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From Rehabilitation to Prevention: Theoretical Perspectives on the Use of Mobile and Wearable Technologies in Health Monitoring and Lifestyle Change

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Abstract: Health should be achieved beyond the hospital setting. Thanks to modern technologies—mobile and wearable devices—significant opportunities have emerged for the prevention and manage-ment of cardiovascular diseases. Mobile devices can monitor physiological signals in real time, such as physical activity and heart rate, to promote healthy behaviors, enable early detection, and support continuous care. Wearable technology is an interdisciplinary and continuously de-veloping field that has advanced significantly over the last two decades owing to progress in sensor technology and connectivity. In this review, the authors use a bibliometric analysis to highlight recent advances and challenges related to the use of mobile devices to assess and pro-mote physical activity and fitness and to monitor heart rate. The database used for extracting ar-ticles was Web of Science (WoS). The keywords used were "portable devices", "cardiac parame-ters", "physical activity", "wearable device", and "wearable devices". Boolean operators "AND" and "OR" were used to combine terms. The evolution in publication volume reflects growing dynamism in the field and anticipates a period of expansion and innovation in research and the application of wearable devices for monitoring risk factors. A total of 12,348 articles and 1,797 reviews were identified. The top three countries in terms of productivity are China, the United States, and Italy. Institutions in China contributed more than 70% of the publications; conse-quently, the Asia region—especially China and India—represents the main center of scientific research and publication, while contributions from France and the United States, although sig-nificant, are relatively smaller in the international context. Although advances in mHealth are promising, important challenges must be addressed to maximize benefits. Data accuracy is cru-cial because clinical decisions rely on precise information. In addition, personal data privacy and security must be guaranteed to prevent breaches and to ensure patient trust in these technologies.

Keywords: Wearable Devices, Prevention, Rehabilitation, Health Maintenance, Lifestyle Change

1. Introduction

Health should be achieved beyond the hospital setting; thanks to modern technology involving mobile and wearable devices, significant opportunities have emerged for the prevention and management of cardiovascular diseases, since mobile devices can monitor, in real time, physiological signals such as physical activity and heart rate to promote healthy behaviors, enable early detection, and support continuous care [1]. Wearable technology is an interdisciplinary and continuously developing field that has advanced significantly in the last two decades due to progress in sensor technology and connectivity. Widely used in areas such as health, sports, entertainment, electronics, textiles, and defense, it includes a variety of wearables (for example, smartwatches and non-invasive sensors) that facilitate monitoring and management of health and other aspects of daily life. The diversity of definitions reflects its interdisciplinary nature and adaptability, being perceived both as a set of comfortable, easy-to-use devices and as an essential technology for improving quality of life and advancing fields such as medicine and sports [2].

In recent years, devices that monitor activity parameters—especially heart rate and step count—have attracted the interest of clinicians, who consider them a promising solution for monitoring and improving patient health. This rising interest reflects their potential to revolutionize how health problems are managed and treated by providing continuous and personalized monitoring [3].

In 2009, Ramírez-Islas E. et al. presented, at the 36th Annual Computers in Cardiology Conference, the benefits of applications installed on mobile devices to monitor cardiac parameters. Thus, SaneHeart was created, a mobile system using modern wireless technology [4].

In 2013, Kwon K. et al. proposed using a system that includes physiological measurement devices, mobile gateways, point-of-care devices, and a server for remote cardiac monitoring, arguing that this system can improve prevention and detection of arrhythmias—potentially reducing complications (e.g., stroke) and optimizing medical resources. It was also shown that implementation depends on overcoming challenges: validation in diverse populations, managing false-positive/false-negative rates, ensuring data security and privacy, interoperability with other systems/EMRs, costs, and patient acceptability [5].

Currently, there is a wide variety of portable biomedical devices (equipment intended for diagnosis or temporary monitoring of a patient's condition) and wearables (small devices worn directly on the body, often for continuous or long-term monitoring of specific biomedical parameters) available on the market. These are designed to be worn constantly and integrated into daily life to continuously collect data, such as smart bands and sensors, which are now widely available and used for continuous health monitoring [6]. While these technologies have evolved from simple data collection to sophisticated systems using biosensors and artificial intelligence [7], evidence of their effectiveness in changing health behaviors or improving outcomes remains limited. Most studies are subjective, short-term, and lack rigorous validation, and many users discontinue use due to design and usability issues. Currently, wearables are primarily used in research and for monitoring chronic conditions, with limited application in clinical practice, especially for cardiovascular prevention [8]. Despite their potential to facilitate early detection, personalized care, and risk mitigation, there is a significant knowledge gap regarding their overall impact on health outcomes. This bibliometric review aims to analyze recent research trends, advances, and challenges in the use of mobile and wearable technologies for cardiovascular health, focusing on their role in promoting physical activity, monitoring heart rate, and supporting preventive strategies.

2. Materials and methods

Evaluating and reviewing the scientific literature is a complex activity due to the large volume of available documents. The bibliometric method meets all the necessary criteria to provide a clear overview of the current level of knowledge on a topic. In addition, this method allows identifying research trends and evaluating the geographical coverage of studies on that topic. Bibliometrics focuses on two main aspects: performance analysis and scientific mapping. The former involves assessing research impact using indicators such as number of publications and citations, as well as the individual impact of documents. Data processing was performed with VOSviewer version 1.6.20. VOSviewer is a versatile software tool, launched in 2010 by Nees Jan van Eck and Ludo Waltman at Leiden University, designed for creating and exploring maps based on network data. By exploring different types of links—such as co-authorship, co-occurrence, citation, bibliographic coupling, and co-citation links—VOSviewer enables users to visualize these relationships in various forms (networks, overlay maps, or density visualizations), facilitating understanding and analysis of complex network data structures [9].

The database used for extracting articles was Web of Science (WoS). Given the interdisciplinary nature of the field—spanning health, technology, engineering, and behavioral sciences—WoS was selected for its comprehensive coverage of high-quality, peer-reviewed literature across these domains. Although incorporating multiple databases such as Scopus, PubMed, or IEEE Xplore could potentially broaden the scope, it would also introduce significant methodological challenges, including data duplication, inconsistent indexing standards, and difficulties in data integration and comparability. By focusing solely on WoS, we ensured a complete, reliable dataset that supports precise, reproducible analyses. This approach enhances the validity and clarity of our findings, providing a solid foundation for interpreting research trends within this complex, multidisciplinary landscape.

The keywords used were "devices portable" AND "cardiac parameters" AND "physical activity" "wearable device" and "wearable devices." Boolean operators "OR" and "AND" were used to combine terms. The publications were then filtered based on specific criteria, including document type (review articles and original research articles), language (English), and years of publication (2021-2025). To ensure data quality and relevance, duplicate records were identified and removed using available deduplication tools (EndNote software). To further ensure data integrity, the metadata for each publication was checked to ensure it was complete, and any inconsistencies or incomplete records were excluded. This rigorous process resulted in a final collection of 14,145 eligible publications, which form the basis of our bibliometric analysis. These steps collectively support methodological rigor, ensuring the relevance, reliability, and suitability of the dataset for further analysis. Initially, 143,511 publications were identified. After applying the previously mentioned filters, 14,194 publications were selected. After removing duplicates (n=38) and irrelevant titles (n=11), a total of 14,145 publications remained for bibliometric analysis. Figure 1 summarizes the publication selection methodology.

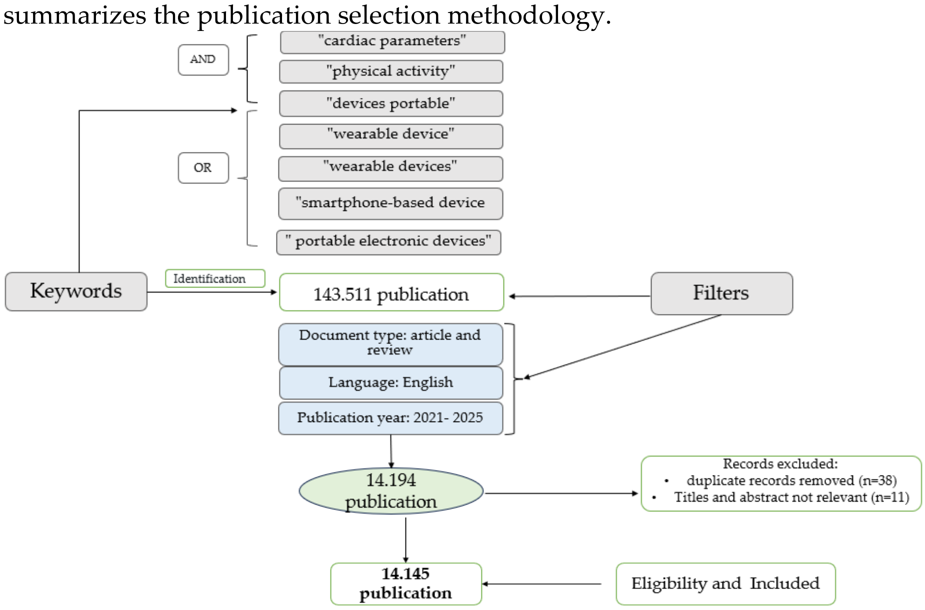


Figure 1. Diagram depicting the study selection process: keywords used, filters applied to limit results to English-language articles and reviews published between 2021 and 2025.

3. Results

3.1. Literature Overview

Analysis of the data presented in Figure 2 indicates a clear upward trend in the number of articles published between 2021 and 2024. In the first three years (2021–2023) there is relative stability in the number of publications, suggesting steady interest in the field. However, in 2024 there is a significant increase, with approximately 300 more publications than in previous years. This marked rise indicates acceleration of research and scientific interest in monitoring risk factors via wearables. The trend can be interpreted as growing recognition of these technologies' potential for preventing and managing risk factors, along with increased investment and interest from the scientific community and industry. In conclusion, the evolution in publication volume reflects a growing dynamic in the field, anticipating a period of expansion and innovation in research and application of wearables for risk-factor monitoring.

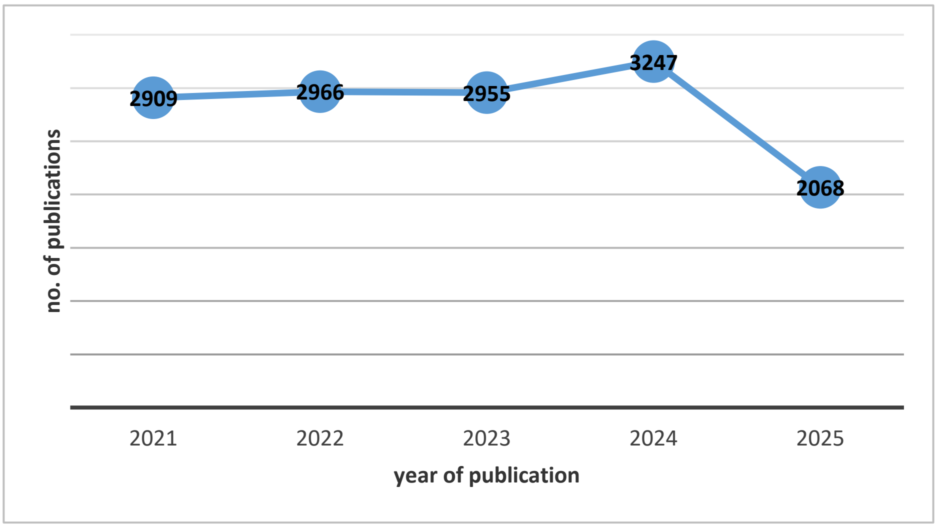


Figure 2. Publication trend from 2021 to August 2025.

Materials Science Multidisciplinary is the most represented category (≈20%), suggesting high interest in multidisciplinary materials research, closely followed by *Chemistry Analytical* (18.08%). This distribution suggests increasing interest in multidisciplinary research across materials and chemistry, with an important perspective on nanotechnology and engineering (Figure 3).

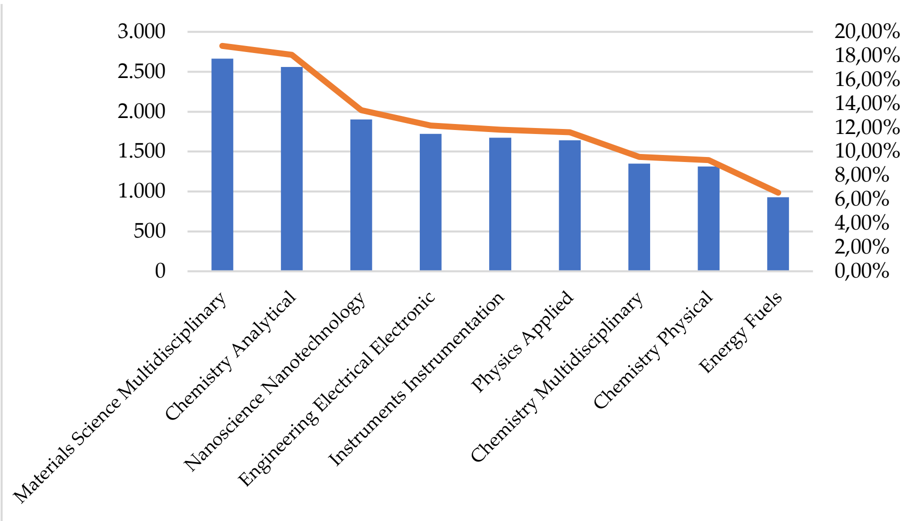


Figure 3. Fields of publication.

3.2. Global Scientific Productivity

The distribution of countries with the highest productivity in the 12,348 articles and 1,797 reviews is shown in Figure 4. Most articles come from Asia, due to the high number of publications by Chinese authors. North America has a significant number, but fewer than China; the USA ranks second with 2,027 articles. Europe has fewer articles than Asia and North America, with Italy leading in Europe (657 publications). This distribution underscores that research activity is heavily influenced by national policies, economic investments, industrial priorities, and historical research infrastructure. Asia, especially China, has emerged as a central hub for research in wearable devices and related health technologies, driven by national strategies to lead in innovation, large domestic markets, and governmental support. The dominance of certain institutions and regions reflects broader geopolitical and economic trends shaping the global research landscape.

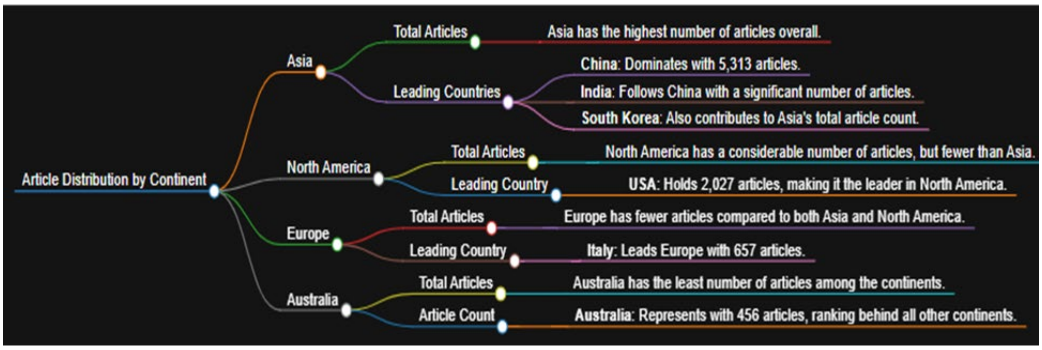


Figure 4. Distribution by continent.

3.3. Academic Influence and Impact of Institutions, Journals, and Publications

Regarding research-center affiliation, the geographic distribution in Figure 5 indicates a predominance of institutions from China (1,486 articles total), followed by representatives from other countries such as the United States and India.
Institutions in China have published over 70% of all listed articles. This indicates a significant concentration of research and publications in that region, especially in science and technology given the high article counts. Institutions in France and the USA have relatively smaller contributions compared with China and India, yet remain significant in the international context. This analysis provides a clear perspective on the geographic distribution of publications and highlights Asia—especially China—followed by India—as the center of gravity of research.

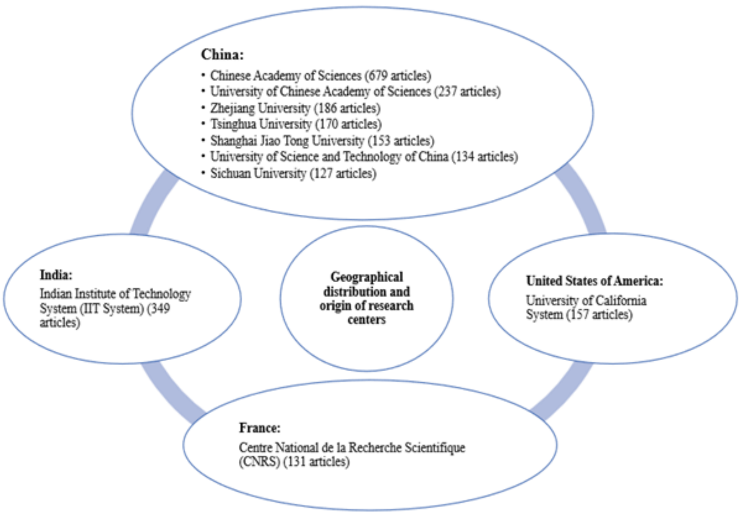


Figure 5. Geographic distribution of research centers.

Figure 6 suggests a diversity of publication languages; however, English predominates (13,933 publications), likely reflecting a global orientation and wider audience. Chinese (131 publications), Spanish (15), German (13), and Japanese (7) follow, indicating their presence but at much lower levels than English.

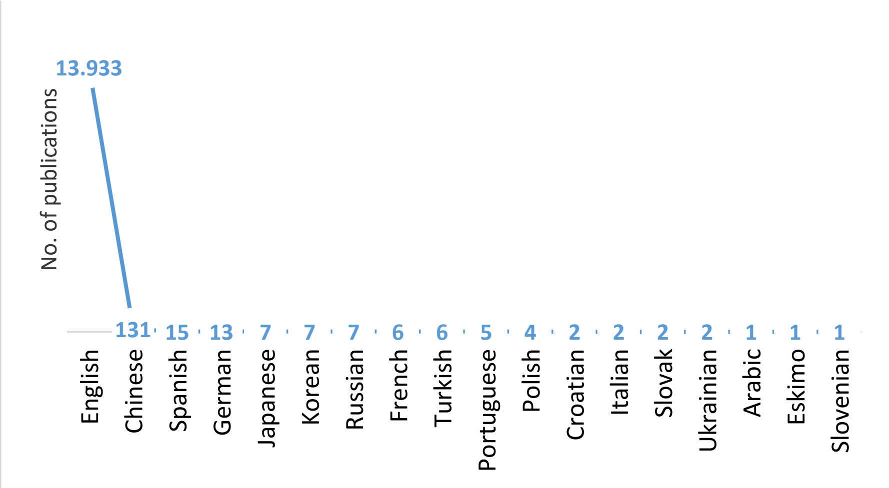


Figure 6. Publication language.

The journals with the most publications in the researched field are listed in Figure 7. The top three are SENSORS (382 articles), the most prolific, indicating strong interest in sensors; CHEMICAL ENGINEERING JOURNAL (250 articles), suggesting a major focus on chemical engineering and its applications; and SENSORS AND ACTUATORS B: CHEMICAL (222 articles).

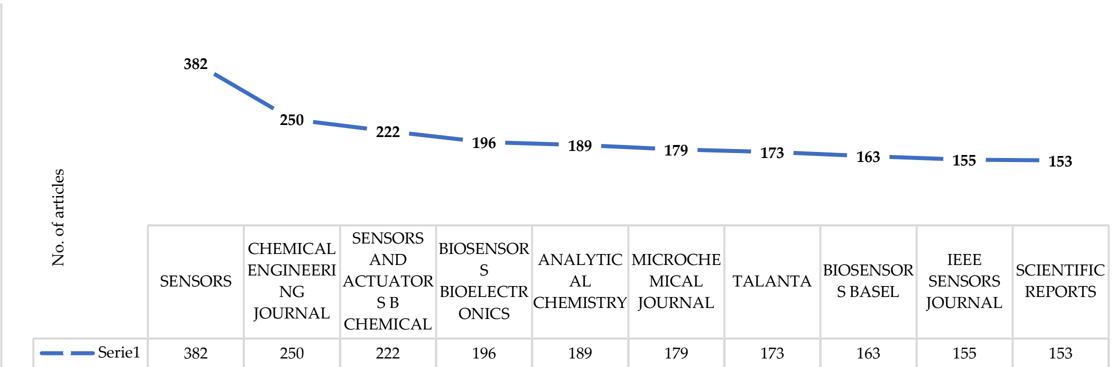


Figure 7. Journals with the most publications.

The publishers most actively engaged with the topic are: Elsevier, with 4,391 publications, due to its extensive portfolio of journals in engineering, materials science, and sensor technology that ensures high visibility and attracts global submissions; MDPI, with 1,772 publications, recognized for its open-access model that facilitates rapid dissemination of research, particularly in emerging fields like wearable health devices; and Wiley, with 1,175 publications, supporting high-quality research dissemination across engineering and applied sciences and fostering interdisciplinary collaboration.

The most cited countries and the number of documents are shown in Table 1. Data suggest that China has the highest number of published documents (5,110), indicating very intense research activity. It also has the highest total citations (94,342), suggesting substantial influence in the field. The average citations per article (18.46) is high, reflecting quality and impact. The USA has a considerable number of documents (1,968) and citations (28,535), representing an important research contributor. Although its total citations are lower than China's, the average citations per article are similar, indicating high-quality research. Australia, though publishing the least by volume, has the highest average citations/article (21.61), suggesting very influential, high-quality research.

Table 1. Top 5 most cited countries.

Country	Documents	Citations	Avg citations/ article	TLS
China	5110	94.342	18.46	5397
USA	1968	28.535	14.49	2755
India	1467	18.477	12.59	2496
South Korea	821	15.552	18.94	1662
Australia	445	9620	21.61	859

3.4. Scientific Mapping

The representation of the country collaboration network (Figure 8) provides strong evidence of a complex international research ecosystem. A minimum threshold of 25 documents was set; the contributing countries were divided into seven collaboration clusters. The largest clusters are represented by China (red) and the US (green). Europe is represented by Italy and Spain (blue).

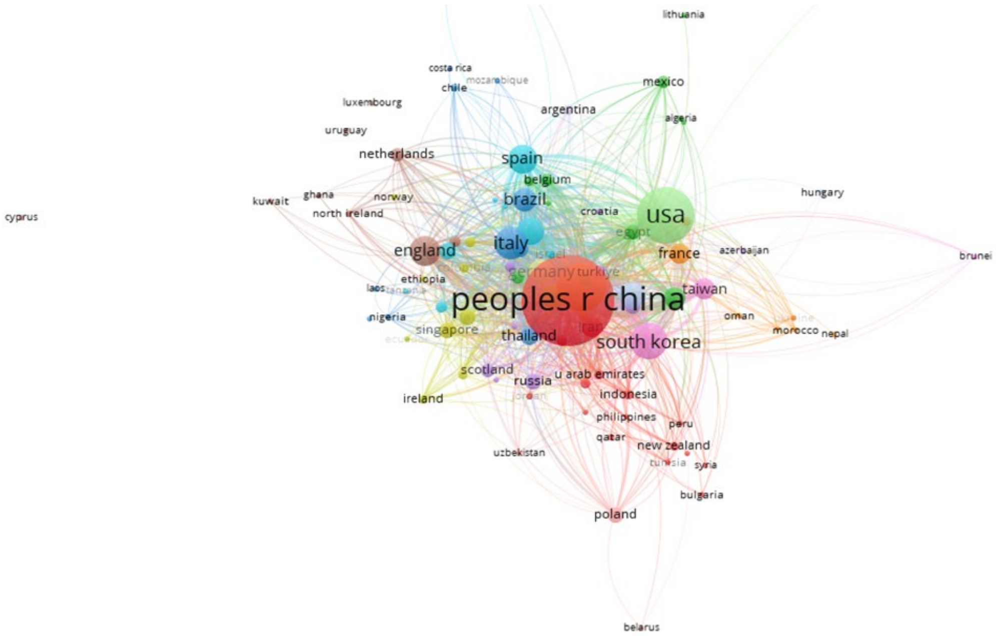


Figure 8. Most-cited countries showing interest in monitoring cardiac parameters and physical activity with portable/wearable devices.

"Keyword co-occurrence analysis" is a method used in research and data analysis to identify and assess how frequently certain keywords appear together in the same context. Of the 47,647 keywords identified, 3,616 were encountered more than five times; these were distributed into four clusters (Figure 9). Each cluster reflects a distinct and complementary aspect of research in the field of biosensors and nanometric technologies: from materials and components (green) to manufacturing and performance (blue), system design and interpretation algorithms (red), and energy and sustainability aspects (yellow). Together, these clusters provide an integrated view of the directions of progress and challenges in the field.

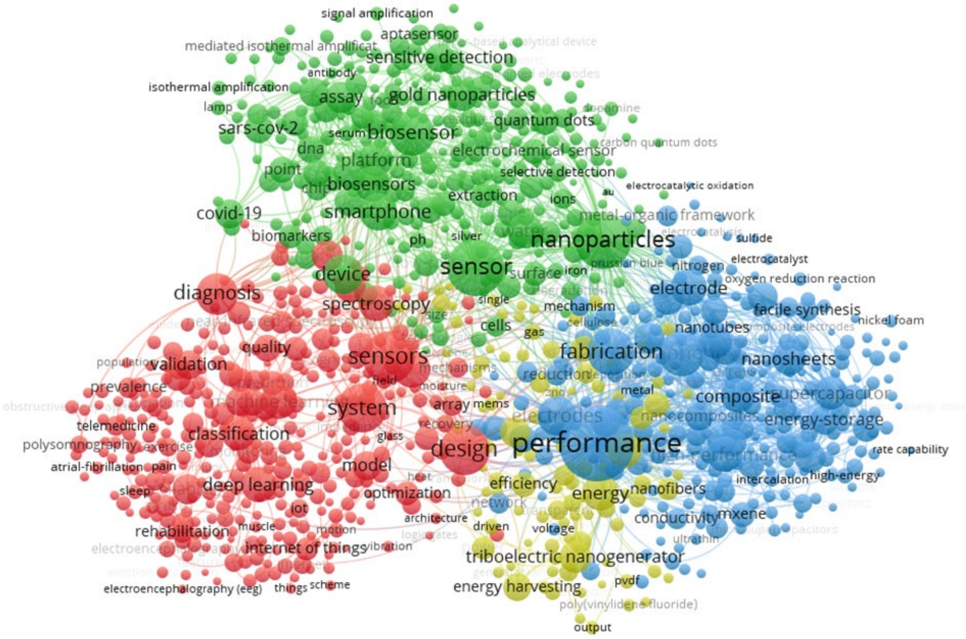


Figure 9. Keyword co-occurrence analysis by research themes, processed with VOSviewer.

Table 2 highlights the leading figures in the field, focusing on the number and impact of their publications. The most prolific author in terms of the number of published documents is L. Wang, with 42 papers, but his average impact, measured by citations (27.35 citations per document), suggests a voluminous output but with a moderate impact in the scientific community. In contrast, authors such as J. Gu and H. Gong, although they have published fewer papers (5), have a very high average number of citations per paper (295.4 and 176.4, respectively), indicating that their work is extremely influential and recognized in the field. Similarly, authors with fewer publications, such as Y. Zhang and Y. Huh, achieve very high average citations (250.5 and 102.23, respectively), suggesting that their impact is significant in relation to the volume of publications. R. Umapathi and G.M. Rani, with over 10 publications, also have a considerable impact, with average citations of over 137 and 150.8, respectively, indicating valuable contributions and recognition in the community.

Table 2. Top 10 authors with the most published documents.

Author	No. documents	Citations	Avg. citations
D. tang	18	1814	100.78
R. Umapathi	11	1516	137.81
G.M. Rani	10	1508	150.8
Y. Zhang	6	1503	250.5
J. Gu	5	1477	295.4
Z.L. Wang	21	1405	66.90
Y.S. Huh	13	1329	102.23
Y. Li	12	1195	99.58
L. Wang	42	1149	27.35
H. Gong	5	882	176.4

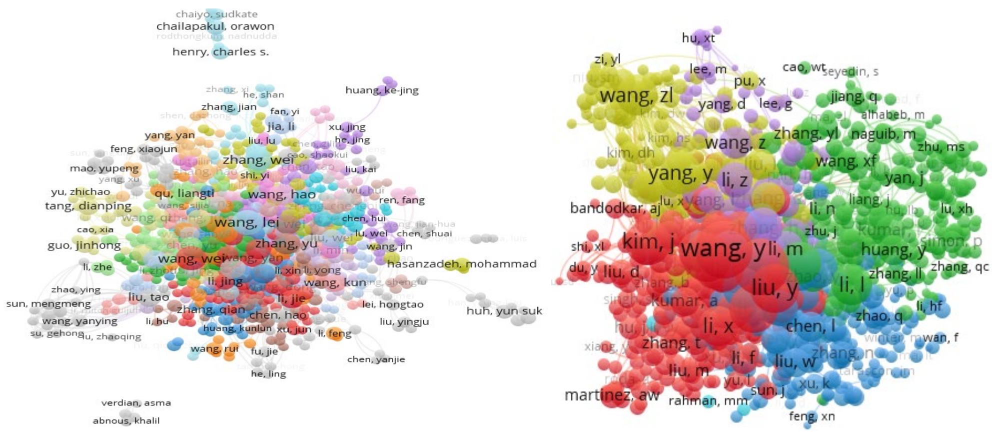
Table 3 identifies the most influential and interconnected authors based on co-citation frequency and network strength. The importance of authors such as Y. Wang (1,385 co-citations), Y. Zhang (1,331 co-citations), and Y. Liu (1,025 co-citations) indicates their significant role in shaping the research landscape, serving as essential references within the scientific community. High co-citation and TLS values highlight their centrality and widespread recognition in the field.

Table 3. Authors with the most co-citation.

author	No. Co-citations	TLS
Y. Wang	1385	39862
Y. Zhang	1331	37720
Y. Liu	1025	25340
J. Wang	1020	25754
Y. Li	1012	31222
J. Kim	855	22309
J. Li	774	20279
L. Wang	744	22294
Y. Yang	737	23474
L. Li	726	23288

The co-authorship map shows how authors contribute together to scientific publications. Of 65,256 authors, 980 were mentioned at least five times. The collaboration map is shown in Figure 10a. This method helps identify groups of authors or works that are considered relevant in the same domain or subject, based on how they are cited together in the literature. Figure 10b includes the map of the most cited authors, grouped into six clusters.

Therefore, the data suggest that D. Tang and Y. Zhang are the authors with the greatest impact in terms of citations and community influence. L. Wang, although prolific, has a lower average citation impact compared with others, which may indicate a different publication strategy or more specialized research domains.



a. b.

Figure 10. a. Co-authorship map. b. Map of the most cited authors.

4. Discussion

The purpose of this paper is to highlight, through a bibliometric analysis, recent developments and challenges associated with the use of mobile and wearable technologies in the prevention and management of cardiovascular disease, with a focus on the impact of these technologies on health, heart rate monitoring, and the promotion of physical activity. The data obtained reflects intense activity, concentrated mainly in Asia, with a significant global influence, and the rapid growth trend in publications indicates a rapidly developing field with potential for innovation and expansion in the near future. In the first three years, 2021–2023, we see relative stability in the number of publications, suggesting constant and stable interest in this area of research. However, 2024 marks a significant change, with a sharp increase of approximately 300 publications compared to previous years. This sharp increase indicates an acceleration of research activity and increased interest from the scientific community and industry in monitoring risk factors through wearable technologies. The distribution by field of activity indicates a clear trend towards integrated research, combining materials and chemistry, with an important focus on nanotechnology and engineering.

The dominance of specific journals and publishers in the research field is driven by disciplinary focus, publication strategies, and market dynamics. Key journals like Sensors, Chemical Engineering Journal, and Sensors and Actuators B reflect the field's emphasis on sensor technology, materials science, and chemical sensing, respectively. Major publishers such as Elsevier, MDPI, and Wiley lead due to their extensive journal portfolios, broad visibility, and open-access models, which facilitate rapid dissemination and high citation potential. This pattern is influenced by the interdisciplinary nature of the research, the desire for impactful publication venues, and evolving trends toward open access and collaborative science. Overall, these factors shape the dissemination landscape and highlight the strategic importance of publication choices in advancing wearable health technology research.

The main aspects discussed in the articles analyzed can be structured as follows: the evolution of personalized healthcare supported by health monitoring technology, the role of wearable devices in prevention and management, cardiovascular parameter monitoring and the benefits of wearables, limitations and challenges identified in the use of wearable devices, the potential and future of portable monitoring in cardiology, the role of digital technologies and connection platforms, and the importance of design and materials in device performance.

Evolution of Personalized Healthcare Supported by Health Monitoring Technology and Role of Wearable Devices in Prevention and Management

Major risk factors for cardiovascular disease include unhealthy lifestyle, diet, smoking, obesity, and physical inactivity. Use of wearables for health monitoring is growing rapidly, gaining appreciation from industry, researchers, and clinicians due to their potential benefits for patient health. Individualized medical care has improved significantly with the advancement of health-monitoring technologies, which allow portable/wearable devices to track parameters such as cardiac health, blood pressure, sleep, and blood glucose levels [10]. Cardiovascular diseases (CVD) contribute substantially to global morbidity and mortality, accounting for approximately 18 million deaths annually. These conditions affect people of all ages, sexes, and socioeconomic status [11, 12]. The rising incidence of CVD highlights the need for accessible, portable, and reliable biosensors for real-time cardiac-health monitoring and biomarker detection—especially since traditional methods are costly [12] and access may be more difficult in some countries. The study published by Dutta et al. (2021) confirms that wearable devices can provide accurate measurements of heart rate and physical activity, contributing to the prevention and management of cardiovascular disease. Recent advances in nanomaterials, chemical molecules, and integrated electronic circuits have enabled the development of compact, efficient devices compatible with wearable technology. These biosensors, safely integrated with the body, allow continuous monitoring of cardiac signals and early detection of conditions, facilitating rapid interventions [13].

Cardiovascular Parameter Monitoring and Benefits of Wearables

Monitoring electrocardiograms (ECG) is increasingly attractive for detecting CVD impacts. Wearables monitor activity and physiological parameters such as heart rate, blood pressure, and cardiac electrical activity, contributing to early detection of risks like arrhythmias and sudden cardiac events. Validation studies confirm that devices like wristbands, smartwatches, and integrated textiles can provide high-quality signals, though performance varies based on sensor technology and activity type. Devices such as the Apple Watch have demonstrated reliable heart-rate evaluation, but current limitations restrict their clinical diagnostic use, positioning them primarily as monitoring tools [14].

Role of Digital Technologies and Connection Platforms

The e-Health concept is increasingly embedded in patient care. For example, Morouço P. et al. suggest benefits of the eHealth Movida.Cronos application for primary care, designed to combat sedentary behavior (exercise prescription and monitoring of biomedical variables). It offers tools and monitoring to promote an active lifestyle, helping prevent and manage health problems associated with lack of movement [15]. The MOVIDA.eros project arose from the need to access rehabilitation programs and continuous health monitoring regardless of location. By integrating a mobile app and a web platform, the initiative aims to increase patient participation and improve communication and medical oversight, addressing key identified issues [16].

Digital health technology has evolved, and wearable sensing devices integrate sensors and wireless circuits for continuous monitoring of physical activity and health, ranging from sports trackers to regulated medical devices (Fitbit, Garmin Vivosmart HR, TomTom Spark 3, Kardia 6L AliveCor, Apple Watch, etc.). Electromechanical sensors in these devices play an essential role in capturing and converting human movements into kinematic and kinetic parameters, enabling precise understanding of motor activities. These sensors use mechanical and electrical components to detect variations in position, speed, and force generated by the body during movement [17].

Recent reviews highlight promising effectiveness of wearables and behavior change in the clinical impact of digital technology. A 2019 review by C. Dinh-Le suggests that 60% of adults in the USA monitor weight, diet, or exercise routines. Projects have attempted to correlate data obtained via portable/wearable devices with various platforms (Apple Health, Google Fit, Fitbit, Nokia, Withings) using HealthKit and Google Fit for direct connection. These devices collect data such as step counts and weight, which are visualized online and continuously expanded [18].

Limitations and Challenges in Wearable Device Use

Portable cardiac monitoring devices are increasingly popular due to advancements in miniaturization and data processing, used for tracking athletic performance and detecting cardiovascular risks like sudden death. A 2023 review by Romagnoli et al. analyzed 35 studies, categorizing them into validation, clinical, and development research, and emphasized the need for standardized validation protocols because of inconsistent results and varied device characteristics. Validation is essential, as factors such as sensor technology, device placement, and activity type affect performance; for example, capacitive chest straps are accurate during intense activity, whereas wristbands and smartwatches with optical sensors may underestimate heart rate due to motion artifacts. Devices like the Apple Watch Series III have demonstrated high reliability, but validation outcomes vary widely depending on activity and metrics, making comparisons difficult [3]. Although these devices show promise in improving performance and preventing adverse events, most lack clinical approval for diagnosis and are currently limited to monitoring and assessment purposes. Ongoing validation efforts and establishing reference ECG values are necessary before wider clinical adoption [11].

Potential and Future of Portable Monitoring in Cardiology

Despite limitations, portable devices hold great promise for continuous cardiac monitoring in sports and clinical contexts, potentially improving health outcomes through early detection. The development of standardized validation protocols and multicenter studies is essential to establish their clinical utility and impact on cardiovascular event prevention [3].

Importance of Design and Materials in Device Performance

The performance of these devices depends significantly on appropriate design and electrode materials, which influence signal quality, user comfort, and measurement reliability. Optimizing these technical aspects is vital for developing effective, accurate wearable ECG devices, contributing to early detection of cardiac conditions and promoting overall health [19].

Future directions

Wearable optical sensors are a groundbreaking advancement in health monitoring, enabling personalized and preventive care by tracking vital physiological parameters. They are low-cost, resistant to interference, sensitive, and comfortable, and are used for detecting glucose, monitoring activity and sleep, and managing chronic diseases like diabetes and heart conditions. Technologies such as Fabry–Perot interferometers and surface plasmon resonance (SPR) sensors allow precise analysis of biomarkers and physiological signals like pulse, respiration, and pressure, while photoplethysmography sensors assess hemodynamic status through pulse waveform analysis [20]. In addition, these sensors are used to monitor physical activity and sleep, helping early detection of health problems and tracking treatment response. Portable and smartphone-based devices are making significant strides in point-of-care diagnostics—they are easy to use and accessible—although reliability and accessibility challenges remain. Overall, these innovative technologies open new perspectives for more proactive, personalized, and efficient medicine, transforming how monitoring and diagnosis are performed in health care [11, 21].

The development of portable optical biosensors offers significant opportunities for rapid, efficient diagnosis of CVD, helping reduce mortality and improve patient management. Innovative electronic systems for autonomous analysis of electrolytes and metabolites in sweat, as well as dynamic monitoring of heart rate—designed especially for athletes—represent a significant contribution to sports monitoring, offering users precise, real-time information to optimize training and prevent possible health problems [22]. Advances in nanotechnology and bioelectronics have led to development of portable optical biosensors capable of detecting biomarkers such as troponin, CK-MB, C-reactive protein, and others in real time and in ambient environments [23].

Progress has been made in creating “synthetic antibodies” with high specificity for large molecules such as cardiac biomarkers. For example, Choudhary et al. developed a real-time detection system for troponin using molecularly imprinted polymers receptors on an SPR sensor, facilitating early myocardial infarction diagnosis [24].

In optical biosensors, significant advances have been made in creating rapid, sensitive, user-friendly devices for detecting cardiac biomarkers; however, challenges remain in validating these technologies in clinical studies and comparing them with traditional laboratory methods [11].

In 2019, Kumar V.D.A. and colleagues proposed a wearable device that uses ECG-based pattern extraction to diagnose photoplethysmography (PPG) outcomes, with real-time monitoring and emergency alerts for abnormal beats. Incorporating additional data like age, height, and weight enhanced the system's accuracy and versatility, making it more user-friendly for health monitoring [25]. A 2025 study by Zang et al. introduced a wearable system for simultaneous ECG and phonocardiogram detection, capable of capturing high-quality signals and extracting key clinical parameters such as electromechanical delay and ventricular ejection time [12].

Limitations of Using Portable Devices

User acceptance of devices, system interoperability (related to smartphone-OS updates); and adaptation to the specific needs of patients and clinicians [16]. Nevertheless, current trends and forecasts indicate significant growth in the use of portable technology for health monitoring, supported by increased consumer acceptance and evolving mobile-integration platforms such as Google Fit and Apple HealthKit. This evolution will lead to greater availability of patient data for health management, facilitating implementation of more effective preventive-care strategies [18]. Wearable technologies have significant potential to improve health, particularly for older adults who could benefit most, but their use remains limited in this group. Despite numerous studies on the performance and reliability of these devices, there are still significant barriers to wider adoption in clinical practice [25].

Limitations and Strengths of the Study

The main strengths of the article are its comprehensive coverage of key topics in the field of portable/wearable cardiac technologies (role, evolution, technical and clinical perspectives, focus on innovation and future developments); the relevance of these technologies to current trends in the medical and technological fields was also highlighted. The bibliometric method has limitations, such as database biases (favoring certain journals, regions, or languages), linguistic restrictions (predominance of publications in English), exclusion of certain types of publications (such as reports or patents), and limitations of visualization with VOSviewer (the interpretation of generated maps can be subjective, and results may be influenced by parameter settings). Therefore, the results should be interpreted with caution and complemented with other methods for a comprehensive understanding of the field.

5. Conclusions

The bibliometric analysis plays an essential role in assessing and understanding progress in the field of mobile health, providing a clear picture of relevant trends, research, and innovations. Although progress in this field is promising, challenges such as data accuracy, privacy, and the integration of technologies into existing infrastructures must be carefully addressed to maximize benefits. In a context where clinical decisions and large-scale implementation depend on accurate and reliable information, bibliometric analysis helps identify the most relevant research directions and monitor their evolution. Ultimately, by combining scientific evaluation with rigorous management of these challenges, it is possible to build a safer, more accessible, and more efficient mobile health system tailored to the needs of each patient.

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