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A Bibliometric Survey of Smart Wearable in the Health Insurance Industry

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ABSTRACT

Smart wearables help real-time and remote monitoring of health data for effective diagnostic and preventive health care services. Wearable devices have the ability to track and monitor healthcare vitals such as heart rate, physical activities, BMI (Body Mass Index), blood pressure, and keeps an individual notified about the health status. Artificial Intelligence-enabled wearables show an ability to transform the health insurance sector. This would not only enable self-management of individual health but also help them focus from treatments to the preventions of health hazards. With this customer-centric approach to health care, it will enable the insurance companies to track the health behaviour of the individuals. This can perhaps lead to better incentivization models with a lower premium to the health-centric customers. Health insurance companies can have better outreach with these customer-centric products. The area is exceptionally novel and shows potential for the research opportunities. Although the literature shows the presence of few works incepting the application of smart wearables in health insurance, it was found that the works are across sections of the society and extremely limited to regions and boundaries. Thus, a need for Bibliometric survey in the area of Smart Wearables in Health insurance is necessary to track the research trends, progress and scope of the future research. This paper conducts Bibliometric study for "Smart Wearables in Health Insurance Industry" by extracting documents of total 287 from Scopus database using keywords like wearables, health insurance, health care, machine learning and health risk prediction. The study is conducted since the last decade that is 2011-2020 for the research analysis. From the study, it is observed that application of wearables in health insurance are in a nascent stage and

there is a scope for researchers, insurance, health care stakeholders to explore the used cases for a better user experience.

Keywords: Wearables, health insurance, healthcare, health risk prediction, Machine Learning, Bibliometric analysis, Deep Learning

1. INTRODUCTION

Wearable devices are smart electronic gadgets built-in sensors that gather, capture and transmit data in their surroundings. Wearable devices are applied in health care monitoring with smartwatch and fitness tracker. They collect human activity data related to step count, physical activity, exercise, heart rate, BMI, calories and many more. Some wearables introduce ways to monitor human health in the form of devices that can be worn on the wrist as well in the form of shoes, jewelry, glasses, clothing, earphones, smart ring and many more [1,2,3]. With the development of wearable technology and Artificial Intelligence, Forecast, prediction outcomes can be generated from the data. Using AI techniques like Machine Learning and Deep Learning a learning model can be built to generate health forecasts. [4].

Wearable technology is influencing healthcare industry with remote healthcare. Wearables are already transforming the medical industry through digital platform [5,6]. Today, professionals are engrossed in a sedentary lifestyle and need healthcare monitoring to forecast health hazards. Many researchers have presented the works on predicting health risk from wearable attributes with predictive model [7]. On the other hand, AI has changed healthcare and bio-medical field by automating things such as identifying risk, monitor activities, classifying image patterns of a patient suffering from any disease and many more. In short, AI leverages the user-friendliness of medical services by adopting recent advancement [8].

With the adoption of wearable gadgets in the market, insurance companies have an oversight to strategize to broaden their business in the market competition. To reinvent their industry, insurers are concentrating towards more personalized products such as providing wearable to customers for delivering fast services. With the sedentary lifestyle in public health, there are growing concerns among people about their health. Hence insurance companies adopted wearable technology and which helps the customer in monitoring and maintaining a healthier lifestyle [9]. Artificial Intelligence (AI) has the ability to change and forecast the results obtained from past data. Emerging AI with Insurance industry helps to increase the efficiency of business development and adopting new technology that assists people getting a better life and benefits from the services provided by an insurance company [10,11].

Moreover, AI and wearables in the healthcare and insurance industry show open opportunities for future research directions. The Bibliometric study helps to know the progress of the research work done in a specific area by eliciting the literature available in articles, journals, conference papers, books and peer-reviewed works. Using statistical tools and methods, the developments in this specific area can be tracked.

Following points shows some goals of the Bibliometric study:

• To identify the research work done in Smart Wearables for health insurance in a specific region.

• To know which countries, regions show the conduction of recognised research in this area

• To explore the contributing authors in this field of the research.

• To identify the directions or trends of publications based on an affiliation of the University or an organisation.

• To perform citation analysis of the publications in this area.

This paper represents a Bibliometric survey for wearables in the insurance field. Section 2 shows, the data collection related to wearables and health insurance. Section 3 shows, the Bibliometric analysis in the form of Statistical analysis, Geographical analysis, Network analysis and citation analysis. Here, analysis is done on the data which is obtained from the Scopus database. Section 4 shows, the discussions from the analysis. In Section 5, limitations are mentioned, and in Section 6 presents the conclusion of the paper. Lastly, references are cited at the end of the paper.

2. COLLECTION OF DATA

There are several platforms and websites which contain many documents like Google Scholar, Scopus, Web of Science, IEEE, Science Direct and many more. These papers consist of the statistical information which can be chosen for the Bibliometric analysis. These websites contain the research papers in the form of the articles, journals, review papers and conference papers. These research papers can be accessible by open access or paying fee or using the institutional/organisational credentials.

Here, in this paper for data collection, Scopus is considered with an immense amount of data for the Bibliometric analysis.

2.1 Analysis of Keywords:

Table 1 List of Primary and Secondary Keywords

Primary - Keyword	“Wearables”	
Secondary – Keyword	AND	“Health insurance.”
		“Health risk Prediction.”
		“Machine Learning”
	OR	“Health care.”
		“Deep Learning”

Table 1, shows the query used to search the documents in Scopus as: "wearables” AND “health insurance” OR “health care” AND “health risk prediction” OR “Machine Learning."

2.2 Initial Search Result

Scopus database is used to find out the research papers. Using keywords, it gives a total of 287 documents. Here, the English language is focused on, which shows 283 documents which are shown in Table 2.

Table 2 Language trends showing Wearable technology in Health Insurance

Publication Language	**Publications**
English	283
Chinese	2
Portuguese	2
Total publications	**287**

Source: http://www.scopus.com (assessed on 27 October 2020)

Figure 1 illustrates the types of paper publication in Conference, Articles, Review, Book Chapter, etc. It can be easily concluded that the maximum publications are Conference Paper and minimum publication is done by Letter journals.

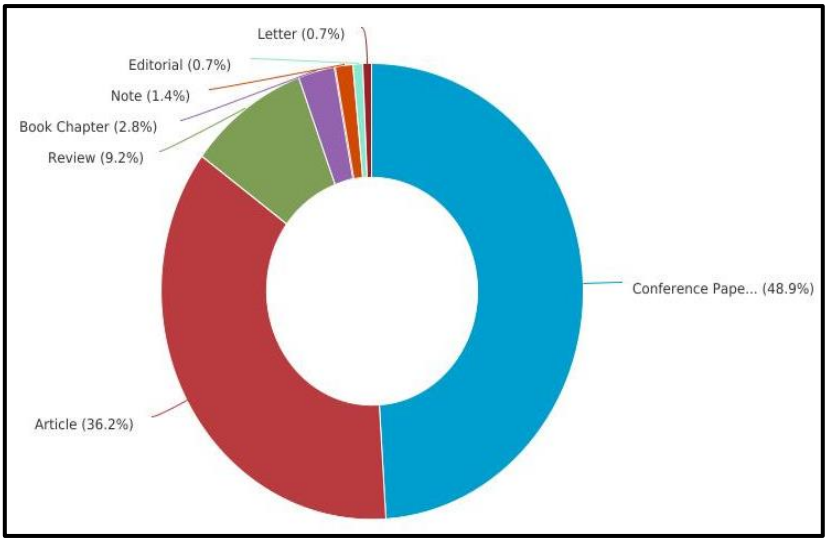

Figure 1 Publication types showing Wearables in Health Insurance

Source: http://www.scopus.com (assessed on 27 October 2020)

2.3 Analysis by year

Figure 2 shows, the documents for Wearables in Health insurance shows an interval of the last decade from 2011 to 2020. The bar graph represents the number of documents published in the last years in this specific area. On analyzing, the research work was carried out from 2017 to 2020. However, this finding shows that less work has been done in the span of 2011 to 2016.

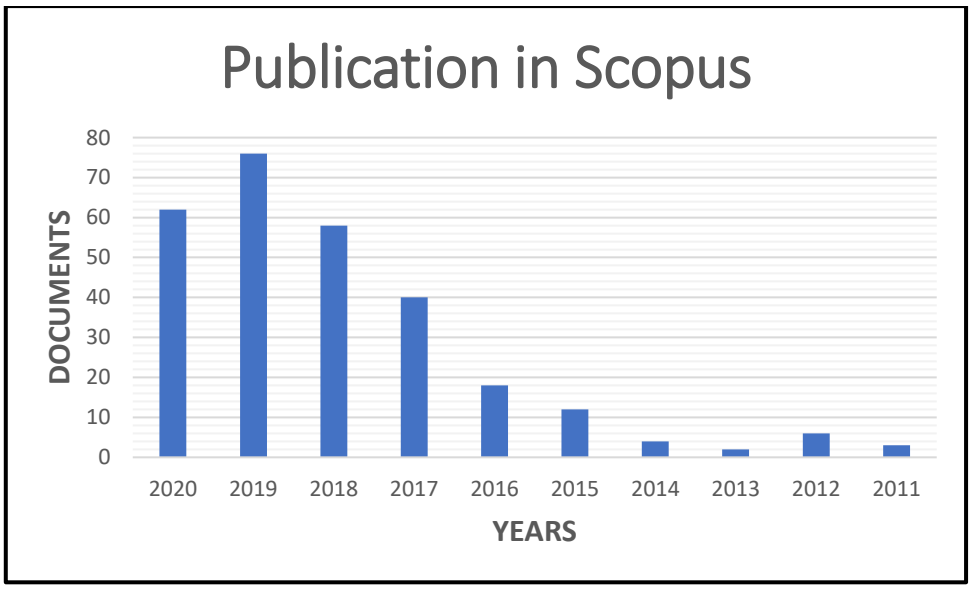

Figure 2 Year-wise Publications

Source: http://www.scopus.com (assessed on 27 October 2020).

3. BIBLIOMETRIC ANALYSIS

To initiate the research, in the field of "health insurance" and "wearables" technology, an analysis is required to be carried out that contains data and information about this topic. The aim of this analysis will help to know where the studies have been conducted and the future direction. This analysis will help to analyse the development and growth in wearable technology and health insurance. The Bibliometric analysis will help in discovering new trends in this domain [12]. The Bibliometric analysis provides insights into the contribution of various institutes, countries, authors, journals, subject categories in the research field. In this analysis, data are collected from the Scopus database using the keywords.

3.1 Analysis of geographic location:

For geographic location analysis, Google sheet tool is used to create the world map. Here, the inputs required are two columns, namely: Countries and Documents count. From the given inputs, a map can be generated, indicating regions where the research work is carried out. In the map below, it shows the maximum, mild and minimum work carried out by the different countries in the area of wearables and health insurance.

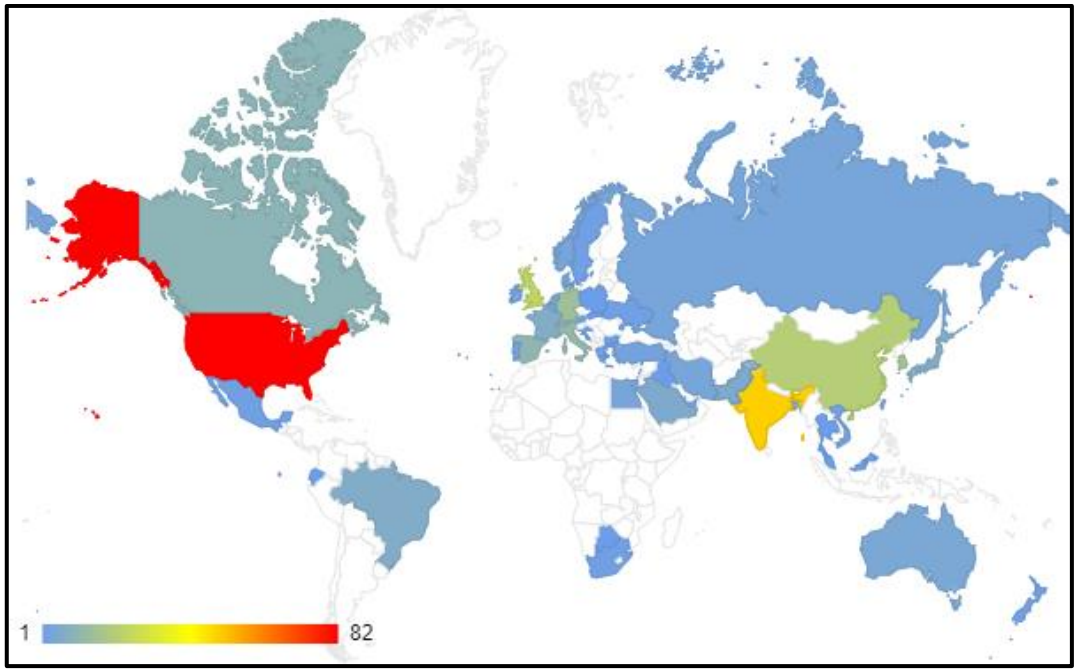

Figure 3 Geographic locations of research work for wearables in health insurance
Source: http://www.scopus.com (assessed on 27 October 2020).

Figure 3 shows geographical region of the published papers. It is drawn using Google Sheet tool. This map shows countries with their research counts. It is observed that maximum research work has taken place in the USA. Mild research work has taken place in India, and minimum work has

been carried out in other countries like China, the United Kingdom, Italy and Brazil.

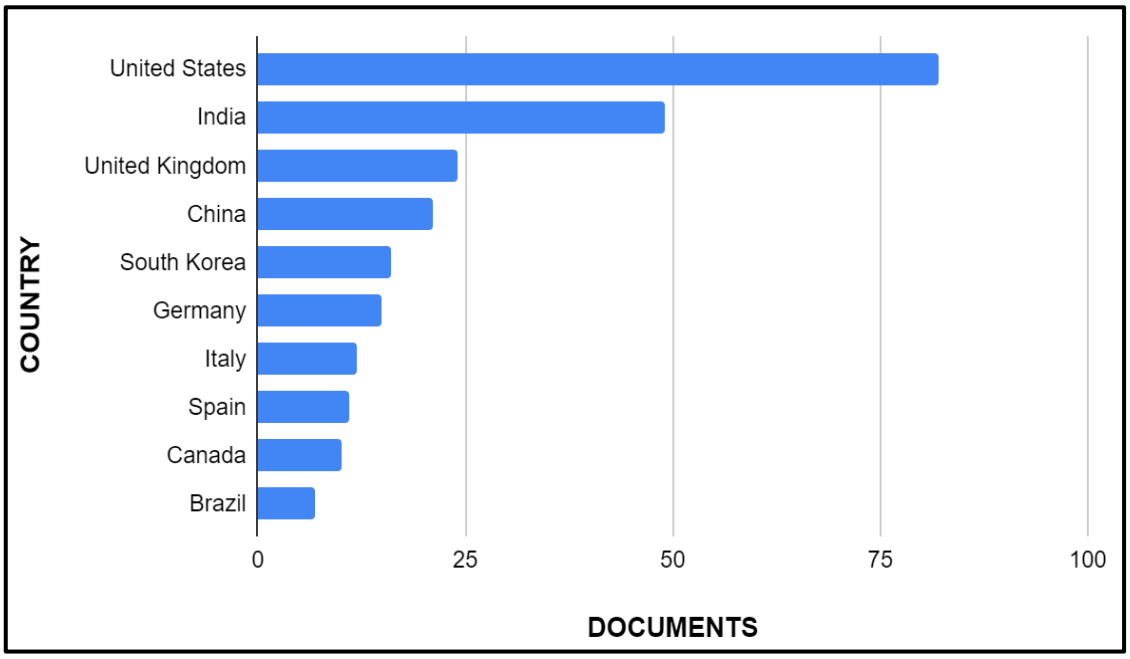

Figure 4 Top ten countries publishing papers on wearables in Health insurance
Source: http://www.scopus.com (assessed on 27 October 2020).

3.2 Analysis by Subject area:

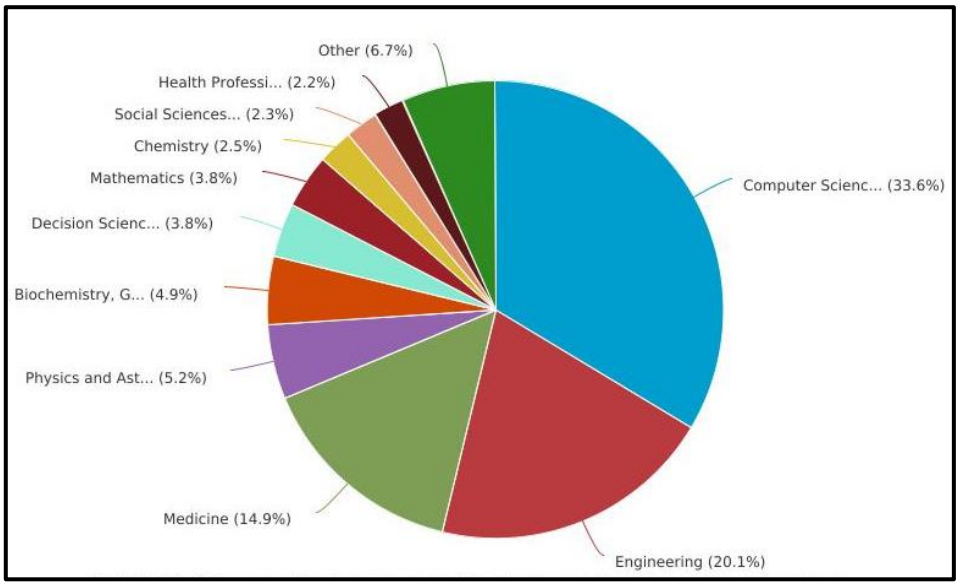

Figure 5 Top ten popular subject areas.
Source: https://www.scopus.com/ (accessed on 27 October 2020)

Figure 5 shows, the work is done in the subject area for Wearables in Health insurance. From the pie chart, it is clear that the maximum work and research has been implemented in Computer Science, followed by Engineering and Medicine.

3.3 Network Analysis:

Network Analysis is a group of Techniques, which is used to show relations among authors and to analyze their association, using the graphical representation. Several tools are used, such as Gephi and VOSViewer. The data is extracted from Scopus for wearables in health insurance.

VOSviewer is open-source software that can be downloaded from the VOSviewer [13] website. It is used for analyses, to create Bibliometric network. The data file can be imported to VOSViewer, which is extracted from the Scopus database. The editor consists of three kinds of visualization: Network visualisation, Overlay visualization, and Density visualization.

Figure 6 shows the relation of keywords and documents title for wearables in health insurance. Here, analysis is done for the authors keyword co-occurrence. The minimum occurrences of a keyword were set to 5, out of the 2723 keywords. Where 203 keywords met the threshold, and the co-occurring link numbers were calculated. The keywords having the maximum link numbers are selected. Here, labels represent the keyword and circle size represents the keyword weight. The big circle represents keywords with higher weight, and the small circle represents keywords with low weight. The curve represents links between the keywords.

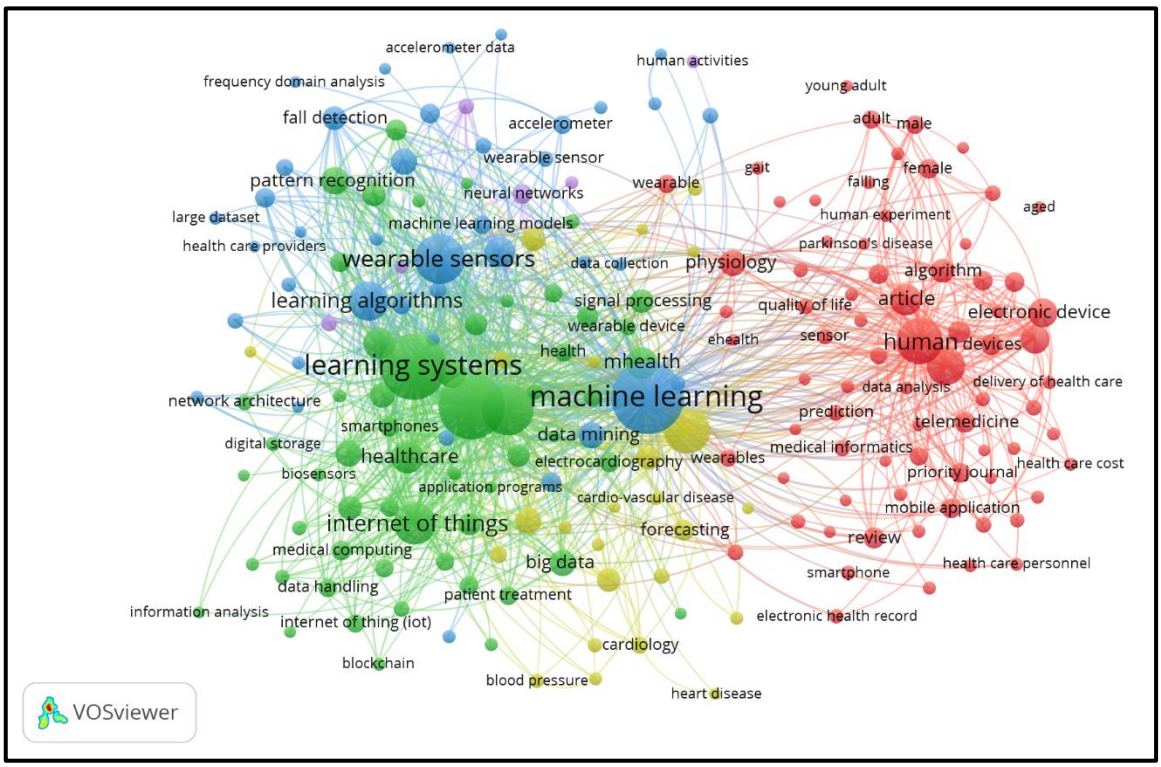

Figure 6 Network visualization diagram based on keywords and document title (For 203 Keywords)

Source: https://www.scopus.com/ (accessed on 27 October 2020)

Figure 7, shows the minimum occurrence numbers of a keyword which was set to 25, out of the 2723 keywords. Here, 23 keywords met the threshold, and the number of the co-occurring link were calculated.

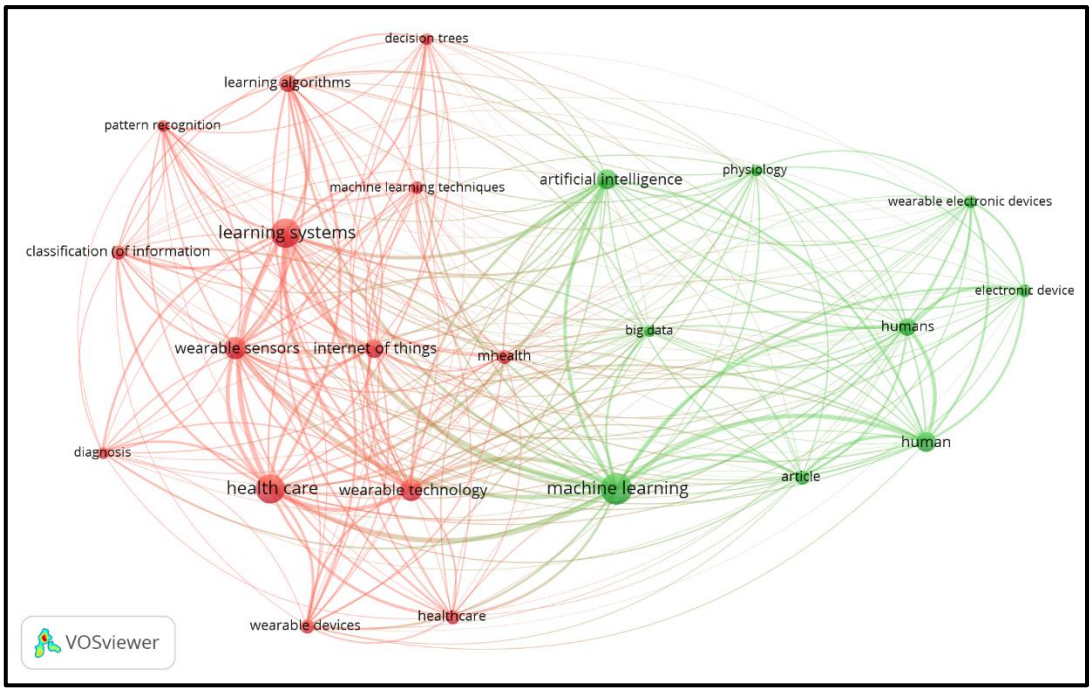

Figure7 Network visualization diagram based on keywords and document title (For 23 Keywords)

Source: https://www.scopus.com/ (accessed on 27 October 2020)

Figure 8 represents a cluster of the number of occurrences of co-authors appearing among the papers. The relationship of the work is shown between the authors. The link represents the authors' work on the documents they have published. Here, the minimum number of documents was set to 2, out of 1065 authors 76 authors meet the threshold value.

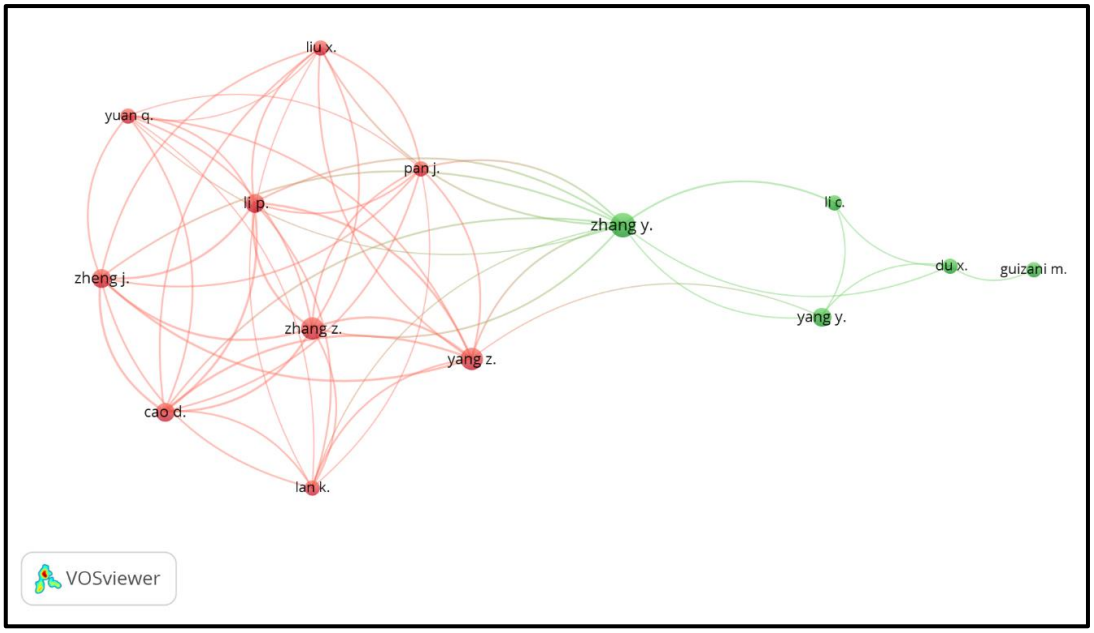

Figure 8 Network visualization diagram for co-appearance of authors among the papers

Source: http://www.scopus.com (assessed on 27 October 2020).

Figure 9 shows the network visualization of the citations received by the documents. The threshold value was set to 1 citation for each document, and 214 documents met the threshold out of 287 documents.

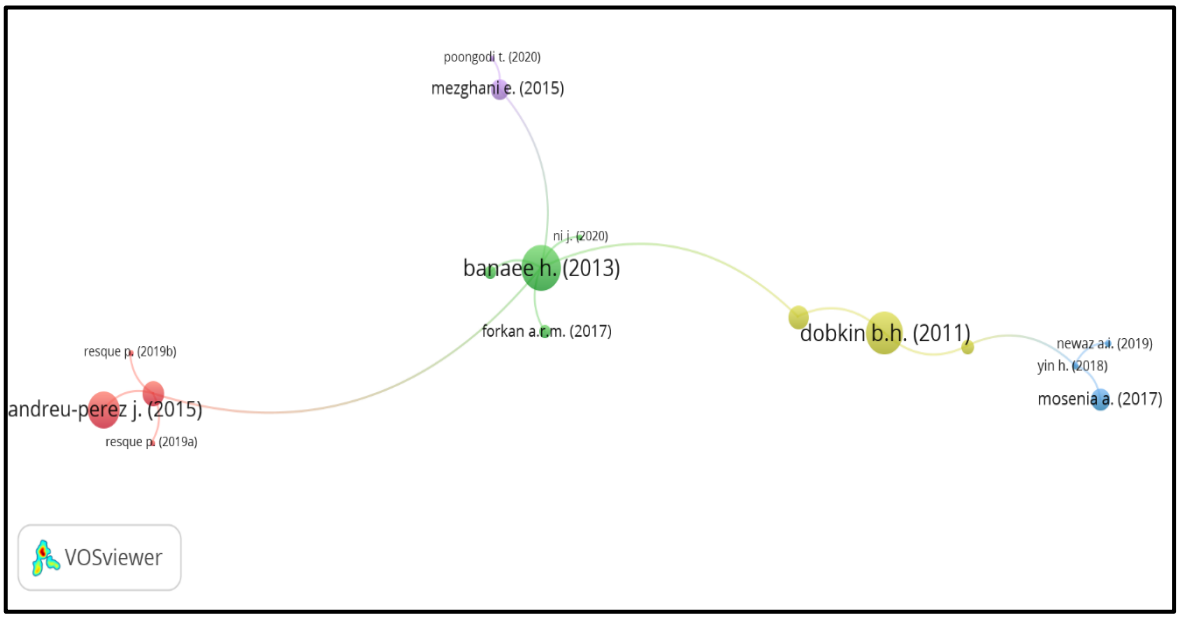

Figure 9 Network visualization of the citations received by the document

Source: http://www.scopus.com (assessed on 27 October 2020).

3.4 Statistical analysis based on Affiliations

Affiliation analysis shows the contribution of research work based on the universities and organisational affiliations. Figure 10 shows the top ten universities for wearables in health insurance. Here, Washington State University shows the maximum contribution in the research field followed by Birla Institute of Technology and Science from India. Vellore Institute of Technology from Vellore shows the minimum contribution.

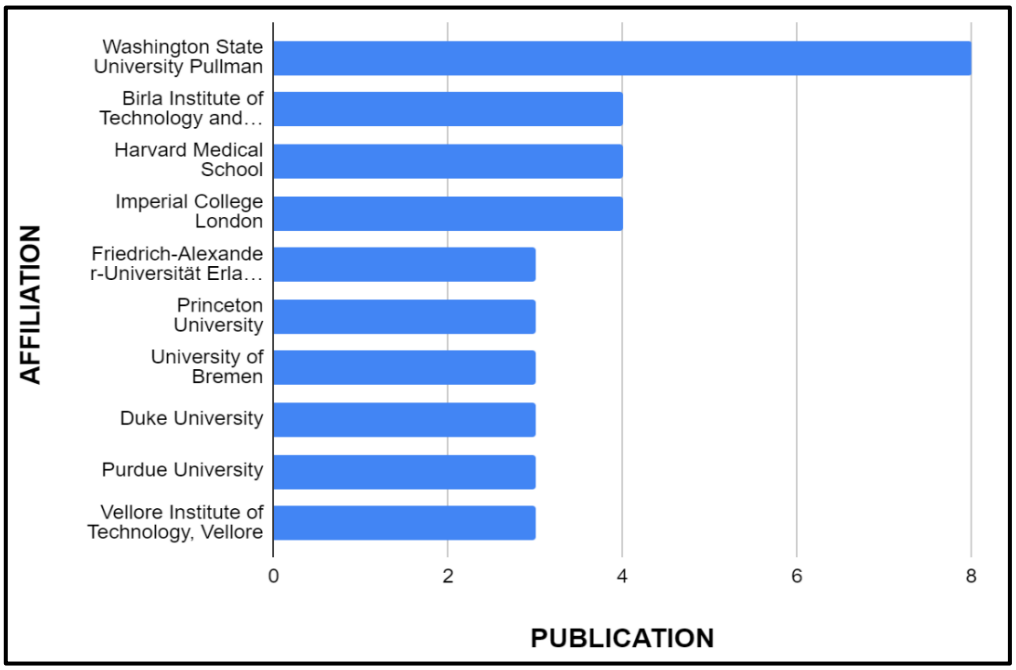

Figure 10 Affiliation statistics for wearables in health insurance

Source: http://www.scopus.com (assessed on 27 October 2020).

3.5 Statistical analysis based on Authors

Figure 11 shows the top 10 authors with the maximum work and research in the area of wearables in health insurance. The top contributing author belongs to Iran. Following authors are from the USA, China, India.

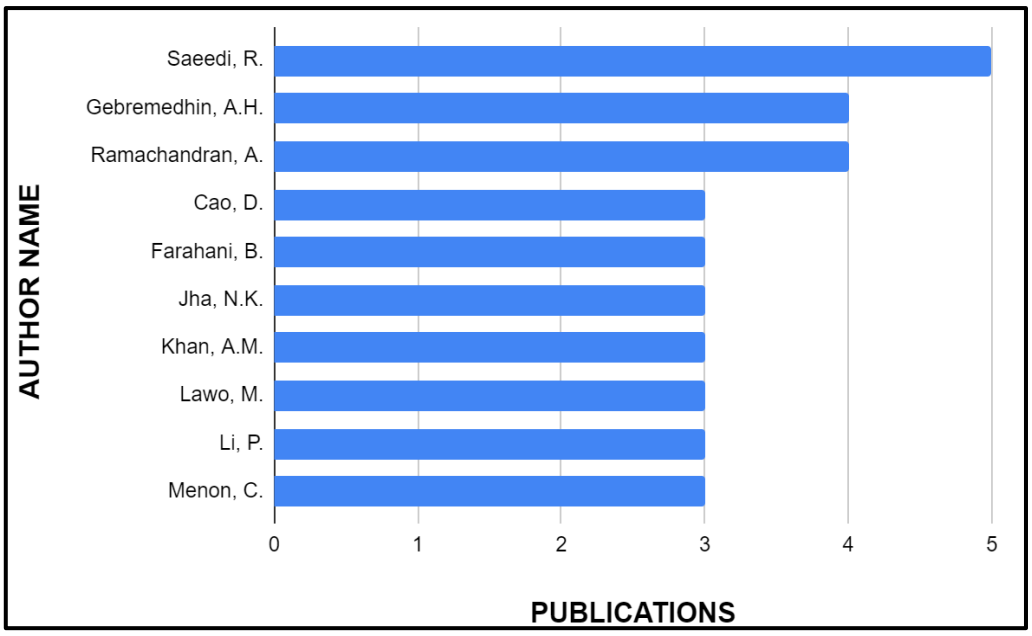

Figure 11 Top ten authors contribution in the research area of wearables in health insurance

Source: http://www.scopus.com (assessed on 27 October 2020).

3.6 Citation Analysis

Citation analysis is a method of determining the impact and importance of an author, article and publication by enumerating how many times that particular author, article and publication has been cited by other researchers for their work. Below, Table 3 shows the Citation done for wearables in health insurance. The total Citation is 2,214 out of a total of 287 publications, to date. Table 4 shows the list of the top ten papers for wearables in health insurance is shown.

Table 3 Citations analysis for publications of wearable in health insurance.

Year	<2015	2015	2016	2017	2018	2019	2020	>2020	Total
No. of Citations	12	306	153	898	464	321	60	0	**2,214**

Source: https://www.scopus.com/ (accessed on 27 October 2020)

Table 4 Citation analysis of the top ten publication of wearables in Health insurance.

Publication Title	<2015	2015	2016	2017	2018	2019	2020	>2020	Total Citation
Personal Sensing: Understanding Mental Health Using Ubiquitous Sensors and Machine Learning	0	0	0	9	27	60	54	2	152
Up-fall detection dataset: A multimodal approach	0	0	0	0	0	6	21	0	27
A Deep Learning Approach to on-Node Sensor Data Analytics for Mobile or Wearable Devices	0	0	0	8	30	61	46	1	146
A Systematic Review of Wearable Patient Monitoring Systems – Current Challenges and Opportunities for Clinical Adoption	0	0	0	3	15	20	30	0	68
From Wearable Sensors to Smart Implants-Toward Pervasive and Personalized Healthcare	0	2	17	34	26	29	27	1	136
Data mining for wearable sensors in health monitoring systems: A review of recent trends and challenges	0	27	27	43	41	42	31	0	184

The promise of mHealth: Daily activity monitoring and outcome assessments by wearable sensors	0	63	25	22	26	24	21	0	118
Artificial intelligence in healthcare	0	0	0	0	1	41	102	2	146
A Semantic Big Data Platform for Integrating Heterogeneous Wearable Data in Healthcare	0	0	3	9	10	11	11	0	44
Personal Sensing: Understanding Mental Health Using Ubiquitous Sensors and Machine Learning	0	0	0	9	27	60	54	2	152

Source: https://www.scopus.com/ (accessed on 27 October 2020)

Table 5 Citation analysis of the top ten journals of wearables in Health insurance.

Journal Title	**<2015**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**>2020**	**Total Citations**
Sensors (Switzerland)	209	0	0	4	7	37	2	0	259
IEEE Transactions on Biomedical Engineering	0	133	0	0	0	0	0	0	133
IEEE Transactions on Mobile Computing	0	51	0	0	0	0	0	0	51

Journal of Biomedical Informatics	0	0	50	0	0	0	0	0	50
Procedia Computer Science	0	18	0	12	16	0	0	0	46
ACM International Conference Proceeding Series	2	0	0	5	4	12	0	0	23
Computer Methods and Programs in Biomedicine	0	0	0	17	0	0	1	0	18
Measurement: Journal of the International Measurement Confederation	0	0	0	0	11	0	6	0	17
Proceedings - 2017 IEEE 6th International Conference on AI and Mobile Services, AIMS 2017	0	0	0	16	0	0	0	0	16
Advances in Intelligent Systems and Computing	0	0	0	0	0	2	6	0	8

Source: https://www.scopus.com/ (accessed on 27 October 2020)

Figure 12 shows the graphical representation of the top ten journals-based citations for wearables in health insurance. This diagram is created using Tableau software [14]. Here, the dataset is taken from Scopus database where input is Source Title and Citation. The size shows the sum of Citation. The diagram is titled as Treemaps which consists of dimension and measures attributes. In Dimension, Source title input is given, and Citation is given as input in measures. Here, in the diagram, it shows "Sensors (Switzerland)" journal receive maximum Citation and "Advances in Intelligent Systems and Computing journal" journal receives the minimum Citation.

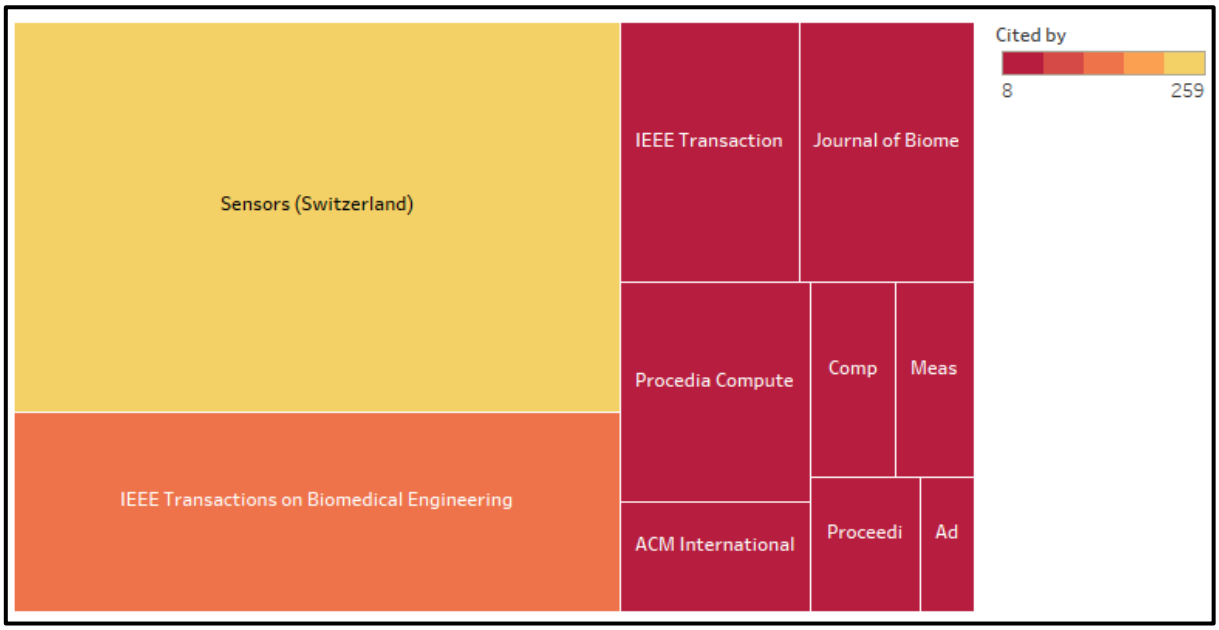

Figure 12 Analysis based on top ten popular journals citation for wearables in health insurance
Source: https://www. scopus.com/ (accessed on 27 October 2020)

3.7 Analysis based on Source Title

Figure 13 shows the statistical analysis of the top ten source titles based on the Citation for wearables in health insurance. From the chart, it is observed that Sensors (Switzerland) journal receive the maximum numbers of Citation. Advances in Intelligent Systems and Computing journal receive the minimum number of citations.

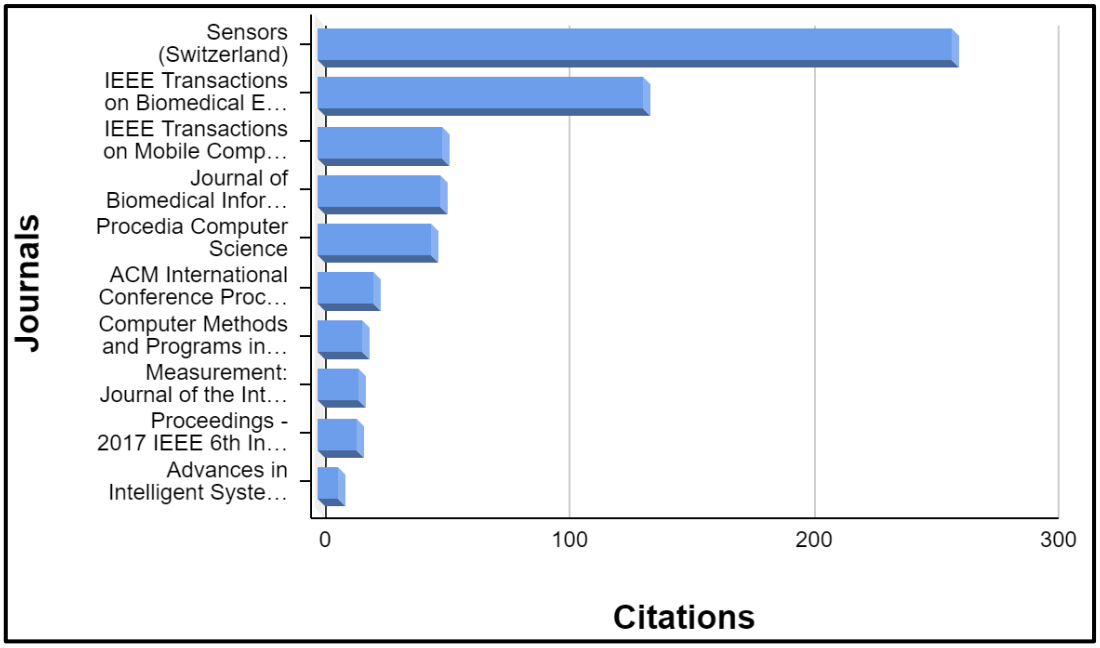

Figure 13 Citation Analysis based on the title for wearables in health insurance for the top ten journals.

Source: https://www. scopus.com/ (accessed on 27 October 2020)

3.8 Analysis based on co-keyword

Figure 14 shows the statistical analysis based on keyword occurrences for wearables in health insurance. This diagram is created using MAXQDA software [15]. The figure is generated using the word cloud, which helps to visualise words frequently occurring in the paper. In this, the input is the keywords and its occurrences. It is observed that “health”, “monitoring”, “learning”, “systems”, “wearables” are the words occurring frequently.

Figure 14 Analysis based on Keyword occurrences

Source: https://www. scopus.com/ (accessed on 27 October 2020)

3.9 Analysis based on Funding Sponsors

Figure 15 shows the statistical analysis based on Funding sponsors for wearables in health insurance. Here, top 10 funding sponsors are considered from the literature. It can be observed that the National Science Foundation is the highest funding foundation and it is followed by the National Natural Science Foundation of China.

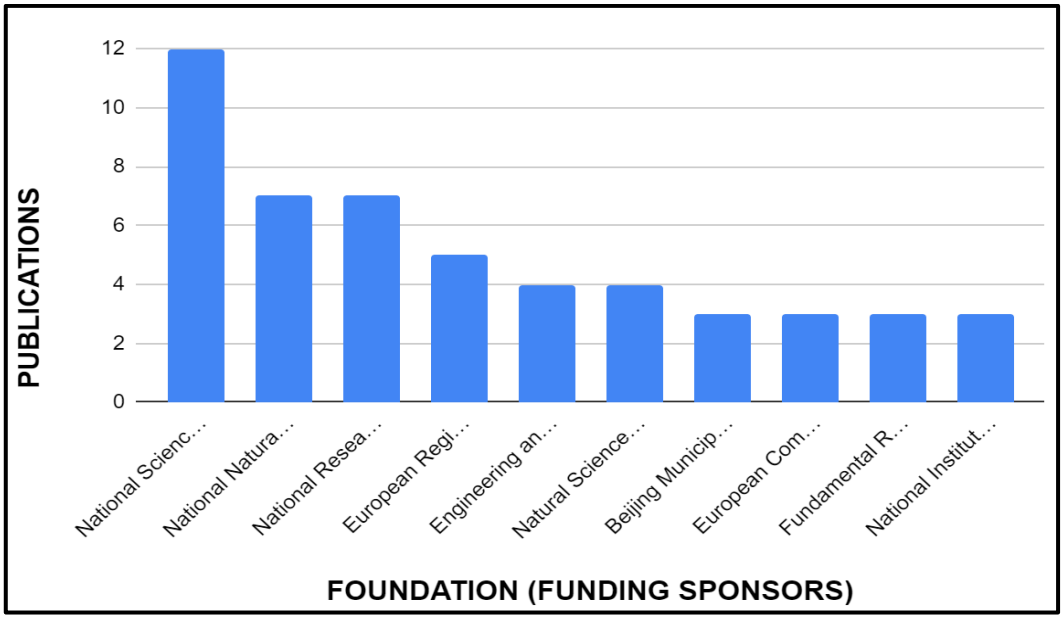

Figure 15 Funding Sponsors statistics of wearables in health insurance

Source: https://www.scopus.com/ (accessed on 27 October 2020)

4. DISCUSSION BASED ON THE RESEARCH STUDY

It is observed and analysed that the majority of the research work is represented mostly by the conference paper and the articles. It is observed from the year wise publication that though there was initially significantly less research work in this specific field, more work has been recently contributed. If the country-wise publication is considered, the United States ranks the highest in contributions followed by India. Here, the total number of publications is 287 documents from overall countries, of which the United States contributes 82 documents and India contributes 49 documents. From the subject area, it is observed that the research work is predominantly in the field of Computer Science and is 33.6%, followed by Engineering 20.1% and Medicine 14.9% of the total published documents. Statistical analysis based on affiliation/university shows top 10 Universities in which Washington State University of USA contributes the highest proportion of publication and Birla Institute of Technology of India is the second most country in contributing much research work in the field of wearables, healthcare and health insurance. From the citation analysis, out of total 2,294 citations, 898 citations in the year of 2017 reflect the most significant interest in the research. The analysis of top ten publications, the title, “Data mining for wearable sensors in health monitoring systems: A review of recent trends and challenges” achieves maximum citation and is published in “Sensors (Switzerland)” journal. “Sensors (Switzerland)” journal has achieved the highest citations.

5. LIMITATIONS OF THE PRESENT STUDY

The current study shows the limitation of the paper, where only the Scopus database has been considered for analysing the literature work done in previous years. On the other hand, another database like Google Scholar and Web of Science can be considered for the literature work. The keywords used for this research work can be rearranged, and according to rearrangement, the outcome of documents changes dynamically. The tools such as Google Sheet, VOSViewer, Microsoft Excel, MAXQDA and Tableau has been considered for creating graphs, charts, cluster diagram and figures. Apart from these, other tools such as Gephi and Leximancer can also be considered. Here, for the research purpose, the dataset is taken within the limited span of years from 2011 to 2020.

6. CONCLUSION

The use of Artificial Intelligence and wearable has shown a substantial rise in health care for effective diagnostic and preventive measures. Smart wearables in the insurance industry help in monitoring human behaviour and provides use-cases such as Prediction, Prevention, Processing, Pricing and Customer Experience, which can lead to the development of better customer-centric products. This leads to better incentivization by reducing the premium cost to the customer. The Bibliometric study is carried out on Smart wearable in Insurance with the Scopus database. The importance of wearable in healthcare and health insurance is shown by including 287 documents extracted from keywords such as wearables, health risk prediction, health care, health insurance and Machine Learning. The analysis in the proposed paper shows that the health risk prediction using wearables is a trending topic, especially in the countries like the United States, India, United Kingdom and China. This Bibliometric study will help and inspire future researchers to get idea, knowledge and understanding of the proposed work done in the previous decade. The area of smart wearables in health insurance shows future possibilities for research opportunities. It can be seen from this study that the adoption of emerging technologies like wearable devices and Artificial Intelligence has been conceived in a smaller way and shows promising future research opportunities in the health insurance industry.

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