QUALITY AND EFFICIENCY OF HEALTH SERVICES IN THE IMPLEMENTATION OF ELECTRONIC MEDICAL RECORDS: BIBLIOMETRIC ANALYSIS

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ABSTRACT

***Background**: Electronic medical records (EMR) were growing rapidly because they were believed to improve the quality and efficiency of health services. Literature studies related to EMR have been carried out, but the bibliometric analysis was not yet known. This study aimed to analyze the bibliometrics of research related to EMR and its impact on quality and patient care.*

***Methods**: We have carried out bibliometric analysis using VOS viewer and Mendeley on articles from the Scopus database for 2014-2023. Articles have been filtered based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) diagram. We used the keywords electronic medical records, quality and efficiency to search for articles. Articles that were not in English, could not be downloaded in full text and were not related to quality or efficiency were excluded. Articles that met the criteria were analyzed.*

***Results**: We obtained 24 articles from the screening results. Most articles in 2020 (6), there was a significant increase in 2019 (4). Most articles have been published in Journal of Medical Internet Research (3). The International Journal of Medical Informatics received the most citations (160 from 2 articles). There were 8 research articles from the United States. The most frequently used keywords were electronic medical record(s). Meanwhile, the issues most commonly associated with the implementation of EMR include; quality improvement, health care quality, patient satisfaction, and cost.*

***Conclusion**: Bibliometric analysis was important to carry out in future research to map the characteristics of research with wider data sources.*

KEYWORDS | electronic medical records, quality, efficiency, health services

INTRODUCTION

Electronic medical records (EMR) are digital systems used to manage patient health records. Complete and accurate medical records can be used to assist management in decision making (Evans, 2016), billing treatment costs (Britton, 2015), as a basis for patient care plans (Kavuma & Mars, 2022) and research (Marshall & Lam, 2020). Healthcare facilities believe that the use of EMR will improve the quality of patient care by reducing medical errors (Jacobs, 2007)(Patton et al., 2018), minimizing duplicative errors (Lindsay & Lytle, 2022), reducing unnecessary diagnostic procedures (Jung et al., 2015)(Hinson et al., 2017), and facilitating data collection and accessibility (Knevel & Liao, 2023)(Cowie et al., 2017), thereby increasing overall patient satisfaction (Liu et al., 2013).

Analysis of EMR data can highlight areas of concern in health care delivery. Thus, EMR plays an important role in efforts to continuously improve the quality of health services (Ozonze et al., 2023)(Granit et al., 2022)(Zheng et al., 2014). As is the hope of health service facilities and patients, improving health services must also be accompanied by efficiency (Hung et al., 2021)(Maphumulo & Bhengu, 2019)(Islam & Li, 2019)(Kanter & Courneya, 2017).

EMR also plays an important role in improving clinical efficiency. EMR can help health workers carry out their duties on time and help patients not wait too long to receive treatment (Alqudah et al., 2021)(Joos et al., 2006). Research results prove that the use of EMR followed by the doctor's skills in operating it can reduce documentation time (Crawford et al., 2019) and make it easier to view examination results and the patient's health history (Hsu et al., 2012)(Zhang et al., 2022).

EMR's efficiency is also achieved because it is able to display various information about examination results and health history so that doctors can more quickly assess the patient's condition compared to manual systems. Other research states that the transition from manual medical records to EMR has an impact on cost savings (Sadoughi et al., 2019)(Fargo et al., 2015). Therefore, EMR is referred to as a tool that can help health service facilities to achieve high scores.

Literature studies proving that EMR can improve high-value health services have been published previously (Li et al., 2022)(K. H. Nguyen et al., 2022)(Tsai et al., 2020)(Neves et al., 2020)(Mullins et al., 2020). However, research analyzing bibliometrics regarding EMR has never been carried out. Bibliometric analysis is important for mapping research on certain topics according to the categories of author, publisher, country, journal and keywords used, so that it can be used as a basis for determining further research topics (Diane Cooper, 2015)(V. Saha et al., 2020). In this research, we conducted a bibliometric analysis of the impact of EMR on the quality and efficiency of health services in various countries in the world.

RESEARCH METHOD

DATA SOURCES AND SEARCH STRATEGY

Scopus is a very important research database. Therefore, this research focuses on analyzing articles from Scopus. The keywords used were electronic medical record, quality and efficiency, translated as: electronic AND medical AND record AND quality AND efficiency. The time period for the article was 2014 – 2023, so the search query was: (LIMIT-TO (PUBYEAR , 2023) OR LIMIT-TO (PUBYEAR , 2022) OR LIMIT-TO (PUBYEAR , 2024) OR LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2015) OR LIMIT-TO (PUBYEAR , 2014).

INCLUSION AND EXCLUSION CRITERIA

All studies on the impact of electronic medical record implementation on the quality and efficiency of health services from 2014 to 2023 were searched. The articles were screened based on the following exclusion criteria:
Articles not in English were excluded.

a. Articles that only contain an abstract and cannot be downloaded in full were excluded.
b. Articles with content unrelated to electronic medical records and one of health care quality and efficiency were excluded; for example, articles that only discuss supporting and inhibiting factors for EMR implementation.

We conducted the screening by referring to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines (Moher et al., 2019), as follows:

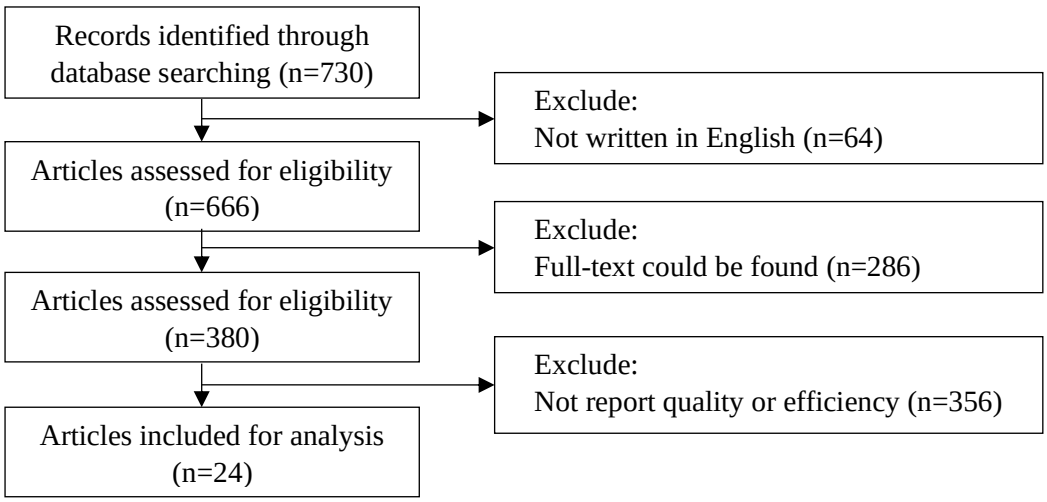


Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) diagram in electronic medical record article screening

We have carried out a screening process through 3 stages. In the first stage, we searched for articles in the Scopus database according to keywords. A total of 730 articles were found. In the second stage, articles obtained from the search results were reviewed to select according to inclusion and exclusion criteria. We excluded articles that were not in English (64), full text could not be downloaded (286), did not explain the relationship of

EMR to quality or efficiency (356). After selecting, we obtained 24 articles for analysis (Figure 1).

Data Extraction and Analysis

The analysis results were taken from articles that met the screening requirements. The data obtained was entered into Mendeley for analysis and data processing. Mendeley and VOS viewer were used for qualitative and quantitative analysis including publication trends for the last 10 years, author, first author's affiliation, first author's country, number of citations, journal publisher and keywords used in detail.

RESULT AND DISCUSSION

Trend of Publication

The implementation of EMR in the world is increasing very rapidly. Several publications report that countries in the world are implementing EMR nationally to improve the quality and efficiency of health services. This is in accordance with the results of trend analysis of publications related to EMR related to the quality and efficiency of health services from 2014-2023 (Figure 2).

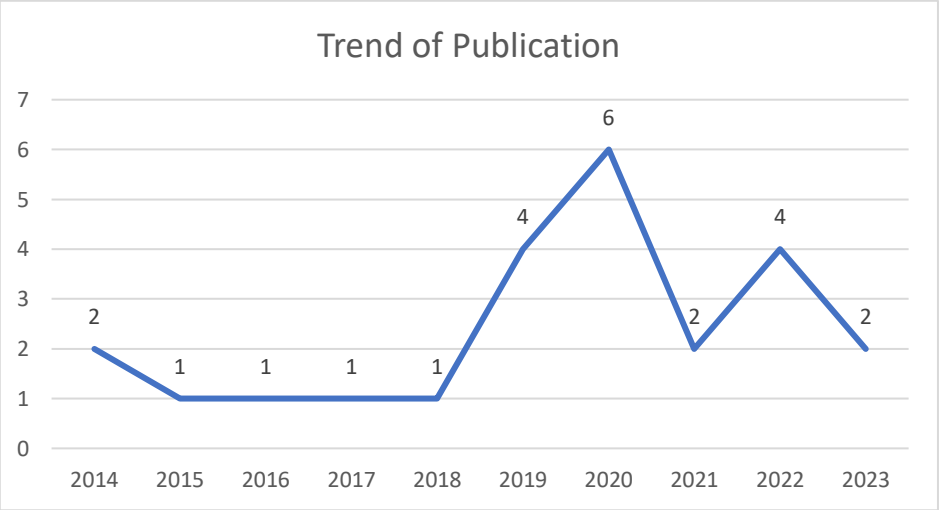


Figure 2. Trend of Publication

Journal Publisher Analysis

Research related to electronic medical records which have an impact on the quality and efficiency of health services has been widely carried out over the last 10 years. This research was published in various publishers and received varying numbers of citations (Table 1).

Table 1. Analysis of Journal Publisher Performance

Journal Publisher	Number of Articles	Total Citations	Average Citations
Journal of Medical Internet Research	3	43	14,3
Applied Clinical Informatics	2	51	25,5
BMJ Quality and Safety	2	126	63
International Journal of Medical Informatics	2	160	80
Medicine (United States)	2	44	22
BMC Health Services Research	1	2	2
BMC Health and Care Informatics	1	2	2
BMJ Open Quality	1	0	0

Journal Publisher	Number of Articles	Total Citations	Average Citations
British Journal of Health Care Management	1	19	19
Ciencia e Saude Coletiva	1	74	74
CIN - Computers Informatics Nursing	1	9	9
Journal of Hospital Medicine	1	24	24
Journal of Medical Systems	1	17	17
Journal of Nursing Administration	1	47	47
Life	1	117	117
npj Digital Medicine	1	11	11
Nutrition and Dietetics	1	19	19
PLoS ONE	1	6	6

Principal Researcher Country Analysis

This analysis also mapped articles by country. The aim is to identify which countries most frequently research electronic medical records. The results of this analysis are presented in Figure 3.

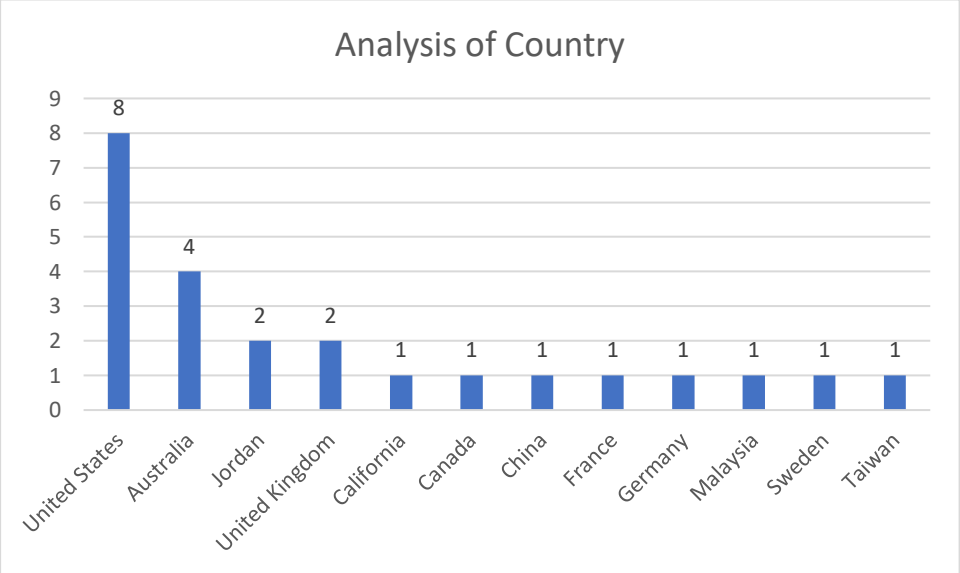


Figure 3. Analysis of Country

Researcher Analysis

From the results of the bibliometric analysis, no author has researched topics related to electronic medical records with the quality and efficiency of health services more than twice. There were only two researchers who conducted EMR-related research more than once. They are affiliated researchers at the Institute of Global Health Innovation, Imperial College London, London, England. They are also co-authors of the same two studies. The total citations obtained from their two studies was 65.

Articles Analysis

This article analysis was used to find which articles were most cited by other authors, who the authors are and what institutions they come from. Based on the results of this analysis, we identified articles with the highest to lowest number of citations (Table 2).

Table 2. Citation Analysis in Articles

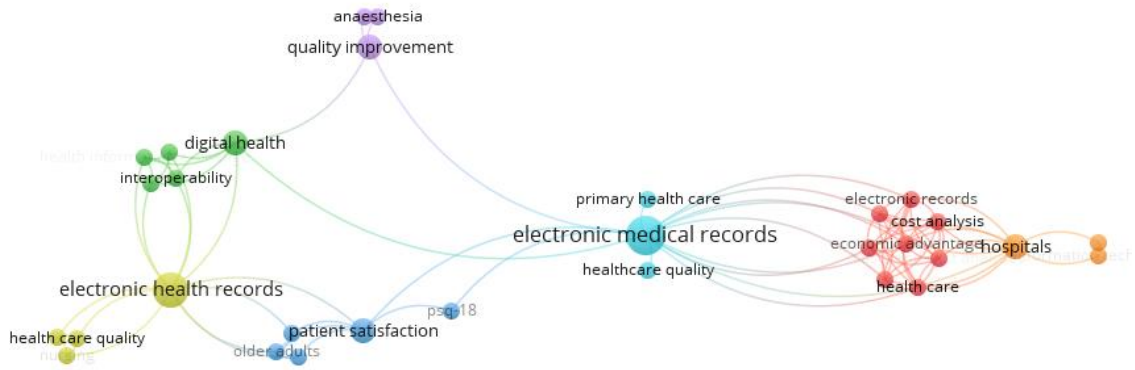
No	Author	Institution	Journal	Year of Publication	Number of Citations
1	Adler-Milstein J, Everson J, Lee SYD (Adler-Milstein et al., 2015)	School of Information and School of Public Health, University of Michigan, United States	BMC Health Serv Res.	2015	136
2	Tsai CH, Eghdam A, Davoody N, Wright G, Flowerday S, Koch S (Tsai et al., 2020)	Health Informatics Centre, Department of Learning, Informatics, Management and Ethics, Karolinska Institutet, Sweden	Life	2020	117
3	Ayaad O, Alloubani A, ALhajaa EA, Farhan M, Abuseif S, Al Hroub A, et al. (Ayaad et al., 2019)	King Hussein Cancer Center, Quality and Patient Safety, Department of Nursing, Jordan	Int J Med Inform [Internet].	2019	104
4	Janett RS, Yeracaris PP (Janett & Yeracaris, 2020)	Cambridge Health Alliance, Cambridge Massachusetts, USA	Cienc e Saude Coletiva.	2020	74
5	Neves AL, Freise L, Laranjo L, Carter AW, Darzi A, Mayer E (Neves et al., 2020)	Patient Safety Translational Research Centre, Institute of Global Health Innovation, Imperial College London, London, United Kingdom	BMJ Qual Saf.	2020	65
6	Taylor SP, Ledford R, Palmer V, Abel E (Taylor et al., 2014)	Division of Hospital Medicine, University of South Florida Morsani College of Medicine, USA	BMJ Qual Saf.	2014	61
7	Plantier M, Havet N, Durand T, Caquot N, Amaz C, Biron P, et al. (Plantier et al., 2017)	Cancer Centre Léon Bérard, Lyon, France	Int J Med Inform [Internet].	2017	56
8	Kutney-Lee A, Sloane DM, Bowles KH, Burns LR, Aiken LH (Kutney-Lee et al., 2019)	Center for Health Outcomes and Policy Research, University of Pennsylvania School of Nursing, Philadelphia, United States	Appl Clin Inform.	2019	49
9	Walker-Czyz A (Walker-Czyz, 2016)	St Joseph's Hospital Health Center, Syracuse, New York, USA	J Nurs Adm.	2016	47

No	Author	Institution	Journal	Year of Publication	Number of Citations
10	Lin H-L, Wu D-C, Cheng S-M, Chen C-J, Wang M-C, Cheng C-A (Lin et al., 2020)	Department of Neurology, Tri-Service General Hospital, Taipei, Taiwan	Med (United States).	2018	42
11	Uslu A, Stausberg J (Uslu & Stausberg, 2021)	USLU Medizininformatik, Düsseldorf, Germany	J Med Internet Res.	2024	25
12	Migdal CW, Namavar AA, Mosley VN, Afsar-manesh N (Migdal et al., 2014)	Assessing Residents' CI-CARE Medical Program, University of California, Los Angeles, Los Angeles, California	J Hosp Med.	2014	24
13	Sharikh EA, Shannak R, Suifan T, Ayaad O (Sharikh et al., 2020)	King Hussein Cancer Center, Quality and Patient Safety, Department of Nursing, Jordan	Br J Heal Care Manag.	2020	19
14	McCamley J, Vivanti A, Edirippulige S (McCamley et al., 2019)	Princess Alexandra Hospital, Brisbane, Australia.	Nutr Diet.	2019	19
15	Mullins A, O'Donnell R, Mousa M, Rankin D, Ben-Meir M, Boyd-Skinner C, et al. (Mullins et al., 2020)	School ofPublic Health and Preventive Medicine, Monash University, Melbourne, Victoria, Australia	J Med Syst.	2020	17
16	Li E, Clarke J, Ashrafian H, Darzi A, Neves AL (Li et al., 2022)	National Institute for Health and Care Research (NIHR) Imperial Patient Safety Translational Research Centre, United Kingdom	J Med Internet Res.	2022	15
17	Nguyen KH, Wright C, Simpson D, Woods L, Comans T, Sullivan C (K. H. Nguyen et al., 2022)	Centre for Health Services Research, Faculty of Medicine, The University of Queensland, Brisbane, QLD, Australia	npj Digit Med.	2022	11
18	Pyron L, Carterleton H (Pyron & Carterleton, 2019)	Capstone College of Nursing, The University of Alabama, Tuscaloosa, United States	CIN - Comput Informatics Nurs.	2019	9
19	Hu X, Qu H, Houser SH, Ding J, Chen H, Zhang X, et al. (Hu et al., 2020)	Department of Health Services Administration, Air Force Medical University, Xi'an, China	PLoS One [Internet].	2020	6

No	Author	Institution	Journal	Year of Publication	Number of Citations
20	Cross DA, Levin Z, Raj M (Cross et al., 2021)	Division of Health Policy and Management, University of Minnesota School of Public Health, Minneapolis, MN, United States	J Med Internet Res.	2024	3
21	Swaleh R, McGuckin T, Campbell-Scherer D, Setchell B, Senior P, Yeung RO (Swaleh et al., 2023)	Faculty of Medicine and Dentistry, University of Alberta, AB, Edmonton, Canada	BMC Health Serv Res [Internet].	2023	2
22	Ibrahim AA, Ahmad Zamzuri MAI, Ismail R, Ariffin AH, Ismail A, Muhamad Hasani MH, et al. (Ibrahim et al., 2022)	Department of Community Health, Faculty of Medicine, Universiti Kebangsaan Malaysia, Malaysia	Med (United States).	2022	2
23	Jedwab RM, Franco M, Owen D, Ingram A, Redley B, Dobroff N (Jedwab et al., 2022)	Department of Nursing and Midwifery Informatics, Monash Health, Melbourne, Victoria, Australia	Appl Clin Inform.	2022	2
24	Fedoruk K, Xie J, Wang E, Fowler C, Riley E, Carvalho B (Fedoruk et al., 2023)	Anesthesiology, Stanford University School of Medicine, Stanford, California, USA	BMJ open Qual.	2023	0

Keyword Co-occurrence Network

The research has analyzed 24 articles based on the keywords used by the authors. Figures 4 and 5 were the results of keyword analysis with VOS viewer. The size of the circle showed the strength of the relationship between keywords. Circles with the same color belonged to the same study cluster. Meanwhile, keywords changed from year to year. Colors closer to blue represent earlier times and closer to yellow represent times closer to 2023 (Figure 4).



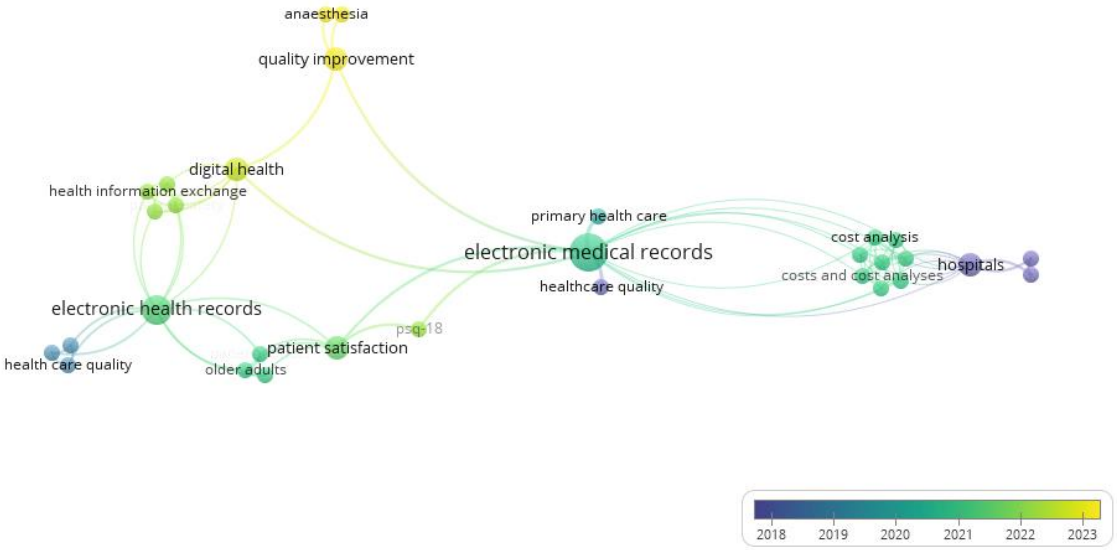


Figure 4. Analysis of Changes in Use and Relationships Between Keywords

The highest number of articles was in 2020 (6 publications), while the lowest number was in several years from 2015-2018 (1 publication). In 2019, there began to be a significant increase (4 publications) and fluctuated from year to year (Figure 2). A significant increase in publications in the field of electronic medical records occurred in 2019, one of which was driven by the Covid-19 pandemic (Winkelman et al., 2022)(Roy et al., 2021)(Pryor et al., 2020)(Satterfield et al., 2021). Research results in the United States show that medical practice experienced a digital transformation in March 2020. This happened because health service facilities had to adapt quickly and continue to provide services during the Covid-19 pandemic (Keesara et al., 2020). The covid-19 pandemic has further accelerated the utilization and implementation of digital health services (Luo et al., 2020)(Bombard et al., 2022)(Golinelli et al., 2020)(Mbunge et al., 2022).

However, the main reason countries in the world implement EMR is to improve the quality and efficiency of health services. According to the Institute of Medicine, widespread use of EMR is critical to improving the quality of health care. WHO defines health service quality as the extent to which health care services provided to individuals and patient populations can improve desired health outcomes. In addition, health care quality is an important component in providing services in health institutions (Kruse & Beane, 2018)(Källström, 2010). Previous research has proven that using EMR has succeeded in improving the health care system including; increasing health workforce productivity, availability of information and quality of care (Khalifa, 2017).

The publisher that published the most articles related to electronic medical records was the Journal of Medical Internet Research (3 articles) (Table 1). The Journal of Medical Internet Research is a journal about health informatics and health services/health policy. This journal is ranked in the first quartile based on Impact Factor in the health informatics discipline. The journal covers topics related to digital health, data science, health informatics, and new technologies for health, medicine, and biomedical research, making it highly sought after for research publications on the topic of electronic medical records.

Assessing the quality of a journal is not an exact science and can be measured using several methods. Some journals declare their quality using Impact Factor (IF) as an indicator (Bała & Sun, 2013). IF is calculated based on the number of citations generated by published journal articles and has been proven to be an indicator of the quality of medical journals (Kapil & Jain, 2016). IF is also used to determine journal rankings and as a reference for authors to select target journals, but cannot be used as an indicator of article quality and author academic achievement (Gasparyan et al., 2017)(Paulus et al., 2018). Previous research results showed that there was no significant relationship between IF and the quality of study results and methodology (Saginur et al., 2020). IF was identified as starting to become irrelevant as a measure of article quality because it is influenced by cost and accessibility factors (Nestor et al., 2020).

We found 24 published articles related to the impact of implementing electronic medical records on the quality and efficiency of health services in various countries in the world. The country with the most research on this topic is the United States (8 articles). This number is 2 times more than in Australia (4), and 4 times more than in Jordan and the United Kingdom and 8 times more than in California, Canada, China, France, Germany, Malaysia, Sweden and Taiwan. EMR is growing more rapidly in developed countries compared to middle- and lower-income countries. In line with previous literature studies, most research on EMR was found from the United States and other developed countries, while in middle- and low-income countries the number was less (K. H. Nguyen et al., 2022).

The highest number of citations was the article written by (Adler-Milstein et al., 2015) with 136 citations, while the lowest number of citations was the article written by (Fedoruk et al., 2023) with 0 citations. Even though there are articles in first place that have received the most citations, articles (Tsai et al., 2020) received 117 citations in 3 years, more significant than (Adler-Milstein et al., 2015) which received 136 citations in 8 years (Table 2). Tsai et al (Tsai et al., 2020) researched the impact of EMR implementation and its inhibiting factors. This research provides a detailed explanation of the impact of EMR on health workers, data and information, patient services and the economy. Apart from that, many of the obstacles that occur in implementing EMR are also explained, such as support from health workers, the EMR system, quality of data and information and other factors. The amount of information presented and its quality may make this article a reference for other research in finding research problems related to EMR implementation. Citation is recognition given by someone to a published work. The number of citations is a quantitative value of the utilization and contribution of a published article. Apart from that, citations also provide an overview of the author's intellectual abilities (Moed, 2005). Currently, research is being carried out to identify and analyze article citations to help readers understand their quality and characteristics (Donthu et al., 2021).

The use of standardized citation scores is a rational method for measuring article quality. However, this method is not perfect and may be misleading. A cohort study showed that there was no significant relationship between the number of citations and the quality of articles (Nieminen et al., 2006). This is caused by several factors including; promotion after publication of a particular article, increased interest in some research area, or the ability of a journal database to provide accurate citation scores (S. Saha et al., 2003). Another opinion states that Co-citation is a more effective and efficient method for searching for relevant articles than keywords (Janssens et al., 2020). Although citations are believed to have contributed to the development of research, they need to be validated and currently their effectiveness is often debated. Some of the reasons for this debate are due to citation bias and citation distortion (Dumas-mallet et al., 2021).

As with publication bias, citation bias can also lead to overinterpretation and unfounded belief in results (Duyx et al., 2017). An analysis showed irrational and inaccurate self-citation of 21% (Thombs et al., 2015). For this reason, other researchers found data that research citations in policy documents do not always illustrate that policies in the field of public health are taken based on the research cited (Newson et al., 2018).

The number of citations is also influenced by the ease with which an article can be found by other research. Choosing the right keywords can help readers find articles on the desired topic. Based on the 24 articles analyzed, the choice of keywords on the topic of electronic medical records that is most widely used is electronic medical record(s) and its synonyms such as electronic health record(s), digital health, and health information exchange. Meanwhile, the issues most commonly associated with the implementation of EMR include; quality improvement, health care quality, patient satisfaction, and cost (Figure 4).

Improving the quality of health services in the implementation of EMR is the most highlighted thing by researchers. Quality improvement is a health care concept that ensures patients receive high-value care (Lopes Sauers et al., 2017). Value care is health care that is high quality and low cost (Teisberg et al., 2020)(Ho, 2020). Quality indicators in health care are effective, safe, superior culture and outcomes that meet expectations (Allen-Duck et al., 2017). To achieve this, accurate and fast data is needed in decision making. Most health service facilities are provided with data from various records and measurement results, but the problem is how the data is processed to reflect needs as well as service development and improvement (Hoog et al., 2014). EMR is a solution to this problem because it is able to process and present various data and information to determine strategies for improving service quality (Alzu'bi et al., 2021).

The use of EMR also has an impact on patient and health care provider satisfaction. EMR has been proven to increase patient satisfaction with the intensity and explanation of doctors during consultations (Wali et al., 2020), provide reminders for taking medication (Varadaraj et al., 2019), improve the quality of doctor services (Rosen et al., 2011)(Lee et al., 2016) and support patient-centered services (Butler et al., 2022). Apart from increasing satisfaction, several studies have actually reported a decrease in satisfaction. According to North et al (North et al., 2020), a decrease in patient and health care provider satisfaction occurred after the use of EMR. The decline in patient satisfaction was more significant than health service provider satisfaction. It takes health care providers between 9-15 months to regain patient satisfaction after using EMR. Other research states that the use of EMR reduces doctors' accuracy in carrying out examinations, documentation, administering drugs, and time for patients (Al-Jafar, 2013).

In addition to patient satisfaction, EMR is also associated with cost issues. Many studies report that EMR can reduce health care costs thereby supporting efficiency in health care providers (Rhoades et al., 2022). Other research states that EMR increases the cost of health services but is accompanied by an increase in patient quality of life (Gilmer et al., 2012). Saving health service costs is also related to time efficiency. EMR is able to make health services faster thereby reducing doctors' working time (Kawamoto et al., 2019)(Naveed et al., 2019). However, health workers who are less skilled in using EMR are a factor that can reduce productivity and efficiency (Khairat et al., 2020)(O. T. Nguyen et al., 2022). For example, the use of EMR with voice recognition to assist clinical documentation actually makes the doctor's work slower and increases the risk of errors (Hodgson et al., 2017).

CONCLUSION

Research related to EMR developed rapidly in the world starting in 2019. This was driven by the spread of the Covid-19 virus. However, improving the quality and efficiency of health services was the main reason why EMR was used. EMR research in developed countries was most dominant, compared to middle- and low-income countries. Journals with the scope of health informatics were most often the target for publication of EMR research articles. The number of citations did not depend on the suitability of the journal's scope but rather the quality of the article which is most important. In addition, choosing the right keywords could increase citations, because it makes it easier for other researchers to find the article. Improving service quality, costs and patient satisfaction were the issues most often associated with EMR as a form of outcome.

Bibliometric analysis provides evidence about current research trends, most visited journals, researchers, country of origin and citations of articles related to a particular topic. Bibliometric analysis can help determine the direction of further research, so this is important to do. This analysis has limitations because it does not take data sources other than the Scopus database. Apart from that, research topics related to EMR continue to develop rapidly, but bibliometric analysis is still limited and all use qualitative analysis, so that future research can do it again with wider data sources and analyze them quantitatively.

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