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PHARMACOVIGILANCE

Global research output in 'pharmacovigilance' during 2010—2020

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Summary The rapid spread of Covid-19 pandemic globally has thrust drugs safety into the spotlight and the public is now more aware of the role of healthcare professionals and health regulators. The present study aimed to measure the global research landscape on pharmacovigilance (PV) indexed in Scopus database for eleven years period spanning from 2010—2020. The study has sought to use quantitative and visualization technologies for data analysis and interpretation. The search strategy accumulated a total of 2052 global publications data on PV. The findings disclose that the global research productivity on PV registered 8.74% average growth rate (AGR) and 7.38% compound average growth rate (CAGR). The mean relative growth rate (RGR) and doubling time (DT) of PV global publications for the 11 years is 0.27 and 3.03, respectively. The average number of authors per paper (AAPP) is 1.52 and average productivity per author (PPA) is 0.68. The authorship patterns in PV research shows collaborative trend as most of the publications have been published by multiple authors (80.75%). The mean values of degree of collaboration (DC), collaboration index (CI), collaboration coefficient (CC) and modified collaboration coefficient (MCC) during the selected period of study are 0.79, 2.74, 0.72, and 0.73, respectively which highly significant and indicates the better authorship collaborations. France is the bellwether in PV related scientific research as produced the highest number of publications.

Abbreviations

ACP	average citations per paper
ADRs	adverse drug reactions
AGR	average growth rate

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BPI Bundesverb and DerPharmazeutischen Industrie
CAGR compound annual growth rate
CC collaboration coefficient
CI collaboration index
CR citations received
COVID-19 coronavirus disease 2019
DC degree of collaboration
DT doubling time
MCC modified collaboration coefficient
PC publication count
PV pharmacovigilance
RCI relative citation impact
RGR relative growth rate
SARS-CoV-2 severe acute respiratory syndrome coronavirus 2
SJR SCImago journal rank
TC total citations
TLS total link strength
TNC total number of citations
TNP total number of publications
UMC Upssala Monitoring Center
WHO World Health Organization

Introduction

Pharmacovigilance (PV) is an arm of patient care in making the rational use of medicines for the prevention of disease. In the recent times, the PV is of great importance as it is a key element in the regulation of effective drug use systems for the detection and prevention of adverse drug reactions (ADRs). According to the World Health Organization (WHO), ADRs defines as ''a response to a drug which is noxious and unintended and which occurs at doses normally used in man for the prophylaxis, diagnosis or therapy of disease, or for the modifications of physiological function'' (as cited by Ibrahim et al. [1]). As per the WHO, ADRs are responsible for a significant number of hospital admissions ranging between $0.3 \geq 11$ percent [2,3]). The WHO has defined the PV as ''the science and activities relating to the detection, assessment, understanding and prevention of adverse effects or any other medicine/vaccine related problem'' [4].

PV is all about the safer and more effective use of medicines for everyone. PV has been regarded as a continuous monitoring of undesired effects and drugs safety related issues. Therefore, the development of PV within a public health programme should be seen as an important opportunity towards the development of PV within the local health service of a comprehensive National PV System and should be seen as an obligatory investment in the future public health of the territory [5,6]. According to WHO, the aims of PV are to:

- improve patient care and safety in relation to the use of medicines and all medical and paramedical interventions;
- improve public health and safety in relation to the use of medicines;
- detect problems related to the use of medicines and communicate the findings in a timely manner;
- contribute to the assessment of benefit, harm, effectiveness and risk of medicines, leading to the prevention of harm and maximization of benefit;
- encourage the safe, rational and more effective use of medicines; and
- promote understanding, education and clinical training in PV and its effective communication to the public.

The safety monitoring of medicines has been used in national health programs of various countries and with the measures of education, awareness, training and technical assistance, the patients or consumers (the end users of the pharmaceutical products) are now reporting the ADRs [7]. The healthcare professionals are the cornerstones in detection and reporting of ADRs to ensure medications safety [8].

To coordinate, report and monitoring ADR detection at global level, the World Health Organization (WHO), Geneva has established the pharmacovigilance (PV) unit at Uppsala Monitoring Center (UMC), Sweden. The current global network consisting of 145 countries have been reporting ADRs to the UMC, Sweden [6].

Within the pharmaceutical field, PV deserves a special attention, as it monitoring the performance of the pharmaceutical products that already available in the market. Although the pharmaceutical products are formulated to prevent, alleviate and to cure the illnesses but even can produce undesirable harmful effects. This duality of pharmaceutical products has significant for the public health and makes PV as an essential activity for health regulation in the country. Through early detection of the risk and timely intervention, the PV protects population from the damage caused by the pharmaceutical products.

PV importance in COVID-19 pandemic

In the current scenario, the clinical trials in drug therapy or drug discovery against novel corona virus prove the importance of PV. The global devastating impact of coronavirus disease 2019 (COVID-19) pandemic has been pushed the PV to innovate and develop new and more efficient ways for collecting and utilizing the drug's safety data. It's a global concern that sufficient information related to safety of therapies or different treatment alternatives being used for the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infections is limited. In light of the rapid drug discovery process (vaccine or drugs) across the globe, it is crucial that countries must share relevant ADRs in a time bound manner towards better understanding the efficacy and safety of the treatment or therapies used against the COVID-19 to manage long-term and pre-existing conditions.

WHO-UMC has provided useful information and issued necessary guidelines to perform the PV work during this COVID-19 pandemic, these include the following:

- medicines safety during COVID-19;
- how to capture adverse event reports (coding guidance) for COVID-19 treatments; and
- how to find adverse event reports linked to COVID-19 in VigiLyze (application used to visualize and analyze the drug safety data in COVID-19).

The rapid spread of COVID-19 pandemic globally has thrust drugs safety into the spotlight and the public is now more aware of the role of health professionals and health regulators. Therefore, the PV experts, clinicians, stakeholders and drug regulators needed to collaborate and assess the suspected ADRs timely to the success of public health across the globe.

In the scientific scenario, the production of the thematic area of PV has increased significantly over the past years therefore, it is essential to evaluate this production. In fact, a limited number of bibliometric studies carried out to measure the quality and impact of PV and ADRs related research activities have concentrated on the traditional bibliometric investigations extricated data from Web of Science, Scopus and PubMed database. Therefore, the present study has tried to bridge the research gap and studies the collaborative networks using the knowledge mapping techniques.

Statement of the problem

In light of the rapid drug discovery process (vaccine or drugs) across the globe, prove the importance of PV in relation to safety of therapies or different treatment alternatives being used for the COVID-19 infections. Therefore, PV across the world has become the important public health issue concern to regulators, drug manufacturers and the healthcare professionals. In light of its increasing relevance, the present study is an effort to evaluate the global research productivity in PV and assess the current research trends on a set of quantitative and qualitative metrics to provide some insights into the complex dynamics of research productivity on PV.

Review of related literature

A limited number of bibliometric analyses related to PV, ADRs and medication errors have been carried out. Huang, Du and Cong [9] analyze the global research trends of PV in China and identified the growth in hospitals, pharmaceutical enterprises and of the opinion that the collaborations between institutions were tight. Zheng, Cheng and Song [10] in analyzing the current status and shortcomings of PV research in China, revealed that the PV research in China still focuses on traditional adverse drug reactions monitoring. The global research growth and patterns on systemic use of off-label and unlicensed drugs has witnessed a general increase in the past two decades [11].

Shrestha et al. [12] emphasized that there is a need to study and evaluate ADR and PV in Nepal to improve PV practice and to promote the quality use of medicines. Zhang et al. [13] stressed that the comprehensive features and the risk factors of cardiac ADRs induced by oral Chinese Materia Medica can be elucidated through the approaches of bibliometric research towards creating awareness of PV. Chen et al. [14] in the field of event detection in social media (ED in SM) identified PV event detection as newly emerged themes among the 14 identified research themes. AlHusaini and AlMubarak [15] emphasized that education on ADRs medical safety are necessary for the population for gaining more awareness of consequences of ADRs and for the healthcare provider to give a clear and accurate information to the patients.

Moore et al. [16] reported that the discovery and quantification of ADRs has long relied on the careful analysis of spontaneously reported cases and the spontaneous reporting remains irreplaceable in signal and alert generation in drug safety. The availability of large databases and computerized automated statistical approaches has modified the assessment of drug safety and of their benefits harms balance [17]. Abou Taam et al. [18] reported that due to paradigm shift in the assessment and management of patient related drug safety, the importance of pharmacoepidemiology and its use in pharmacovigilance has significantly increased.

Lefebvre et al. [19] to enhance the effectiveness of PV programs, clustered the 1244 respondents into 4 segments: not engaged (12%), low-involvement users (29%), careful users (50%) and social information seekers (9%) distinguishing by perceived seeking control, self-appraisal of skill, information insufficiency, self-efficacy, information competency and health literacy towards identifying for prescription drug safety social marketing and communication activities. The result shows significant differences among the segments in their comprehension and perceived utility.

Wilbur, Sahal and Elgaily [20] explore how the pharmacists identify, prioritize and communicate ADRs to patients in a Doha hospital, Qatar. They found that expert cardiology pharmacists used widely accessible resources during choosing the most commonly reported ADR to communicate during medication counselling. Shang, Chen and Livoti [21] proposed a framework to detect Avandia ADRs using Google Trends to early identify the ADR events and the resultant data proved to have a longer leading time than the traditional drug reaction discovery methods.

The research related to detection methods of cardiotoxicity and preventive drugs is gradually increasing [22]. With the extensive digitalization of medical information globally, the natural language processing is becoming more crucial [23]. Santos et al. [24] highlights the significant increase in the papers from 2009—2018 focusing mostly on infectious, parasitic and communicable diseases, chronic diseases and risk factors for chronic diseases. The *Journal of Medical Internet Research* and *PLoS ONE* published the highest number of papers. Huang et al. [25] retrieved 3343 medication errors and 3342 adverse drug event documents from 1961—2013 through Web of Science database. The study focused 3 key themes namely medication errors in adult inpatients, computerized physician order entry in medication error studies, and medication errors in pediatric inpatients. More research on implementing patient safety improvement initiatives might be needed [26].

Research objectives

The main objective of the study is to measure the global research landscape in the field of PV as reflected in the publication output spanning from 2010—2020. The specific objectives of the study are:

- to identify the growth rates and doubling time of PV research;
- to identify the author productivity and collaborative trends in PV research;
- to identify the contributions of the prolific authors, institutions and countries in PV research;
- to identify the prominent research themes using the keywords analysis.

Table 1 Types of publications.

Types of Publications	TNP	%TNP	TNC	%TNC	h-index
Article	1317	64.18	10828	77.14	47
Review	202	9.84	1909	13.61	25
Letter	107	5.21	350	2.49	12
Book Chapter	99	4.83	83	0.59	5
Note	85	4.14	284	2.02	12
Editorial	79	3.85	315	2.24	11
Short Survey	75	3.66	47	0.34	4
Conference Paper	71	3.46	195	1.39	8
Book	7	0.34	18	0.13	2
Erratum	7	0.34	2	0.01	1
Undefined	3	0.15	6	0.04	2

TNC: total number of citations; TNP: total number of publications.

Material and methodology

The global research publications data on PV was retrieved and downloaded from Scopus database for the period from 2010-2020 using ''date range tag''. The Scopus database was used as a tool to retrieve potential publications as Scopus database in terms of wide global coverage of scientific journals, is the largest abstract and citation databases. The search string used for the purpose included ''pharmacovigilance'' as per the Medical List of Subject Heading. A total of 6789 publications data were retrieved as recall value through the search string ''TITLE-ABS-KEY (pharmacovigilance) AND PUBYEAR > 2009 AND PUBYEAR < 2021''. Further, to precise the result, the search query was refined as ''TITLE (pharmacovigilance) AND PUBYEAR > 2009 AND PUBYEAR < 2021'' for retrieving the most refined and potential datasets. As a result, the search strategy accumulated a total of 2052 (TNP = 2052) global publications data on PV. The global data between 2010 and 2020 were downloaded on 27th October, 2021 for analysis based on the preset query sets. The study has sought to use quantitative and visualization technologies for data analysis and interpretation. Network visualization maps including research collaboration of authors, journals, institutions and countries were created by using the VOSviewer program. The study has also made use of analytical provisions as available in the Scopus database [27].

Bibliometrics indicators and scientometric parameters used

Author has used two bibliometric indicators in the present study. These are total number of publications (TNP) and total number of citations (TNC) for measuring the scientific output and impact. Besides these bibliometric indicators, two relative indicators viz average citations per paper (ACP) and relative citation impact (RCI) have also been used. Various scientometric parameters have also been applied such as average growth rate (AGR), compound average growth rate (CAGR), relative growth rate (RGR), doubling time (DT), Pearson correlation, authors' productivity and explored statistical techniques for the present study. To measure collaboration patterns among authors; degree of collaboration (DC), collaboration index (CI), collaboration coefficient (CC), and modified collaboration coefficient (MCC) methods used.

Result and discussion

Types of publications

The study presents the types of publications in PV related global scientific research output during the study period from 2010—2020. Ten ($n = 10$) types publications excluding undefined category indexed in the Scopus database were found in the total publications (TNP = 2052) retrieved. The researchers of PV preferred to publish work in the form of the journal article with a proportion of 64.18 per cent ($n = 1317$) of the total publications. At the second place was review accounting for 9.84 per cent ($n = 202$). Other publication types included letter with proportion of 5.21 per cent ($n = 107$), book chapter with 4.83 per cent ($n = 99$), note with 4.14 per cent ($n = 85$), editorial with 3.85 per cent ($n = 79$), short survey with 3.66 per cent ($n = 75$) and conference paper accounting for 3.46 per cent ($n = 71$) publication share. The table shows that less than 1 per cent of publications appeared as book and erratum. The impact of citation in the terms of research was also noticeable in PV related global research output and journal articles with h-index 47 received the highest number of citations with a proportion of 77.14 per cent ($n = 10828$) of the total citations (TNC = 14037), followed by review accounting for 13.61 per cent ($n = 1909$) (Table 1).

Source types

The journals considered as the vital source and main channel of information towards disseminating the research output. Five ($n = 5$) source types excluding undefined category indexed in the Scopus database were found in the total publications (TNP = 2052) retrieved. The most preferred source type was journal accounting for 90.74 per cent ($n = 1862$) of the total publications. At the second position was book with a proportion of 4.53 per cent ($n = 93$). Other source

Table 2 Source types.

Source types	TNP	%TNP	TNC	%TNC	h-index
Journal	1862	90.74	13791	98.25	50
Book	93	4.53	100	0.71	6
Conference proceedings	41	1.99	109	0.78	7
Book series	28	1.37	31	0.22	3
Trade journal	27	1.32	6	0.04	1
Undefined	1	0.05	0	0	0

TNC: total number of citations; TNP: total number of publications.

Table 3 Global research output and citations count.

Time span	TNP	%TNP	TNC	%TNC	ACP	AGR	h-index
2010	106	5.17	27	0.19	0.26	00	19
2011	139	6.77	138	0.98	0.99	31.13	25
2012	167	8.14	349	2.49	2.09	20.14	23
2013	156	7.60	623	4.44	3.99	−6.59	24
2014	207	10.09	942	6.71	4.55	32.69	23
2015	185	9.02	1180	8.41	6.38	−10.62	22
2016	190	9.26	1424	10.15	7.49	2.70	20
2017	221	10.77	1643	11.70	7.43	16.32	18
2018	253	12.33	2326	16.57	9.19	14.48	18
2019	196	9.55	2433	17.33	12.41	−22.52	15
2020	232	11.30	2952	21.03	12.72	18.37	14

ACP: average citations per paper; AGR: average growth rate; TNC: total number of citations; TNP: total number of publications.

types included conference proceedings accounting for 1.99 per cent ($n = 41$), book series with 1.37 per cent ($n = 28$) and trade journal with a proportion of 1.32 per cent ($n = 27$). The impact of citation in the terms of research was also noticeable in PV related global research output and journal received the highest number of citations with a proportion of 98.25 per cent ($n = 13791$) of the total citations (TNC = 14037), followed by conference proceedings accounting for 0.78 per cent ($n = 109$) (Table 2).

Global research output and citations count

Table 3 demonstrates the chronological global research output (TNP = 2052) and the impact of citations (TNC = 14037) on PV literature during the study period from 2010—2020. The PV has made a remarkable development in terms of scientific principles and effective clinical practices towards establishing itself as a well-recognized research topic. This led to the rapid jump in the number of publications over the past years. The global research output in PV registered an 8.74 per cent AGR and 7.38 per cent CAGR. The research impact of global publications in PV averaged to 6.84 ACP. Of the retrieved publications data, it revealed that the year 2018 has recorded the highest annual output with a proportion of 12.33 per cent ($n = 253$) and fetched 16.57 citations ($n = 2326$) averaged to 9.19 ACP. The lowest output recorded in the year 2010 with a proportion of 5.17 per cent ($n = 106$) with 0.19 per cent citations. The highest *h-index* 25 is in the year 2011 (Table 3).

The following equation is used for calculating the AGR:

$$r = \frac{P_1 - P_0}{P0} \times 100$$

Where, r = Publication growth in percentage
P0 = Number of publication in the base year
P1 = Number of publication in the present year
The formula given by Pandya, Joorel and Solanki [28] is used to calculate the compound average growth rate (CAGR).
$CAGR = (V_{final}/V_{begin})^{1/t} - 1$
Where,
CAGR = compound average growth rate
V_{begin} = beginning value
V_{final} = final valuet = time in years

Relative growth rate and doubling time of publications

Relative growth rate (RGR) is a measure to study the increase in the number of publications per unit of time over the specific period of the interval and is calculated using the following equation (as cited in Mohan and Kumbar [29]):

$$RGR = \frac{lnN2 - lnN1}{t2 - t1}$$

Where,

Table 4 Relative growth rate and doubling time of publications.

Time span	TNP	Cumulative	Natural Log	RGR	DT
2010	106	106	4.66	–	–
2011	139	245	5.50	0.84	0.82
2012	167	412	6.02	0.52	1.33
2013	156	568	6.34	0.32	2.17
2014	207	775	6.65	0.31	2.24
2015	185	960	6.87	0.22	3.15
2016	190	1150	7.05	0.18	3.85
2017	221	1371	7.22	0.17	4.08
2018	253	1624	7.39	0.17	4.08
2019	196	1820	7.51	0.12	5.78
2020	232	2052	7.63	0.12	5.78

DT: doubling time; RGR: relative growth rate; TNP: total number of publications.

Log N_1 = natural log of the initial number of publication

Log N_2 = natural log of the final number of publication$t_2 - t_1$ = unit difference between the initial and final time

On the other hand, doubling time (DT) is the time required for the publication to double in existing number and is calculated using the following equation:

$$DT = \frac{ln2}{RGR}$$

The RGR for the PV global publications decreased gradually from the rate of 0.84 to 0.12. On the other hand, DT of PV global publications displays an increasing trend from the rate of 0.82 to 5.78. Therefore, it revealed from the data that as the relative growth of publications decreased, simultaneously, the corresponding doubling time of publications will increase. The mean RGR and DT of PV publication for 11 years is 0.27 and 3.03, respectively (Table 4).

Authors' productivity

It has been inferred from the data that the total average number of authors per paper (AAPP) is 1.52 and the average productivity per author (PPA) is 0.68. It revealed that the highest number of author's productivity 253 (0.76) was registered in the year 2018 and lowest number 106 (0.52) in 2010 (Table 5).

The formula given by Yoshikane, Nozawa, Shibui, and Suzuki [30] is used to calculate the author productivity over the time period;

Average author per paper = Number of authors/Number of papers

Productivity per author = Number of papers/Number of authors

Authorship collaboration

The degree of collaboration (DC), collaboration index (CI), collaboration coefficient (CC), and modified collaboration coefficient (MCC) methods used to measure collaboration patterns among authors.

The degree of collaboration (DC) defined as ''the ratio of the number of collaborative publications to the number of publications in a given field during a particular period of time''. The equation given by Subramanyam [31] is used to calculate the DC:

$$Degree\ \ of\ \ collaboration\ \ (DC) = \frac{Nm}{Nm + Ns}$$

Where,

DC = degree of collaboration

Nm = number of multiple-authored research papers

Ns = number of single-authored research papers

Collaboration index (CI) is a measure of mean number of authors and it neither lies between 0 and 1 and nor expressible in terms of percentage. The following equation is used to count the CI:

$$\mathrm{CI} = \frac{\sum_j^A = 1jfj}{N}$$

Where, j = number authors in an article; fj = number of j authored articles

N = total number of articles published in a year

A = total number of authors per articles

Collaboration coefficient (CC) vanishes for a collection of single-authored papers and distinguishes between single-authored, two authored, three-authored, etc., papers. However, it fails to yield 1 for maximal collaboration, except when the number of authors infinite [32,33]. The following equation is used to count the CC:

$$\mathrm{CC} = 1 = \frac{\sum_j^A = 1\left(\frac{1}{j}\right)fj}{N}$$

Modified collaboration coefficient (MCC) is a measure for quantifying the degree of research collaboration. The following equation is used to count the MCC:

$$\mathrm{MCC} = \left(\frac{N}{N-1}\right)\{1 - \frac{\sum_j^A = 1\left(\frac{1}{j}\right)fj}{N}\}$$

Table 5 Authors' productivity.

Time span	TNP	TNA	AAPP	PPA
2010	106	203	1.92	0.52
2011	139	250	1.79	0.56
2012	167	231	1.38	0.72
2013	156	260	1.67	0.60
2014	207	266	1.29	0.78
2015	185	223	1.21	0.83
2016	190	325	1.71	0.59
2017	221	281	1.27	0.79
2018	253	331	1.31	0.76
2019	196	341	1.74	0.58
2020	232	327	1.41	0.71

AAP: average author per paper; PPA: productivity per author; TNA: total number of authors; TNP: total number of publications.

Table 6 Authorship collaboration.

Time span	TNP	TNA	Single-authored documents Ns	Multi-authored documents Nm	DC	CI	CC	MCC
2010	106	203	35	71	0.67	2.65	0.78	0.79
2011	139	250	45	94	0.68	2.48	0.76	0.77
2012	167	231	49	118	0.71	2.62	0.75	0.76
2013	156	260	36	120	0.77	2.58	0.71	0.72
2014	207	266	45	162	0.78	2.64	0.73	0.74
2015	185	223	43	142	0.77	2.56	0.76	0.77
2016	190	325	30	160	0.84	2.51	0.74	0.75
2017	221	281	32	189	0.86	2.84	0.72	0.73
2018	253	331	45	208	0.82	3.17	0.74	0.74
2019	196	341	15	181	0.92	3.16	0.71	0.72
2020	232	327	20	212	0.91	3.19	0.57	0.57

CC: collaboration coefficient; CI: collaboration index; DC: degree of collaboration; MCC: modified collaboration coefficient; TNA: total number of authors; TNP: total number of publications.

The analysis discloses that the authorship patterns in PV research shows collaborative trend as the most of the publications have been published by multiple authors. In all, a total of 80.75 percent ($n = 1657$) publications have been published in co-authorship, whereas only 19.25 per cent ($n = 395$) published in single-authorship. The resultant data inferred that the magnitude and density of collaborative patterns among the authors are high in PV research. It has been calculated from the data that the DC (0.92) is maximum in the years 2019 and lowest value 0.67 found in the year 2010. The mean value of DC during the selected period of study is 0.79. The calculated values show that the CI is highest in the year 2020 (3.19) and lowest in the year 2011 (2.48). The mean value of CI during the period is 2.74. The analysis demonstrates that the highest value of CC found in the year 2010 (0.78) and lowest in the year 2020 (0.57). The mean value of CC during the study period is 0.72. The figures show that the highest value of MCC found in the year 2010 (0.79) and lowest in the year 2020 (0.57). The mean value of MCC during the selected period is 0.73 (Table 6).

Correlation between number of papers and number of authors

Pearson correlation analysis used to evaluate the correlation between number of papers and the number of authors. The resultant data inferred significant and positive relationship ($r = 0.738$, $n = 11$, $P = 0.009$). As the P-value is < 0.05, therefore, it is highly significant. It means that the higher numbers of co-authors were contributed to the higher number of papers (Table 7).

Most productive authors

It is imperative that contributions by authors in PV related literature have spanned across the globe. A good number of authors (TNA = 3038) had contributed unevenly in global research output in PV. The top ten author's productivity varied between $21 \geq 62$ publications per author. The top 10 authors dominate research in PV together accounted for 18.37 per cent ($n = 377$) of global publication share and

Table 7 Correlation between number of papers and number of authors.

		Number of papers	Number of authors
Number of papers	Pearson correlation	1	0.738
	Sig. (2-Tailed)		0.009
	n	11	11
Number of authors	Pearson correlation	0.738	
	Sig. (2-Tailed)	0.009	
	n	11	11

*Correlation is significant at the 0.05 level.

accounting for 31.69 per cent ($n = 4449$) citations exhibiting with a proportion of citation impact of 11.80 average citations per paper (ACP). It denotes that it is necessary for the authors to collaborate for strengthening the international co-authorship patterns. The resultant data revealed that among the top 10 productive authors; Montastruc, Jean Louis with a proportion of 3.02 per cent ($n = 62$) produced the highest number of publications and most of the publications are in *Therapies* journal, followed by Thurisch, Boris accounting for 2.63 per cent ($n = 54$) publications and Sickmüller, Barbara with a proportion of 2.39 per cent ($n = 49$) publications ranked at second and third positions, respectively. Other authors with publications ranging between $21 \geq 36$ were actively participated in producing the global research output in PV. The author Lapeyre-Mestre, Maryse has the highest citation impact of 26.88 ACP and exhibit highest 3.92 relative citation impact (RCI). The analysis also discloses that most of the productive authors in the list belong from France (7 authors), followed by Germany (2 authors) and 1 from Sweden. RCI is an indicator (developed by Thomas Reuters erstwhile Institute of Scientific Information) used to measure the impact of research production of nations/institutions/authors/journals. The authors having RCI < 1 implies that the research output was not commensurate with their impact, whereas, authors having RCI > 1 indicates the high impact research (Table 8).

Collaborative network of authors

There were 47 authors meeting the threshold of a minimum of 10 documents per author and grouped into clusters, where cluster indicates group of closely collaborating authorship [34]. The co-authorship network of authors in the field of PV is visually depicted in Fig. 1. Out of the total 3038 authors, 47 meet the criteria; however, only 38 items are seen to be connected in terms of collaboration. The network visualization map demonstrates the strength of collaboration between 38 authors, distributed across 5 clusters, coloured differently, with 142 links and total link strength (TLS) of 572 (Fig. 1).

Most productive countries

In all, a total of one hundred fifty two ($n = 152$) countries contributed unevenly in global PV scientific research. The countries were ranked according to the descending order of their total publications. The top ten countries share ranging between $77 \geq 373$ publications reflect the major contributions on PV research. France has the highest number of publications with a total of 373 publications accounting for 18.18 per cent of the total publications in this field. It revealed that France is the bellwether in PV related scientific research. United States of America (USA) ranked second with a proportion of 15.11 per cent ($n = 310$) of the total publications, followed by India accounting for 10.09 per cent ($n = 207$) publications share. The top 10 leading countries in a combined manner contributed with a proportion of 85.23 per cent ($n = 1749$) of the total publications denotes increasing in the collaborative research. A large number of publications by the top 10 countries denote that these countries have the greater advantages than the others. The USA has the highest 1.82 RCI followed by Switzerland with 1.54. The countries having RCI < 1 implies that the research output was not commensurate with their impact, whereas, countries having RCI > 1 indicates the high impact research (Table 9).

Collaborative network of countries

Wang and Chang [35] opined that collaboration network of countries reflect the collaboration relationship in the research. The network visualization map has been created with a threshold of 10 documents per country and out of the total 152 countries participated in the PV research, 39 meet the criteria. These 39 countries have been distributed among 7 clusters, coloured differently, having a total of 254 links and a total link strength (TLS) of 862. As depicted in Fig. 2, clusters of various colours represent the diversification of PV research conducted by authors in collaborative manners. The big nodes represent the dominant countries. The links between the nodes represent the cooperative relationship in PV research. The distance between the nodes and thickness of the links symbolize the cooperative level among the countries (Fig. 2).

Most productive organizations

The total number of PV focused publications was produced by 5322 organizations. The organizations were ranked according to the descending order of their total publications. The top 10 organizations dominate research in PV together accounted for 30.51 per cent ($n = 626$) of global publication share and Exhibit 54.72 per cent ($n = 7682$) citations. The global publication share of top 10 organizations ranging between $36 \geq 130$ publications reflect the contributions on PV research. The highest share in publication was

Table 8 Most productive authors.

Most productive authors	Affiliation	PC	%PC	CR	%CR	ACP	RCI	h-index	TLS
Montastruc, Jean Louis	Universite Paul Sabatier Toulouse III, France	62	3.02	1109	7.90	17.89	2.62	63	107
Thurisch, Boris	Bundesverband der Pharmazeutischen Industrie (BPI) e. V., Germany	54	2.63	4	0.03	0.07	0.01	5	49
Sickmüller, Barbara	Bundesverband der Pharmazeutischen Industrie (BPI) e. V., Germany	49	2.39	3	0.02	0.06	0.01	4	49
Bagheri, Haleh	Centre Hospitalier Universitaire De Toulouse, France	36	1.75	648	4.62	18	2.64	27	65
Montastruc, Franois	Centre Hospitalier Universitaire De Toulouse, France	32	1.56	337	2.40	10.53	1.54	19	61
Durrieu, Geneviève	INSERM, France	29	1.41	267	1.90	9.21	1.35	18	66
Lebrun-Vignes, Bénédicte	Sorbonne Universite, France	26	1.27	612	4.36	23.54	3.43	27	5
Lapeyre-Mestre, Maryse	Université Fédérale France	24	1.17	645	4.59	26.88	3.92	43	42
Edwards, Ivor Ralph	Uppsala Monitoring Centre, Sweden	23	1.12	282	2.01	12.26	1.79	37	0
Bondon-Guitton, Emmanuelle	Centre Hospitalier Universitaire De Toulouse, France	21	1.02	339	2.42	16.14	2.38	16	49
Gautier, Sophie	CHU Lille, France	21	1.02	203	1.45	9.67	1.42	20	7

ACP: average citations per paper; CR: citations received; PC: publication count; RC: relative citation impact; TLS: total link strength

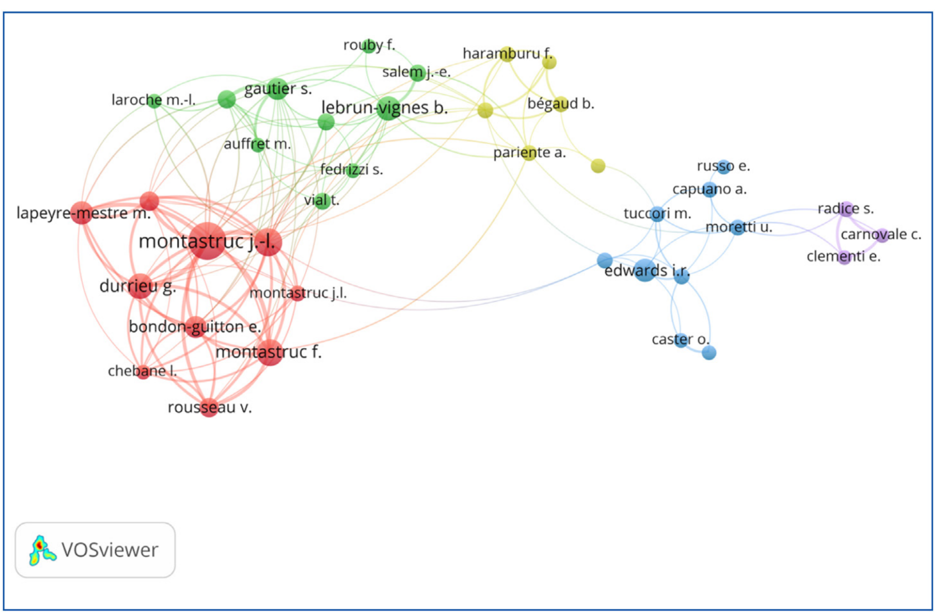

Figure 1. Collaborative network of authors.

reported by *Institut national de la santé et de la recherche médicale* (INSERM), France with a proportion of 6.36 per cent ($n = 130$) publications and fetched a citations accounting for 10.08 per cent ($n = 1415$) with citation impact of 10.88 ACP and having 1.59 RCI followed by *Centre hospitalier universitaire* de Toulouse, France with a proportion of 4.29 per cent ($n = 88$) publications, 8.69 per cent ($n = 1221$) citations, ACP of 13.88 and 2.03 RCI. The data also exposes that

Table 9 Most productive countries.

Most productive countries	TNP	TNC	ACP	RCI	TLS
France	373	4461	11.95	1.28	92
United States of America	310	5265	16.98	1.82	138
India	207	996	4.81	0.51	18
United Kingdom	205	2080	10.14	1.08	140
Germany	179	894	4.99	0.53	60
Italy	145	1378	9.50	1.01	64
Sweden	86	1095	12.73	1.36	88
Netherlands	85	972	11.43	1.22	83
Switzerland	82	1176	14.34	1.54	87
Spain	77	810	10.51	1.12	44

ACP: average citations per paper; RCI: relative citation impact; TNC: total number of citations; TLS: total link strength; TNP: total number of publications. Scopus data may not have been harmonized inflates the output citations counts

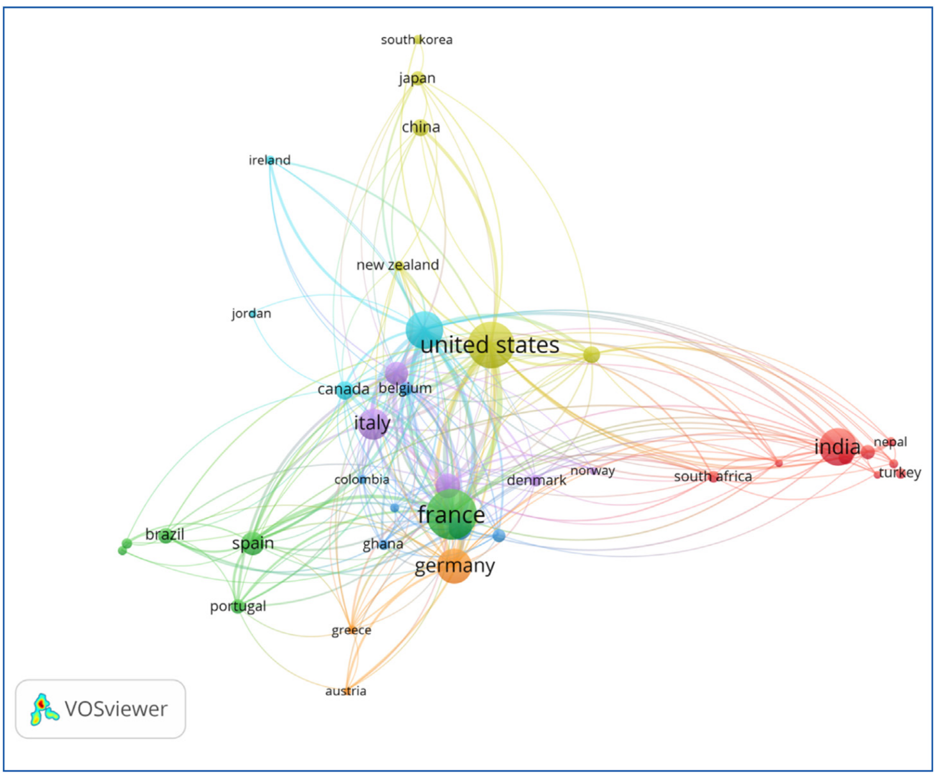

Figure 2. Collaborative network of countries.

most of the organizations in the list belong from France; therefore, it revealed that France is the bellwether in PV related scientific research and indicating the significant efforts of these organizations. Except one, all the organizations exhibit RCI > 1, indicates the high impact research (Table 10).

Collaborative network of organizations

The network visualization mapping among the organizations in the field of PV research has been visually depicted in Fig. 3. The map has been created with a threshold of 2 documents per organizations and out of the total 5322 organizations, 384 meet the criteria. However, only 49 items are seen to be connected in terms of collaboration. The map demonstrates the strength of collaboration between 49 organizations, distributed across 11 clusters, coloured differently, with 85 links and TLS of 96. The organizations have shown the weak collaboration (Fig. 3).

Most productive journals

The PV focused research publications were produced in 1862 journals and the top 10 productive journals depicted in Table 11. According to the Bradford's Law, the journals were ranked in terms of the decreasing order of their

Table 10 Most productive organizations.

Most productive organizations	TNP	%TNP	TNC	%TNC	ACP	RCI
Institut national de la santé et de la recherche médicale (INSERM), France	130	6.34	1415	10.08	10.88	1.59
Centre hospitalier universitaire de Toulouse, France	88	4.29	1221	8.69	13.88	2.03
Universite Paul Sabatier Toulouse III, France	78	3.8	986	7.02	12.64	1.85
Uppsala Monitoring Centre, Sweden	65	3.17	701	4.99	10.79	1.57
AP—HP Assistance publique—Hopitaux de Paris, France	62	3.02	741	5.28	11.95	1.75
Université de Bordeaux, France	49	2.39	762	5.43	15.55	2.27
CERPOP - Centre d'epidémiologie et de recherche en santé des populations, France	42	2.05	732	5.22	17.43	2.55
Bundesverband der Pharmazeutischen Industrie (BPI) e. V., Germany	38	1.85	3	0.02	0.08	0.01
Université fédérale Toulouse Midi-Pyrénées, France	38	1.85	661	4.71	17.39	2.55
Sorbonne Universite, France	36	1.75	460	3.28	12.78	1.87

ACP: average citations per paper; RCI: relative citation impact; TNC: total number of citations; TNP: total number of publications.

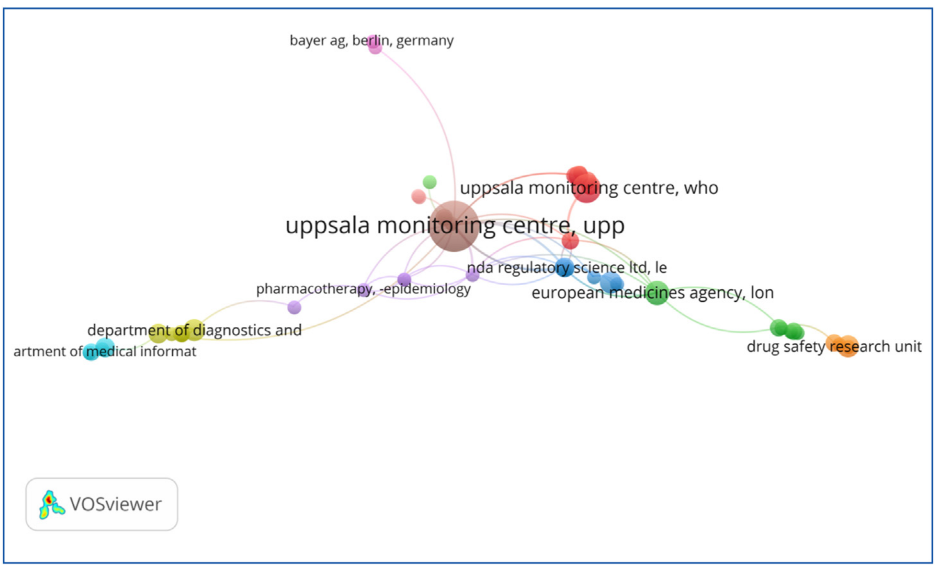

Figure 3. Collaborative network of organizations.

Table 11 Most productive journals.

Most productive journals	Publisher	PC	TC	ACP	RCI	CiteScore (2020)	SJR
Drug Safety	Springer Nature	136	1891	13.90	2.03	6.7	1.377
Pharmazeutische Industrie	Editio Cantor Verlag	83	8	0.09	0.02	0.1	0.102
Therapies	Elsevier	71	621	8.75	1.28	2.5	0.387
European Journal of Clinical Pharmacology	Springer Nature	41	534	13.02	1.91	4.8	0.845
Pharmacoepidemiology and Drug Safety	Wiley-Blackwell	41	541	13.19	1.94	4.4	1.023
Expert Opinion on Drug Safety	Taylor & Francis	32	264	8.25	1.21	6.1	1.086
Mann's Pharmacovigilance: Third Edition	NA	29	54	1.86	0.28	NA	NA
Pharmaceutical Medicine	Springer Nature	26	123	4.73	0.69	2	0.403
British Journal of Clinical Pharmacology	Wiley-Blackwell	25	700	28	4.09	6.9	1.216
International Journal of Clinical Pharmacy	Springer Nature	24	197	8.21	1.19	2.7	0.538

ACP: average citations per paper; PC: publication count; RCI: relative citation impact; SJR: SCImago journal rank (Scopus); TC: total citations.

productivity. The resultant data inferred that the most productivity journal was *Drug Safety* with a proportion of 6.63 per cent ($n = 136$) papers and fetched highest citations accounting for 13.47 per cent ($n = 1891$) with exhibiting 13.90 ACP and 2.03 RCI, followed by *Pharmazeutische Industrie* with 4.05 per cent ($n = 83$) papers. At the third position was *Therapies* with a proportion of 3.46 per cent ($n = 71$) papers and accounting for 4.42 per cent ($n = 621$) citation and exhibiting 8.75 ACP with 1.28 RCI. The top 10 leading journals in a combined manner contributed with a proportion of 24.76 per cent ($n = 508$) papers of the total publications. The number of citations fetched for the publications reflect the quality of a paper [36]. According to the analysis of the data, the top 10 journals fetched citations with a proportion for 35.14 per cent ($n = 4933$) of the total citations with an average citation impact of 9.71 ACP. In terms of RCI, the *British Journal of Clinical Pharmacology* exhibit highest with 4.09. The journals having RCI < 1 implies that the research output was not proportional with their impact, whereas, RCI > 1 indicates the high impact research (Table 11).

Co-citation of source

The journal co-citation analysis was performed using citation as the unit of analysis in the counting method in order to identify the core journals by using the minimum threshold number of 100 citations per source and it revealed 32 sources meet the criteria. The network visualization map of 32 sources yielded 5 clusters with 447 links and TLS of 69,943. The link demonstrates the interrelatedness of the journal with other journals. The distance between two journals represents the relatedness in terms of their co-citations. The larger size of label and circle indicates more influence of the journals in pharmacopoeia research. The *Drug Safety* in cluster 2 tops with 30 links 30 and TLS of 24,539 exhibiting 2267 citations (Fig. 4).

Mapping of co-occurrence of keywords

Co-occurrence of keywords provides the secondary support to understand the scientific research trends by highlighting the research hotspots in research field. A total of 2804 author keywords have been used in PV research during the period 2010—2020. Out of the 2804 keywords, 49 meet the thresholds with minimum of 10 occurrences considered for analysis. A total of 49 keywords yielded 7 clusters represented by different colours and found 308 links and TLS of 1547. According to the frequency and strength of the links, the clusters are sorted. The size of bubble reveals nature of link strength and occurrence relationship. The node's size indicates dense keywords network and different colours represent distinct cluster. The most frequently used author keywords were pharmacovigilance (frequency = 812), Adverse drug reactions (frequency = 207), adverse drug reaction (frequency = 151), and pharmacoepidemiology (frequency = 104) (Table 12; Fig. 5).

Subject-wise breakup of research output

Table 13 demonstrated the top 10 most crucial research areas in PV. The broad ranging scope of PV remains a dynamic medical discipline to prevent ADRs in human beings, to promote patient safety and also in promoting rational use of quality medicines. The findings revealed that there is a considerable research output in the area of medicine with a proportion of 48.33 per cent ($n = 1563$) papers of the total publications, followed by pharmacology, toxicology and pharmaceutics accounting for 30.30 per cent ($n = 980$) publications share. Other subject areas appearances ranging between $3 \geq 138$ publications share. The figures revealed that PV research in the areas of medicines is in full bloom and in pursuant to this, the researchers and scientists are constantly carrying out the research for better mechanism towards safeguard of the public health (Table 13).

Highly cited papers

Table-14 recorded the top 10 most cited research papers in PV that registered citations between $130 \geq 330$ citations. The citation per year (CPY) is also calculated to overcome the problem encountered during variation of citations (Garg and Tripathi, 2017 [37]). Highly cited papers accumulated a sum of 2033 (14.46%) citations during the time span 2010—2020. All these highly cited papers were collaborative papers. The table shows that the research paper entitled ''Pharmacovigilance from social media: Mining adverse drug reaction mentions using sequence labeling with word embedding cluster features'' by Nikfarjam et al. [38] was the most cited publication with 308 citations, followed by ''Cardiovascular toxicities associated with immune checkpoint inhibitors: an observational, retrospective, pharmacovigilance study'' by Salem et al. with 300 citations [39] (Table 14).

Funding agencies

Of the retrieved total 2052 documents, 27.63 per cent ($n = 567$) publications were the funded projects. The National Institute of Health (NIH) with a proportion of 1.90 per cent ($n = 39$) publications was the most active funding agency in PV research at global level.

Recommendations

The recommendations for improving ADR reporting system working under the umbrella of PV mechanism of country are as under:

- Every governmental and the private hospital should established a PV centre for ADRs reporting;
- PV workshops/seminars/conferences/webinars should be conducted time to time to create awareness and to guide healthcare professionals;
- Patient should be encouraged for self-reporting alongside reporting by healthcare professionals;
- Comprehensive national PV programs should be initiated;
- PV specialists should guide healthcare professionals;
- New modern technology should be incorporated to facilitate ADRs reporting;
- Education on PV should be introduced in pharmacy curricula;
- ADRs reporting should be made compulsory for all the pharmaceutical companies and healthcare professionals.

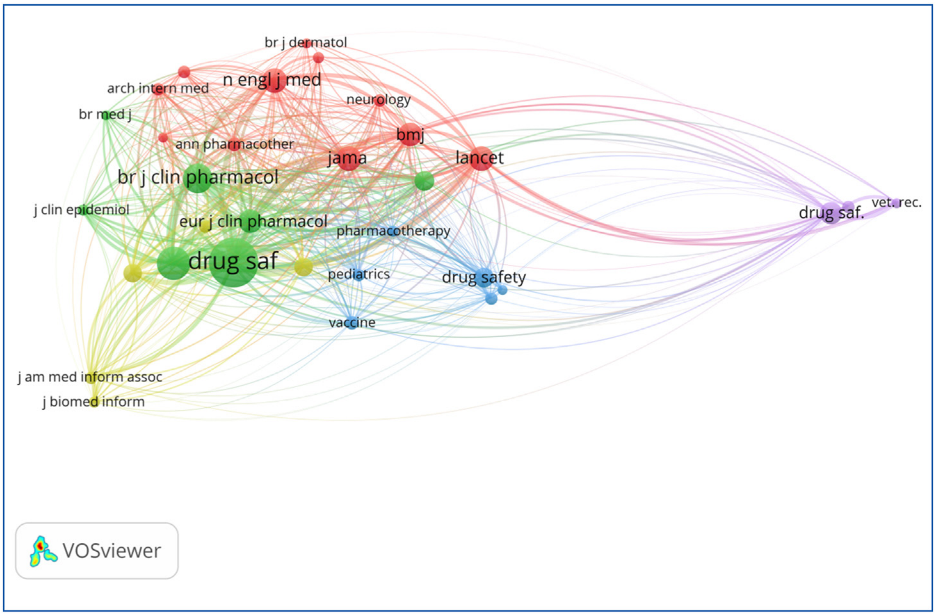

Figure 4. Co-citation of source.

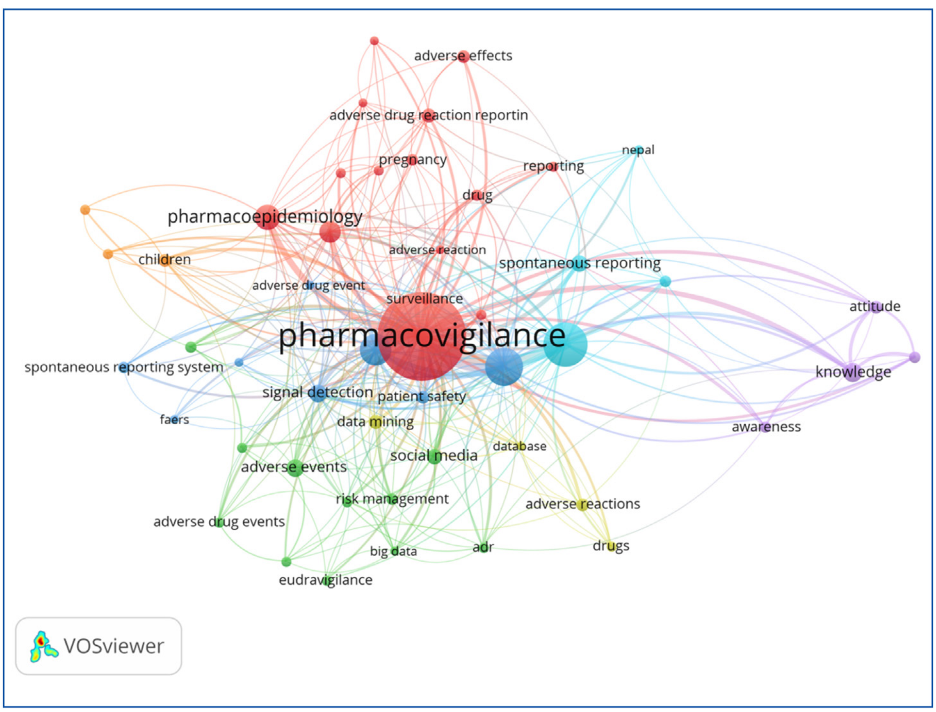

Figure 5. Mapping of co-occurrence of keywords.

Summary and conclusion

The research and analytical development across the globe have become a focal point in the national policy of all the countries, which results into the enhancement in research productivity in the scientific field. The present study provides a quantitative and qualitative analysis of global research productivity in PV. The study is based on the 11 years' global research data (TNP = 2052) on the research theme PV sourced from Scopus database for the time span 2010—2020. Results of this scientometric assessment found that the global research productivity in PV registered 8.74% AGR and 7.38% CAGR. The research impact of global publications in PV averaged to ACP of 6.84. The RGR for the PV global publications decreased gradually from the rate of 0.84 to 0.12. On the other hand, DT of PV global publications displays an increasing trend from the rate of 0.82 to 5.78. The mean RGR and DT of PV publication for 11 years is 0.27 and 3.03, respectively. It was found that the AAPP is 1.52 and PPA is 0.68. The analysis discloses that the

Table 12 Important keywords.

Important keywords	Frequency	TLS
Pharmacovigilance	812	918
Adverse drug reactions	207	316
Adverse drug reaction	151	226
Drug safety	104	195
Pharmacoepidemiology	68	109
Safety	49	75
Knowledge	39	102
Signal detection	37	82
Adverse events	33	41
Spontaneous reporting	31	67
Social media	24	46
Adverse drug reaction reporting systems	22	29
Data mining	21	40
Adverse effects	19	17
Patient safety	19	41
Attitude	18	60
Children	18	40
Adverse reactions	17	21
Pharmacists	16	30
Spontaneous reporting system	16	20
Awareness	15	33
Biosimilars	15	26
Drug	14	22
Practice	14	46
Pregnancy	14	15
Risk management	14	28
ADR	13	26
Adverse drug events	13	19
Adverse event	13	29
Drugs	13	19
Multiple sclerosis	13	9
Natural language processing	13	33
Adverse-reaction-monitoring	12	10
Drug-related side effects and adverse reactions	12	20
Eudravigilance	12	12
Machine learning	12	17
Biologics	11	20
Legislation	11	16
Reporting	11	21
Surveillance	11	27
Adverse drug event	10	22
Adverse reaction	10	20
Big data	10	27
Database	10	24
Disproportionality analysis	10	16
Drug monitoring	10	16
Faers	10	13
Product surveillance	10	13

TC: total link strength.

authorship patterns in PV research shows collaborative trend as the most of the publications have been published by multiple authors. In all, a total of 80.75% publications have been published in co-authorship, whereas only 19.25% published in single-authorship. The resultant data inferred that the magnitude and density of collaborative patterns among the authors are high in PV research. The DC (0.92) is maximum in the years 2019 and lowest value 0.67 found in the year 2010. The mean value of DC during the selected period of study is 0.79. The CI is highest in the year 2020 (3.19) and lowest in the year 2011 (2.48). The mean value of CI during the period is 2.74. The analysis demonstrates that the

Table 13 Subject-wise breakup.

Subject areas	TNP	%TNP
Medicine	1563	48.33
Pharmacology, toxicology and pharmaceutics	980	30.30
Biochemistry, genetics and molecular biology	138	4.27
Health professions	115	3.56
Immunology and microbiology	71	2.19
Computer science	56	1.73
Social sciences	40	1.24
Engineering	36	1.11
Nursing	35	1.08
Neuroscience	28	0.87

TNP: total number of publications. Scopus data may not have been harmonized inflates the output counts.

highest value of CC is found in the year 2010 (0.78) and lowest in the year 2020 (0.57). The mean value of CC during the study period is 0.72. The figures show that the highest value of MCC found in the year 2010 (0.79) and lowest in the year 2020 (0.57). The mean value of MCC during the selected period is 0.73. The resultant data inferred significant and positive relationship ($r = 0.738$, $n = 11$, $P = 0.009$). As the *P*-value is < 0.05, therefore, it is highly significant. It means that the higher numbers of co-authors were contributed to the higher number of papers. The results disclose that the top 10 authors dominate research in PV together accounted for 18.37% of global publication share and accounting for 31.69% citations with a proportion of citation impact of 11.80 ACP. Montastruc, Jean Louis of France with a proportion of 3.02% produced the highest number of publications and most of the publications are in *Therapies* journal. The analysis also discloses that most of the productive authors in the top 10 list belong from France (7 authors). The top 10 leading countries in a combined manner contributed with a proportion of 85.23% of the total publications denotes increasing in the collaborative research. France has the highest number of publications with a total of 373 publications accounting for 18.18% of the total publications in this field. It revealed that France is the bellwether in PV related scientific research. The results exposes that the top 10 organizations dominate research in PV together accounted for 30.51% of global publication share and fetched 54.72% citations. The resultant data revealed that the highest share in publication was reported by INSERM, France with a proportion of 6.36% publications and fetched a citations accounting for 10.08% with citation impact of 10.88 ACP and having 1.59 RCI. The resultant data inferred that the most productivity journal was *Drug Safety* with a proportion of 6.63% papers and fetched the highest citations accounting for 13.47% with exhibiting 13.90 ACP and 2.03 RCI. Based on the co-occurrence of keywords analysis, the most important author keywords were '*pharmacovigilance*' and '*adverse drug reactions*'. The broad ranging scope of PV remains a dynamic medical discipline to prevent ADRs in human beings, to promote patient safety and also in promoting rational use of quality medicines. The findings revealed that there is a considerable research output in the area of medicine with a proportion of 48.33% papers. The PV research in the areas of medicines is in full bloom and in pursuant to this, the researchers and scientists are constantly carrying out the research for better mechanism towards safeguard of the public health.

The rapid spread of COVID-19 pandemic globally has thrust drugs safety into the spotlight and the public is now more aware of the role of healthcare professionals and health regulators. Amid new drugs discovery process against COVID-19, it needs to be ensuring the efficacy and safety of the drugs during clinical trials of the drugs and even in the post-marketing period for the safeguard of the public health. The monitoring of safety of therapies or treatment being given to corona patient is crucial and facing challenges. Monitoring of the safety of medicinal products is an ongoing process and enormous safety related data gathered during clinical trials from different patient population at global level, therefore, a systematic approach to PV should be implemented to identify the ADRs for taking appropriate action to reduce risk and increase benefits associated with the medicines. Therefore, it is needed that the PV experts, clinicians, stakeholders and drug regulators collaborate in the assessment of suspected ADRs timely to reduce risks and increasing benefits associated with the medicinal products towards success of public health across the globe. Further, to generate substantial amount of data, electronic means of reporting must be enhanced in the present time.

The global phenomenon of PV is attracting the scientists of similar interest for collaborative research across the globe towards safeguard of the public health. Although, due to advancement in measuring safety use of medicines or due to 'publish or perish' scientific community's keen interest, the PV research productivity enhancing with every passing day. The study exposes that the PV research is in full bloom and recommended that the scientometric assessment will have to examine the research progress at regular intervals focussing on quantitative and qualitative indicators of publications. The present scientometric assessment is based solely on the literature indexed in the core collection of Scopus database and although the literature available in other databases like Web of Science (WoS) and PubMed as well may be harvested in future research. Overall, this study has led us to grasp the current trends of PV research. The outcome of the study may help drug manufacturers, medical scientists, drug regulators and health-care professionals to identify current research progress in PV at global level.

Table 14 Highly cited papers.

Top 10 highly cited papers	Authors	Source journal	Year	TNC	TNC per year
Pharmacovigilance from social media: Mining adverse drug reaction mentions using sequence labeling with word embedding cluster features	Nikfarjam, A., Sarker, A., O'Connor, k., Ginn, R., Gonzalez, G.	*Journal of the American Medical Informatics Association*	2015	308	51.33
Cardiovascular toxicities associated with immune checkpoint inhibitors: an observational, retrospective, pharmacovigilance study	Salem, J.-E., Manouchehri, A., Moey, M., Johnson, D.B., Moslehi, J.J.	*The Lancet Oncology*	2018	300	100
Utilizing social media data for pharmacovigilance: A review	Sarker, A., Ginn, R., Nikfarjam, A., Upadhaya, T., Gonzalez, G.	*Journal of Biomedical Informatics*	2015	277	46.17
Once-daily opioids for chronic dyspnea: A dose increment and pharmacovigilance study	Currow, D.C., McDonald, C., Oaten, S., Johnson, M.J., Abernethy, A.P.	*Journal of Pain and Symptom Management*	2011	203	20.30
Benefits and strengths of the disproportionality analysis for identification of adverse drug reactions in a pharmacovigilance database	Montastruc, J.-L., Sommet, A., Bagheri, H., Lapeyre-Mestre, M.	*British Journal of Clinical Pharmacology*	2011	195	19.50
Performance of pharmacovigilance signal-detection algorithms for the FDA adverse event reporting system	Harpaz, R., Dumouchel, W., Lependu, P., Ryan, P., Shah, N.H.	*Clinical Pharmacology and Therapeutics*	2013	162	20.25
Causality assessment in pharmacovigilance: The French method and its successive updates | [Imputabilité en pharmacovigilance: De la méthode française originelle aux méthodes réactualisées]	Miremont-Salamé, G., Théophile, H., Haramburu, F., Bégaud, B.	*Therapies*	2016	160	32
Web-scale pharmacovigilance: Listening to signals from the crowd	White, R.W., Tatonetti, N.P., Shah, N.H., Altman, R.B., Horvitz, E.	*Journal of the American Medical Informatics Association*	2013	154	19.25
Characterizing major bleeding in patients with nonvalvular atrial fibrillation: A pharmacovigilance study of 27,467 patients taking Rivaroxaban	Tamayo, S., Peacock, W.F., Patel, M., Yannicelli, D., Yuan, Z.	*Clinical Cardiology*	2015	142	23.67
Pharmacovigilance of herbal medicine	Shaw, D., Graeme, L., Pierre, D., Elizabeth, W., Kelvin, C.	*Journal of Ethnopharmacology*	2012	132	14.67

TNC: total number of citations.

In addition, it will also help to identify the most prolific authors, institutions, countries and channels of communication in the development of research. PV is a global developing field with significant future research.

Disclosure of interest

The author declares that he has no competing interest.

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