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A bibliometric study on the adoption of mobile health: trends and future directions

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ABSTRACT

This study presents a comprehensive overview of research on mobile health applications (mHealth apps) from 2013 to 2023. A total of 207 research papers from the Scopus database were analyzed. Based on keyword co-occurrences and co-authorship mapping, the paper identifies emerging trends and research patterns by using the VOSviewer software. Over the past ten years, there has been a discernible increase in the number of mHealth publications. However, a lack of attention has been given to the Asian context. It is anticipated that applications of mHealth will be observed in numerous health services given the high volume of citations obtained in this subject. The present review paper is assisted by the bibliometric approach and offers a rigorous analysis of journal papers on mHealth that have been published. The findings of the current work may serve as a foundation for further research in this discipline that focuses on bringing attention to the nature of the subject matter. This overview could be a central resource for researchers and practitioners looking for information that can help with cross-disciplinary projects by directing them to recognized peer-reviewed publications, journals, and networks.

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1. INTRODUCTION

The global endeavor to attain Universal Health Coverage (UHC) and the sustainable development goals (SDGs) necessitates a major transition toward integrated healthcare systems [1], [2]. In affluent nations, the share of overall fiscal expenditure that goes toward health care is continuously increasing. For instance, in the United States, healthcare spending represented 18.2% of GDP in 2015, up 5.7% from the previous year [3]. On the other hand, it might be challenging to get appropriate medical care in some emerging nations and less developed regions due to a lack of medical resources, an uneven rise in supply and demand, and the high cost involved [4], [5].

Mobile health (mHealth) is an implementation of mobile technology that aims to enhance health outcomes through the transmission and acquisition of health data and information [6], [7]. mHealth is defined by the World Health Organization's Global Observatory as a public health practice that is aided by mobile technology, including smartphones, personal digital assistant (PDAs), patient monitoring devices, and other wireless gadgets [8]. mHealth refers to the use of wireless technology to transmit and facilitate various health

data and services that may be easily accessed through mobile devices, including mobile phones, smartphones, PDAs (including medical sensors), laptops, and tablet PCs [9], [10]. The utilization of smartphone programs, generally referred to as apps, has significantly risen worldwide because of the greater prevalence of smartphones. Nearly all developed nations, as well as certain developing nations, have achieved a mobile penetration rate that is approaching 100%.

The growing enthusiasm for mHealth solutions as a transformative force in global health has been driving interest [11]. The mHealth concept was first introduced by Jones in 2001 and was further developed in the work of Ventresca and Mohr in 2000 [12]. Recently, there has been a growing trend in developing nations towards the adoption of mHealth [13]. The two largest online app stores that provide mHealth apps are Google Play and the Apple App Store (iTunes). A lesser selection of apps is available for other platforms including BlackBerry World and the Windows Phone Store [14]. Digital devices have grown in importance in many developing nations because of technology's ability to address health-related problems and its ability to offer affordable technical solutions that lessen the financial burden of a patient's illness [15], [16].

Many governments in these countries have acknowledged the potential advantages of mHealth and have incorporated it into their strategies to achieve their health system objectives in line with the SDGs [11]. The digital health sector has experienced significant growth, along with increased investment in digital technologies. Among these technologies, mHealth has garnered significant interest from patients, healthcare professionals, providers, and scholars [17], [18]. This is because mHealth allows individuals to access healthcare services without being limited by time or location, thereby improving the availability and quality of healthcare services [19]. Numerous health services, such as encouraging medication adherence, preventing behaviors linked to certain diseases, providing psychological support for patients with chronic illnesses, helping patients lose weight, helping people quit smoking, and many more also among the benefits offered by mHealth [20], [21]. According to Eze *et al.* [9], the growth of mobile technology in developing nations has been extraordinary, prompting governments, non-governmental organizations, and practitioners to utilize its potential for expanding developmental initiatives to impoverished rural areas mostly located in emerging countries [22].

Mobile health has the potential to benefit public health systems in many ways. These include improving mental health, raising awareness and health literacy, and promoting healthy eating and physical activity to prevent diseases and other health problems before they arise, also known as preventive medicine or health [23]. mHealth is seen as a simple, inexpensive, and cost-effective way to increase access to healthcare services, particularly for individuals who have a severe lack of medical resources [24], [25]. mHealth is used to provide healthcare information to the public, collect health data, monitor patients remotely, access health records, make medical diagnoses, and assist in disease prevention and management [8]. According to a prior study, users of mHealth services can experience shorter waiting times (97%) and save money (91%), as well as traveling time (98%) [26]. By utilizing big data and cloud computing, mHealth (such as digital personal healthcare services, remote consultations, and remote monitoring) can track people's health conditions, assess how their conditions are changing over time, and offer prompt treatment. The time and expense of diagnosis can be reduced using mHealth services. Additionally, it contributes positively to raising the standard and effectiveness of medical resources, which is turning into one of the health industry's most promising future developments [3]. Recent studies also found that mHealth is significantly helping to improve people's mental health including to elderly [6], students [27], [28], mental health patients [29], [30], suicide prevention [31], schizophrenia [32], physical activity, diet, drug and alcohol use [33], clinical psychiatry [32], adolescent [34], people with or without mental health problems [35], and others.

Technology acceptance theories have been used in earlier research to assess people's behavioral intentions to adopt new technologies and their level of happiness after using them. In particular, the theory of reasoned action (TRA) by Ajzen and Fishbein [36]; the theory of planned behavior (TPB) by Ajzen [37]; the technological acceptance model (TAM) by Davis [38]; and the innovation diffusion theory (IDT) by Rogers [39]. Most studies look at smartphone users' behavioral intentions which are dominated by this hypothesis [40]. In the past, most studies have examined key components from well-known theories including the TAM, the theory of planned behavior (TPB), the motivation theory [3], [41], and the unified theory of acceptance and use of technology (UTAUT) [42]. However, there are some limitations in the individual mobile health services adoption proposed by previous research.

Despite the widespread adoption of mobile phones and the acknowledged potential of using them to improve healthcare services, the adoption and acceptance of this technology are significantly different among the elderly population [24]. According to Alam *et al.* [11], it is still unclear how to understand what factors influence the uptake of mHealth apps. Furthermore, the variables influencing the younger generation's use of mHealth apps have received comparatively little attention. Moreover, research on how to encourage users to continue using these IT services to preserve their health and keep an eye out for others is still scarce. While a prior study identified that the primary drawbacks of previously published mHealth research include the use of

underpowered pilot data in certain patient groups or with apps, or the concentration on medical professionals alone [43].

To gain a deeper understanding of where research is headed in the healthcare field, it is crucial to analyze and classify the existing literature on the given subject. Recent studies have utilized bibliometric mapping techniques to analyze extensive datasets, aiming to reveal research patterns within a particular subject. This analysis helps to tap into the growing pool of knowledge, and assess specific research, its impact, and article connections. It also aids in defining the current knowledge landscape. The analysis of co-authors' countries (or regions) and research institutions to shed light on collaboration between various regions or research institutions, the extraction of keywords for co-occurrence analysis to pinpoint research hotspots, the visualization of the intellectual structure and evolution of innovation systems research, and keyword clustering to pinpoint the primary research directions in a field are just a few of the many tools that researchers have recently developed to meet the needs of bibliographic analysis and enhance the bibliographic treatment. As a result, bibliometrics is crucial for both offering a historical perspective and making predictions [44].

To date, the studies of mHealth are scarce in Malaysia. While mHealth acceptance has been studied in different contexts, the adoption among employees at the workplace received limited attention [45]. Some of the identified mHealth are only focusing on the use of mHealth among obese people [21], [46] medical students [8], pharmacy clients [19], and the general population [40]. Recent bibliometric analysis studies include those conducted by Sweileh *et al.* [20] covering 2006-2016, Cao *et al.* [44] covering from 2000 to 2020. The researchers created the following research questions considering the growing body of knowledge on mHealth and the dearth of bibliometric analysis: i) What is the publication trend of mHealth research from 2013 to 2023?; ii) Which countries and institutions have produced the highest number of articles?; iii) Who are the authors that are most prolific and have the highest citation counts?; iv) Which are the key publications in mHealth research?; v) Which subject area dominates the studies? And vi) What are trends in co-authorship and keywords in mHealth research?

An overview of the body of knowledge on mHealth published in academic journals between 2013 and 2023 is the primary goal of this endeavor. The principal aim of the research is to conduct an analysis of mHealth research and to significantly add to the body of knowledge on the topic. This will be achieved through the explanation of several statistical studies and a critical evaluation of the trends and scope of this topic from 2013 to 2023 using a bibliometric analysis based on publications indexed in Scopus. This study provides important insights into how the field of mHealth research is changing by looking at highly cited papers, identifying nations with significant productivity in the field, identifying significant journals, emphasizing research areas, tracking annual data, and identifying prolific authors in mHealth research.

2. METHOD

2.1. Design

This study aimed to analyze and assess literature published in the field of mHealth that was published between 2013 and 2023. The study's main goals are to assess mHealth research and greatly expand the corpus of already published works. The Scopus database was used to retrieve articles in mHealth. The year 2013-2023 was chosen as the study period. VOSviewer was employed to visualize the data. Using common bibliometric measures, the growth of publications, citation analysis, and research output were displayed. This study provides valuable insights into the evolving context of mHealth research by examining highly cited papers, identifying countries with significant productivity in mHealth research, identifying influential journals, highlighting research areas, tracking annual data, and identifying prolific authors in the field. Future researchers will find it useful in comprehending the research area and in determining the best areas to focus their efforts.

2.2. Eligibility criteria

The criteria for including and excluding research papers for the systematic review are presented in Table 1. Research studies have only been included if these conditions are met. Thus, from Table 1, we can infer that the articles and documents relating to the field of social sciences, business, management and accounting, and arts, and humanities are in the final study.

2.3. Bibliographic database

This analysis only looks at publications published between 2013 and 2023 to reflect the most recent developments in this subject. The articles were collected in December 2023 using publications from the Scopus database, including research papers published between 2013 and 2023. Data for mHealth were taken from Scopus, a bibliographic database that includes around 22,000 titles in the social, scientific, technical,

and medical sciences. In addition, Scopus has the largest database as compared to PubMed or Web of Science, therefore, it becomes the choice by researchers [20].

Table 1. Criteria for selecting research paper

Access type	Document type	Subject area	Publication year	Number of publications
Open access	Article	Social Sciences	2013	283
		Business, Management and Accounting	2014	61
		Arts and humanities	2015	
			2016	38
			2017	
			2018	
			2019	
			2020	
			2021	
			2022	
			2023	

2.4. Search strategy and validity

One method used to find journal publications was to search for them using the term “mobile health” in the author’s keywords or the title abstract. Since not all publications in the field of mobile health could be found in this manner, the second strategy was employed. The three terms or acronyms most frequently used to refer to “the practice of medicine and public health supported by mobile devices” are mobile health, m-Health, and mHealth (WHO, 2011). In this review, however, the terms employed were expanded to include “mobile health” OR “m-Health” OR “mHealth” OR “mobile health application” OR “mHealth app” OR “mobile application”. The time frame for each strategy was established between 2013 and 2023, and the sources should only be journal papers. To get the most articles returned, the "OR" operator was applied. In this method, any documents that might contain the terms we utilized were searched to guarantee a thorough examination along with a word related to any area of health while adhering to the guidelines for analysis and conclusions provided by the preferred reporting items for systematic reviews and meta-analyses (PRISMA) statement as shown in Figure 1.

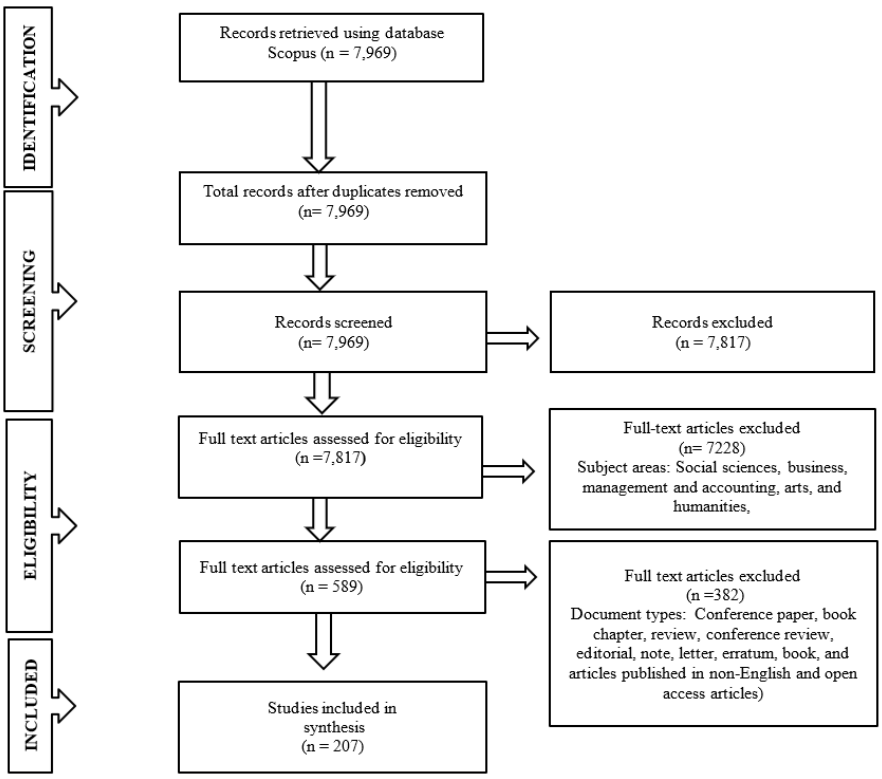

Figure 1. PRISMA flowchart

3. RESULTS AND DISCUSSION

3.1. What is the publication trend of mHealth research from 2013 to 2023?

Figure 2 shows the trend of publications from 2013 to 2023. The data showed that only one publication was produced during 2014, five to six in 2015 and 2016. The average volume has been produced from 2017 to 2018. There is a sharply growing trend in mHealth publications from 2019 to 2023. Researchers' interest in studying this topic was expanded in tandem with the global pandemic that swept the globe. Of the research output published in 2019, 21 publications were published, indicating a significant rise. Nevertheless, publishing appeared to be a little slow in 2020 (17 publications). During that period, the global community was fighting the COVID-19 pandemic and prioritizing physical and mental well-being areas. As individuals learn to cope with the pandemic, the focus shifts to improving mental health, which has emerged as the illness that is least marketable. Consequently, the number of publications escalated to 36 in 2021 and continued to rise to 48 in 2022. In 2023, the total number of publications is 43. The statistics within the past few years proved that the fields of social sciences and medicine have recently dominated the publication.

The increasing pattern of publications indicates that scholarly studies on this topic are receiving more attention. The COVID-19 problem, which has forced various sectors to integrate the usage of mHealth applications in enhancing employees' mental health, is one possible element leading to this situation. This demonstrates that academics continue to recognize the importance and influence of mHealth, indicating their optimism about it is significance and effects. The application of mHealth in domains beyond medicine has shown that it is a helpful strategy for treating mental health problems in a variety of multidisciplinary fields and industries. Further publications are anticipated in the future as knowledge of it is benefits to employees grows.

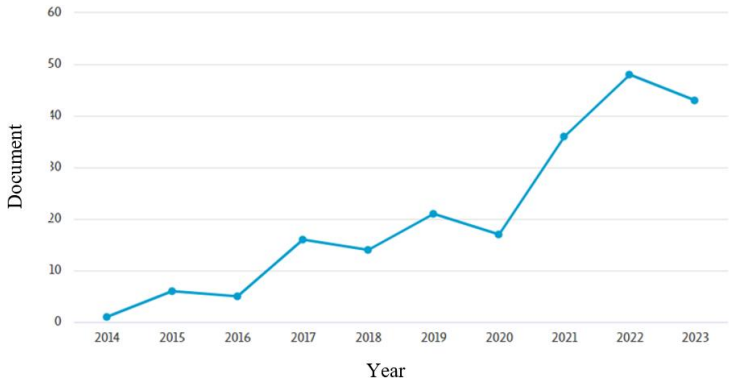

Figure 2. Publication trend from 2013 to 2023

3.2. Which countries and institutions have produced the highest number of articles?

Research on mobile health has been conducted in a total of 50 countries. The United States has the most publications, with 62 between 2013 and 2023. The United Kingdom (34), Germany (17), Canada (15), Australia (14), and China (11) come next. The top ten nations that have published on mobile health are listed in Figure 3. These nations' current publications reflect their roles as the world's developed nations.

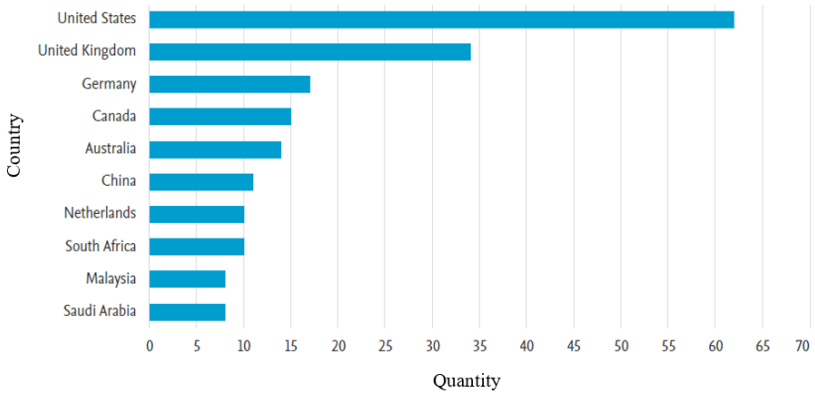

Figure 3. Most productive countries on mobile health publications

The universities that published the greatest number of studies on mobile health were included in Table 2. They include Université McGill (5 publications), the University of Tasmania, the University of Toronto, and Universität Heidelberg produced four publications each. While other universities produced three publications each.

The finding of this study also found that several articles have actively been published during 2013-2023. As shown in Figure 4, the highest number of publications is JMIR Human Factors Journal (Universities and research institutions in Canada) which focuses on the Medicine and Social Sciences area (H-Index 27, Quartile 2) with 29 publications. The second highest productive journal is JMIR Aging Journal (the universities and research institutions in Canada) which focuses on medicine, nursing, and social science area (H-Index 18, Quartile 1) with 12 publications. The third-ranked journal is Patient Preference and Adherence Journal, which belongs to a university and research institution located in New Zealand with H-Index=61 and focus on Medicine, Pharmacology, Toxicology, and Pharmaceutics and Social Sciences with Quartile 1. It produced 11 articles throughout this period of the study's duration. The other journals include the Journal of Technology in Behavioral Science (5 publications), Sustainability Switzerland (4 publications), Human Resources for Health, and Sociology of Health and Illness, then followed by the other journals that published 3 publications each including AIDS Education and Prevention, and Computers in Human Behavior. Table 3 shows the first nine top journal publications.

Table 2. Most productive universities

Rank	Universities	Publications
1	Université McGill	5
2	University of Tasmania	4
3	University of Toronto	4
4	Universität Heidelberg	4
5	University of Johannesburg	3
6	Universiteit van Amsterdam	3
7	Centre Universitaire de Santé McGill	3
8	The University of Vermont	3
9	King's College London	3
10	University of Leeds	3

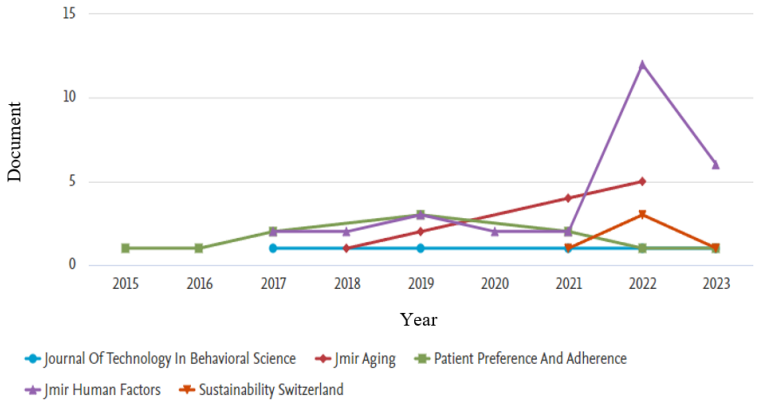

Figure 4. Publication by top journal by year

Table 3. Publication by top journal by year

Rank	Journals	Publications
1	JMIR Human Factors	29
2	JMIR Aging	12
3	Patient Preference and Adherence	11
4	Journal of Technology in Behavioral Science	5
5	Sustainability Switzerland	5
6	Human Resources for Health	4
7	Sociology of Health and Illness	4
8	AIDS Education and Prevention	3
9	Computers in Human Behavior	3

3.3. Who are the authors that are most prolific and have the highest citation counts?

The most influential author in the field of mobile health is Schnall, Rebecca B., with three publications. It is followed by Al-Samarraie, H., Frandes, M., Garafalo, R., Hingle, M. and others with two publications, respectively. Figure 5 indicates the most prolific authors and the first top ten authors with most publication in mobile health research. As shown in the figure, the majority of authors published two papers, while only one author published three academic papers. Table 4 reveals that Briz-Ponce *et al.* [47] were in the top place with 256 citations for the paper "Learning with mobile technologies: Students' behavior" followed by Fox *et al.* [48] with 80 citations per paper. Munos *et al.* [49] in their study "Mobile health: the power of wearables, sensors, and apps to transform clinical trials" obtained 72 citations. The other authors received an average of 71-46 citations for their studies.

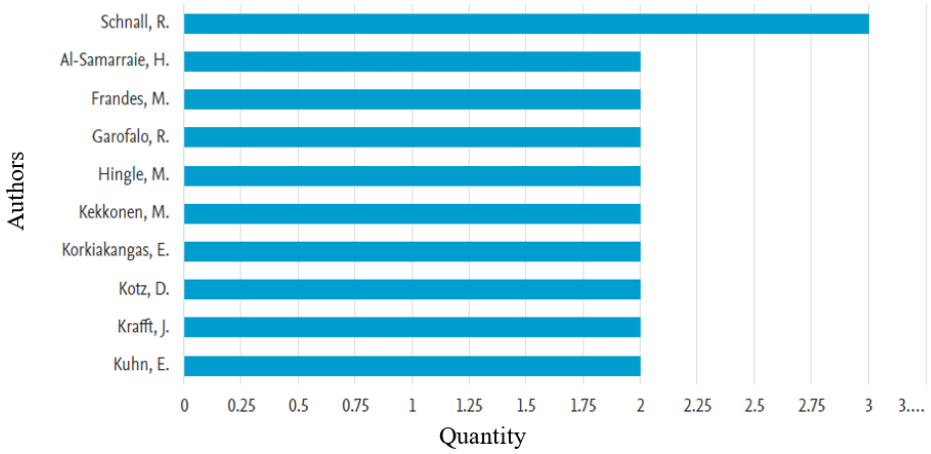

Figure 5. Most prolific authors on mobile health

Table 4. Most cited publications and authors

Authors	Title	Year	Source title	Cited by
[47]	Learning with mobile technologies: Students' behavior	2017	Computers in Human Behavior	256
[48]	Exploring the competing influences of privacy concerns and positive beliefs on citizen acceptance of contact tracing mobile applications	2021	Computers in Human Behavior	80
[49]	Mobile health: The power of wearables, sensors, and apps to transform clinical trials	2016	Annals of the New York Academy of Sciences	72
[50]	Efficacy of a mindfulness-based mobile application: A randomized waiting-list controlled trial	2018	Mindfulness	61
[51]	Lack of adoption of a mobile app to support patient self-management of diabetes and hypertension in a federally qualified health center: interview analysis of staff and patients in a failed randomized trial	2017	JMIR Human Factors	58
[22]	Theoretical advancements in mHealth: A systematic review of mobile apps	2018	Journal of Health Communication	58
[52]	Smartphone threshold audiometry in underserved primary health-care contexts	2016	International Journal of Audiology	57
[53]	Digital information technology use and patient preferences for internet-based health education modalities: Cross-sectional survey study of middle-aged and older adults with chronic health conditions	2019	JMIR Aging	57
[54]	Effectiveness of mobile apps for smoking cessation: A review	2017	Tobacco Prevention and Cessation	53
[55]	Using a mHealth tutorial application to change knowledge and attitude of frontline health workers to Ebola virus disease in Nigeria: A before-and-after study	2016	Human Resources for Health	46

3.4. Which subject areas dominate the studies?

There are no subject-matter restrictions that were employed even though this bibliometric analysis of mobile health covered selected topic areas (social sciences, business, management and accounting, and arts and humanities). The objective of this analysis is to offer a comprehensive understanding and insight into the areas of subject publication that exert the most significant influence. The data reveals that there is a stronger emphasis on publications in the field of social sciences as it is the highest discipline contributed to mobile health publications with 73 (35.29%) articles. This is followed by the medicine discipline, which accounts for 46 (22.4%) number of publications. The third biggest concentration is observed in the domain of computer science representing 18 (8.7%) number of publications. Business, management, and accounting as well as psychology contributed to 11 (5.3%) articles and 10 (4.3%) articles from the total publications. Based on this analysis, it appears that there is significant room for expansion in the fields of art and humanity, engineering, medicine, decision science, and computer science in the context of future research. Figure 6 illustrates the most influential publications on the subject area accordingly.

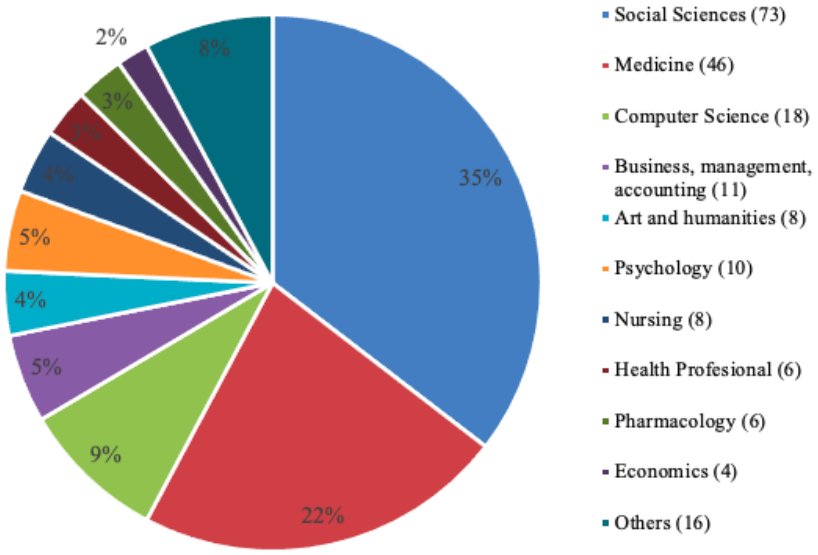

Figure 6. Most influential publication on subject area

3.5. What are trends in co-authorship and keywords in mHealth research?

Co-Authorship and country analysis: bibliographies or data sets with bibliographic fields (title, author, journal) can be visualized using VOSviewer [43]. VOSviewer is a tool used in the field of research for bibliometric analysis, which involves finding the most frequently used references in particular domains and themes that still have the potential for further investigation [56]. Numerous studies examined the use of international co-authorship as a measure of global scholarly collaboration and emphasized the benefits it offers for raising the profile, significance, caliber, or output of research [57]. Co-authorship, which includes author co-citation, co-authorship, and co-word analysis, is a popular issue in bibliometrics research and is one of the most significant ways to show that the social network among scholars in a certain research field exists [14]. As a valuable technique for evaluating interdisciplinary science, social network analysis (SNA) assesses several kinds of collaboration networks, including co-authorship networks. As a result, this approach can help understand networking trends and could be a potent tool for organizing future joint research projects [58]. Moreover, working together is crucial to enhance the effectiveness, efficiency, and scope of scientific research and experimentation [59]. Figure 7 represents the analysis of co-authorship based on countries. The mobile health publication data set included 50 countries. Among the 50 countries involved, 16 had met the threshold; hence, 107 links were found. Researchers had set five minimum documents from each country and the top 16 countries with the most frequent co-authorship ties were used in this analysis.

There were 4 clusters created by VOSviewer software. The cluster is a group of scholars who frequently work with one another and are more likely to co-author articles with one another than with other researchers outside the cluster. Figure 7 explains the respective co-authorship and country analysis. Cluster 1 showcases the collaboration among the co-authors from the United Kingdom, Saudi Arabia, Germany,

Switzerland, India, and Norway. Cluster 2 involves co-authors from Malaysia, Australia, China, and Singapore; cluster 3 involves collaboration among the United States, Canada, Netherlands, and South Africa. and cluster 4 reflects researchers from Spain and Portugal.

Figure 7. Co-authorship and country analysis

Clusters 1 and 2 exhibit collaborations between high-income countries, developing, and developed countries. In cluster 1, the United Kingdom collaborates with the United States, Canada, and the Netherlands, while Saudi Arabia also collaborates with Malaysia, China, Australia, and Singapore. In cluster 2, Malaysia collaborates with Saudi Arabia, Australia collaborates with Canada, and Singapore collaborates with the United States. Moreover, cluster 3 which involves the United States, Canada, and the Netherlands demonstrates the collaborations with the United Kingdom, Australia, and Singapore. Lastly, cluster 4 (Spain) shows the collaboration only among high-income countries, the United Kingdom. Figure 7 illustrates the co-authorship and country analysis of this study and Table 5 listed the top ten co-authorships and the country total link strength details.

Table 5. Top 10 co-authorship and country total link strength

No.	Country	Documents	Citations	Total link strength
1	United Kingdom	34	407	22
2	South Africa	10	119	15
3	Australia	14	198	13
4	United States	62	865	12
5	Canada	15	121	10
6	China	11	42	10
7	Saudi Arabia	8	50	10
8	Germany	17	108	7
9	India	7	32	6
10	Norway	6	19	6

Keyword analysis: one selection criterion in VOSviewer aids in understanding the relationships between documents. The essential information that reflects the articles' main topic is made clearer by the inclusion of keywords. This means that only terms that appear three or more times are recognized by the software. A list of mHealth-related terms that appeared three or more times in the Scopus database between 2013 and 2023 is shown in Figure 8.

The software recognizes a total of 1569 distinct keywords in the screening result. Only 55 keywords, with 6 clusters, 659 links, and a total link strength of 1,683, match this predetermined requirement. Additionally, every node symbolizes a term, and the association between two connected nodes is represented by the formation of a link between them. The size of the node indicates the frequency of occurrences of the keyword. Keywords such as mobile health, procedures, mental health, usability, self-care, and others show the highest occurrence in mHealth research. Figure 8 visualizes the occurrence of keywords on mHealth research while Table 6 represents the top 10 keywords used in mHealth research. The highest keyword weas mobile health, while the lowest one is attitude to health. In addition, procedures were in the second rank, followed by mental health and usability.

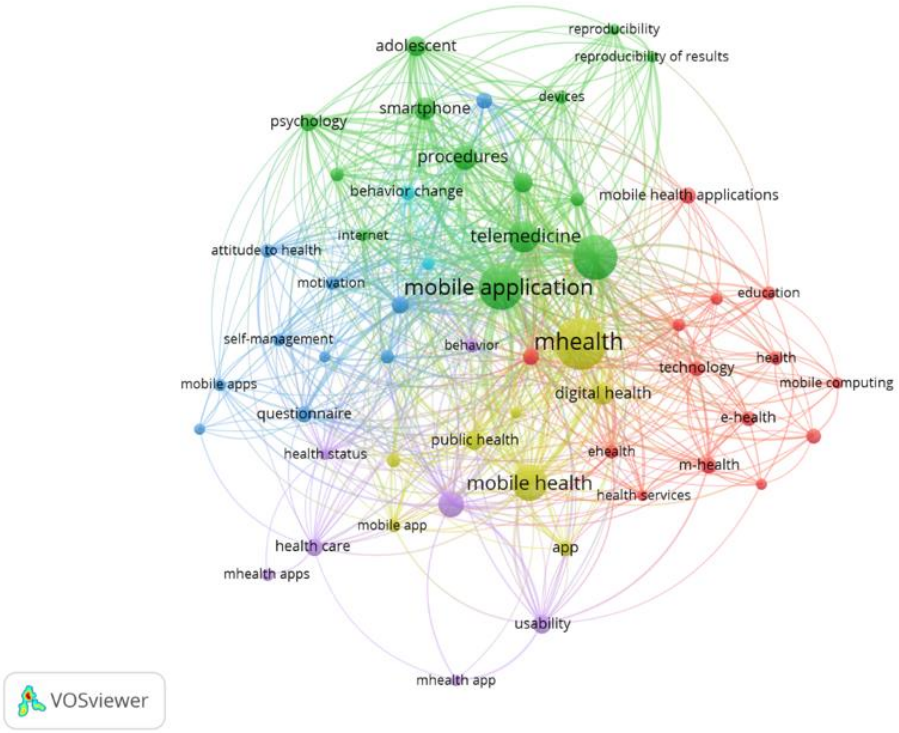

Figure 8. Network visualization of author keywords occurrence.

Table 6. Top 10 keywords used by author in mhealth studies

No.	Keyword	Occurrence	Total Link Strength
1	Mobile health	46	148
2	Procedures	21	132
3	Mental health	14	69
4	Usability	13	45
5	Usage	13	45
6	Self-care	11	81
7	Telehealth	9	61
8	Behavior change	8	44
9	Technology	8	39
10	Attitude to health	7	39

3.6. Discussion

The purpose of this research is to describe and offer useful information to everyone with an interest in the mHealth research area by identifying the trends in mHealth publications between 2013 and 2023. The result revealed that there is a considerable increase in the number of publications from 2013 and 2023. Over 95% of the documents retrieved in the subject of mobile health were written in English, making it the language of science in this field. The United States ranked first in productivity, far ahead of other nations and areas, but the contribution made by the United Kingdom and Germany was also prominent. Literature in mHealth covered a wide range of disciplines including the top three disciplines including social studies, medicines, and computer sciences.

JMIR Human Factors Journal is the most preferred journal for publishing documents in mHealth (29 publications), followed by JMIR Aging Journal (12) and Patient Preference and Adherence Journal (11 publications). The volume of literature in mHealth showed an exponential increase in the second half of the study, i.e., after 2019. The mean number of authors per document increased throughout time, which is consistent with an increase in author collaboration on research, along with the volume of literature. Additionally, there was a notable increase in the quantity of publications in mHealth research from 2019 to 2023. Mobile health became a top priority for organizations of all stripes due to two main factors: the COVID-19 pandemic and the advent of digitalization, or IR 4.0. It is agreed that the technology development and the advent of health applications for smartphones and other mobile devices have improved people's

access to healthcare services and lessened the workload for healthcare professionals [20]. Consequently, a great deal of research was done on mHealth, leading to a significant rise in empirical studies.

On the other hand, the most productive institutions are Université McGill (Canada), the University of Tasmania (Australia), and the University of Toronto (Canada) which took the top spot with 5 and 4 publications, respectively, when ranked among the most productive universities as similar studies done by previous researchers such as Sweileh *et al.* [20]; Peng *et al.* [60]. The study also reveals that the authors with the highest number of citations are Schnall, Rebecca B, who obtained a total of 3,087 citations with 171 documents. The author is from the Columbia University, United States. Al-Samarraiem Hosam University of Leeds, United Kingdom with 2,323 citations and 92 documents. The third highest citation received by Frandes, Mirela with 377 citations from 43 documents. It is possible to conclude that high-income countries and developed nations dominate the field in terms of most productive universities, most productive authors, and the highest cited authors. The most frequently keywords used in mHealth research are mobile health, procedures, mental health, usability, self-care, telehealth, behavior change, technology, and attitude to health.

Nevertheless, national economies, regulatory regulations, and privacy concerns will all pose obstacles to mHealth's progress. Thus, to advance the mHealth study area, future researchers should work on related topics. Governments, companies, and even private institutions may consider or prioritize investing in mHealth. As agreed by Chen *et al.* [61], technology has impacted smart digital devices and apps beyond all else, and research into developing and applying technologies to facilitate the creation of cutting-edge digital devices and applications will continue. Consequently, to make digital devices and applications smart and effective, attention should be paid to the application and incorporation of various cutting-edge technologies, rather than just computer/web-based ones. Emerging new mobile technologies ought to be developed to assist individuals and nations in addressing a serious public health crisis and enhancing national health. The information provided in this study will also be used in the future to compare and record how mHealth is affecting the next studies.

4. CONCLUSION

Mobile health (mHealth) has demonstrated a great deal of promise for application in various facets of our lives in recent years. This study aims to provide a bibliometric analysis of mHealth from 2013 to 2023. In general, this study significantly contributes to the understanding of mHealth research trends over the past decade. Over the past ten years, there has been an apparent rise in the number of mHealth publications. It is anticipated that applications of mHealth would be observed in numerous health services given the high volume of citations obtained in this subject. The increasing number of publications in this field underscores its growing importance. However, it is important to note the limitations of this study. The choice of the database depends on the goals of the study, the field of study, and the requirements of the analysis. Although Scopus is a well-known and credible bibliographic database that offers comprehensive coverage of scholarly literature, researchers must recognize that there are other databases available. Thus, future researchers can use the patterns and directions identified in this study as a starting point for probing important questions about cutting-edge studies on the impact of mobile health among researchers. It can be summarized that bibliometric analysis and network visualization have illuminated the research horizon, trends, and hot subjects surrounding mobile health app development. These results can offer insightful advice on potential avenues for future investigation and viewpoints on this quickly evolving topic. Specifically, given the key findings, the researchers suggest future studies to examine the dynamics of cross-country collaborations and comparative studies of productive countries to understand the unique strategies, policies, and research ecosystem.

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