despite a drop in publications between 2011 and 2014, SMJ was far ahead of all other journals in publishing HTN research as it consistently churned out articles over the last 20 years. Cureus, Medical Science, and Indo-American Journal of Pharmaceutical Sciences showed a very sharp rise in publications in the last 5 to 6 years, most likely due to many experimental trials and RCTs on newly discovered medicines for the treatment of HTN. Another interesting aspect of these three journals is that they had no HTN publications before 2015.

The major networks of keywords also showed that the epicenters of major webs were HTN and KSA, and their interconnections were mostly with search words indicating cardiovascular risk factors and other co-morbid diseases. This indicated that the researchers were not analysing HTN in isolation but from a broader perspective that included diabetes, obesity, and dyslipidemia. They were particularly interested in how it related to cardiovascular disease. The other major keywords were mainly related to the prevalence and awareness of hypertension in Saudi Arabia and the known complications of hypertension including myocardial infarction heart failure and mortality Very recently, researchers have been interested in how COVID-19 is affecting HTN in KSA.

CONCLUSION

In summary, a few substantial conclusions have been drawn from the present scientometric analysis of HTN in KSA, with possible implications for future related research trends. In the previous 2 to 3 years, there has been a large increase in HTN-related publications in KSA due to various expected causes. KSU has the most overall affiliations among authors, followed by KAU, indicating that other Saudi universities have a lot of gaps to fill in the country's HTN research. Saudi Journals other than SMJ have a lot of room to contribute to HTN research in the future. In the last five years, some international journals have made a tremendous contribution to HTN research in KSA, indicating renewed interest in managing this important chronic disease.

There is a need for substantial research work in KSA and other countries in the Middle East region because there is not enough data to determine the sufficiency of HTN research. This is evident when comparing the overall research output related to HTN in KSA to the international landscape. More research will facilitate the study of all critical clinical aspects of this significant chronic disease and develop better management strategies for HTN in the regional context.

ETHICS APPROVAL

Not applicable.

CONSENT FOR PUBLICATION

Not applicable.

AVAILABILITY OF DATA

The data set may be acquired from the corresponding author upon a reasonable request.

FUNDING

No funding was required for this study.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORS' CONTRIBUTION

Authors, Fahad Answer (FA) and Ahmad Azam Malik (AAM) contributed to the conception of the idea, study design, data collection, data analysis, and writing up of the manuscript of this study.

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