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AI-DRIVEN WEARABLES: TRANSFORMING HEALTHCARE FOR ENHANCED HEALTH AND WELLNESS

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ABSTRACT

The integration of artificial intelligence (AI) with wearable technologies is transforming healthcare by enabling real-time health monitoring and predictive analytics. While these advancements enhance personalized health management, challenges such as data privacy, limited personalization, and clinical integration persist. This review evaluates the current state of AI-driven wearables in healthcare, with a particular focus on their applications in diabetes management, cardiovascular health, and elderly care. The novelty of this study lies in its comprehensive analysis of AI algorithms utilized in wearables across diverse health domains. A systematic review was conducted to examine high-quality, peer-reviewed studies published between 2022 and 2024. A comprehensive database search yielded 164 records, with 21 studies meeting the inclusion criteria. These studies provided both quantitative and qualitative insights into the clinical applications of AI-powered wearables for chronic disease management. Data extraction focuses on study characteristics, wearable technologies, health applications, and existing challenges. Findings indicate that AI integration enhances personalized health monitoring, facilitates early disease detection, and supports proactive health management, ultimately improving patient outcomes and reducing strain on healthcare systems. However, issues related to data accuracy, system interoperability, and user acceptance remain critical barriers to widespread adoption. AI-powered wearables demonstrate significant potential in preventive healthcare, chronic disease management, and personalized medicine. As technology advances, these devices are expected to offer more sophisticated diagnostic capabilities and adaptive health interventions. Future research should address challenges such as device accuracy, ethical concerns, and data security while exploring AI applications in mental health and remote patient monitoring. Additionally, longitudinal studies and real-world implementations will be essential to fully integrate AI wearables into mainstream healthcare and maximize their impact on patient care.

KEYWORDS: AI-enhanced wearables; predictive analytics; real-time health monitoring; wearable devices; wearable technology emotional

1. INTRODUCTION

The integration of artificial intelligence (AI) with wearable devices has revolutionized healthcare by enabling real-time health monitoring and personalized treatment. These devices continuously collect data, allowing for ongoing assessment and management of chronic conditions such as diabetes, cardiovascular diseases, and heart failure. By leveraging predictive analytics, AI- driven wearables can forecast potential health issues before they become critical, thus improving preventative care and outcomes (Ahmed et al., 2022; Gautam et al., 2022). The constant evolution of AI technology has made wearables an essential tool in personalized healthcare, enabling more tailored treatment approaches that adapt to an individual's specific needs (Kapoor et al., 2023; Takkalapally et al., 2024). This technology not only enhances the efficiency of healthcare delivery but also empowers patients by enabling them to take a more active role in managing their health.

1.1 ISSUES AND GAPS

Despite the potential of AI and wearable technologies to revolutionize healthcare, several significant challenges impede their widespread adoption. One key issue is data privacy. The sensitive nature of health-related data raises concerns about the security of personal information, with stringent regulations often needed to safeguard patient privacy (Zhu et al., 2023). Another challenge is the limited battery life of wearables, which impacts continuous monitoring and data collection, crucial for accurate health management (Shajari et al., 2023). Additionally, ensuring real-time data accuracy and reliability is vital for AI-driven systems to make timely and correct predictions.

Technologically, wearables often face limitations in processing power, leading to a gap in real- time analytics. Regulatory hurdles also pose barriers as healthcare systems and governments must establish frameworks for the safe integration of AI in clinical practice (Zhu et al., 2023). Ethical concerns further complicate the integration, particularly regarding the potential for AI to replace healthcare professionals, sparking debates over the balance between human care and machine-driven solutions (LaBoone & Marques, 2024). Resistance from healthcare workers may also stem from concerns that AI may undermine their roles, rather than support them.

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These challenges hinder the broader acceptance and implementation of AI in healthcare, despite its promising benefits for chronic disease management, real-time health monitoring, and personalized treatment plans. Addressing these issues is essential for technology to fulfill its potential in enhancing patient care.

1.2 OBJECTIVES

The review provides a comprehensive overview of advancements in AI-powered wearable devices in healthcare, with a focus on chronic disease management, including diabetes, heart disease, and foot ulcers (Ardelean et al., 2024; Marvasti et al., 2024). It aims to explore the benefits of these devices in remote monitoring, predictive analytics, and personalized care (Gaffar & Gearhart, 2024; Etli et al., 2024) and assess the challenges hindering their adoption. These challenges include data privacy, device limitations, and healthcare system integration, with the review identifying potential solutions for overcoming these barriers (Wang & Hsu, 2023; Subhan et al., 2023).

1.3 SCOPE

The review examines the convergence of wearable technologies, artificial intelligence (AI), and personalized healthcare, focusing on their role in monitoring chronic diseases like diabetes and cardiovascular conditions. The review emphasizes the predictive capabilities of these devices, highlighting their potential to improve patient outcomes through accurate data collection and real- time monitoring. It explores recent advancements in wearable devices for diabetes management, heart disease monitoring, and general health tracking, drawing on recent studies and emerging applications that showcase the evolving role of AI in enhancing personalized healthcare (Neri et al., 2023; Liu et al., 2023).

1.4 NOVELTY CONTRIBUTIONS

The novelty of the review lies in its comprehensive approach to AI-driven wearable technologies, covering a diverse range of health conditions and applications. Unlike traditional reviews, the study goes beyond chronic disease management to explore cutting-edge developments in wearable AI, focusing on its role in personalized health solutions. The review identifies emerging trends such as the integration of wearable AI for personalized nutrition and lifestyle management, providing insights into how these devices are shaping the future of healthcare (Romero-Tapiador et al., 2023; Yadav et al., 2024). By focusing on both current applications and future possibilities, the review offers an updated perspective on AI's expanding role in health monitoring, predictive analytics, and customized treatment plans. This forward-looking approach is vital for understanding the evolving landscape of healthcare, which is increasingly influenced by advancements in AI technology and wearable devices.

2. METHODS

2.1 ELIGIBILITY CRITERIA

The selection of studies for the review was structured to ensure the inclusion of high-quality literature relevant to AI-driven wearable technologies in healthcare. The eligibility criteria emphasized peer-reviewed articles, conference proceedings, and systematic reviews to maintain a strong foundation of scientific rigor and evidence. By incorporating both quantitative and qualitative studies, the review aimed to capture a broad range of insights on wearable devices that utilize artificial intelligence. This holistic approach allowed for an inclusive understanding of how AI is integrated into wearables, providing varied perspectives on effectiveness, technological challenges, and the future of these innovations in health management.

The review's focus on AI-driven wearable technologies for health monitoring was guided by the growing need for real-time diagnostics, predictive analytics, and personalized health management. Priority was given to studies that highlighted wearables used in chronic disease monitoring, such as diabetes, heart failure, and diabetic foot ulcers, as these are areas where wearable technologies have shown significant promise in improving patient outcomes. Additionally, general health applications, including cardiovascular monitoring, mental health management, and elderly care, were considered, reflecting the broader impact of wearable AI devices across diverse health domains. By limiting the selection to studies published between 2022 and 2024, the review ensured that the findings reflected the latest technological advancements and trends in the field.

2.2 REVIEW SELECTION

The review selection process employed a systematic approach to ensure that only the most relevant and high-quality studies were included. Initially, a comprehensive database search was conducted across well-established platforms such as PubMed, IEEE Xplore, Scopus, and Google Scholar. This search utilized a combination of carefully selected keywords, including "AI-driven wearable devices," "health monitoring," "chronic disease management," "predictive analytics," and "wearable sensors." These keywords were chosen to target studies focused on AI-integrated wearable devices in healthcare, ensuring a wide array of relevant articles was identified. The results of this search were then subjected to an initial screening phase.

During the screening phase, titles and abstracts of the identified articles were reviewed to assess their relevance to the review's specific focus. Studies that appeared to meet the eligibility criteria, such as focusing on AI-driven wearable technology for health monitoring or chronic disease management, were retained for further consideration. Following

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this, full-text versions of the selected articles were thoroughly assessed to confirm their alignment with the inclusion criteria. The full-text review ensured that the studies addressed key aspects of the research question, such as AI-enabled wearables for healthcare applications and peer-reviewed status. Articles that failed to meet these criteria or did not provide substantial information on the relevant technologies were excluded. Upon confirming the eligibility of studies, relevant data were extracted for synthesis and analysis, forming the foundation for the findings presented in the review.

- **PRISMA FLOWCHART**

The PRISMA flowchart (Figure 1) for the review outlines a systematic process for selecting relevant studies on AI-driven wearable devices in healthcare. Initially, 144 records were identified through database searches, and 20 additional records were sourced from other channels, resulting in 164 records. After eliminating duplicates, 70 records were screened, with 42 excluded based on titles and abstracts. The full text of 28 articles was assessed, leading to the exclusion of 7 for specific reasons. Ultimately, 21 studies were included in the qualitative and quantitative synthesis, ensuring a thorough and rigorous selection process.

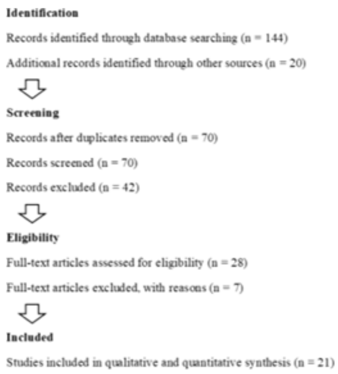

Figure 1: PRISMA Flowchart for Systematic Review on AI-Driven Wearable Devices in Healthcare

- **PRISMA CHECKLIST**

The PRISMA checklist (Table 1) serves as a comprehensive guide for conducting systematic reviews, ensuring transparency and reproducibility in research. The items listed cover the entire review process, starting with the title that should clearly reflect the review's focus, such as AI- driven wearable devices in healthcare. The abstract provides a structured summary, while the rationale justifies the review's necessity due to emerging technologies. The objectives define clear research questions, and eligibility criteria ensure relevant studies are included. Detailed search strategies, data extraction, risk of bias assessment, and data synthesis methods ensure the review's rigor and transparency. The checklist also emphasizes the importance of discussing the findings, implications, and limitations in the results and discussion sections. Conclusions provide clarity on the technology's effectiveness, while acknowledging potential conflicts of interest. Funding disclosures and protocol registration add to the review's credibility, with appendices offering further documentation. Lastly, authorship contributions are clearly stated, ensuring responsibility and accountability in the research process. Each section aims to enhance the quality, reliability, and replicability of the review.

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Table 1:PRISMA Checklist for Systematic Review on AI-Driven Wearable Devices in Healthcare

PRISMA Item	Details	References
1. Title	The title of the study should reflect the focus of the review.	AI-Driven Wearable Devices for Diabetes, AI-Enhanced Wearables for Cardiovascular Monitoring, etc.
2. Abstract	A structured summary of the systematic review, highlighting the key components (e.g., aim, methods, findings).	Each article provides a structured abstract such as "Overview of Artificial Intelligence-Driven Wearable Devices for Diabetes" (Ahmed et al., 2022) and others.
3. Rationale	Justification for conducting the systematic review.	Artificial intelligence and wearable devices are emerging technologies in healthcare, requiring systematic evaluation (e.g., Ahmed et al., 2022; Gaffar & Gearhart, 2024).
4. Objectives	Define the primary research question(s).	Various articles set clear objectives such as evaluating AI in health monitoring, wearable devices in diabetes, cardiovascular health, etc.
5. Eligibility Criteria	Eligibility criteria for studies included in the review.	Inclusion of studies on AI and wearable devices in health (e.g., Gautam et al., 2022; Subhan et al., 2023).
6. Information Sources	Databases and other information sources used for literature search.	Databases like PubMed, IEEE Xplore, and Springer for articles such as "AI in Heart Failure" (Gautam et al., 2022).
7. Search Strategy	The exact search strategy including terms, dates, and limitations.	Articles searched with terms like "AI wearable devices," "AI healthcare wearables," etc. (e.g., Takkalapally et al., 2024).
8. Study Selection	Process of selecting studies (screening, eligibility assessment, etc.).	Selection based on AI and wearable technology in healthcare applications (e.g., Kapoor et al., 2023).
9. Data Extraction	Methods for extracting relevant data from included studies.	Data extraction done manually and through software, analyzing wearable AI technology's impact on healthcare (e.g., Liu et al., 2023).
10. Data Items	Specific data items extracted from studies (e.g., sample size, study design, outcomes).	Outcomes like wearable device performance, healthcare impact, and AI integration are extracted (e.g., Gaffar & Gearhart, 2024).
11. Risk of Bias	Assessment of the risk of bias in included studies.	Bias is assessed using tools like Cochrane's risk of bias tool (e.g., Shajari et al., 2023).
12. Data Synthesis	Methods used to synthesize data (qualitative or quantitative synthesis).	Systematic review and meta-analysis methods (e.g., Shajari et al., 2023; Marvasti et al., 2024).
13. Risk of Bias in Studies	Consideration of the risk of bias in studies included in the synthesis.	Risk of bias evaluation with respect to AI implementation in healthcare (e.g., Neri et al., 2023).
14. Results	Presentation of results with respect to the research question(s) and synthesis of findings.	Synthesis of results focusing on AI in wearable devices for health monitoring (e.g., Ardelean et al., 2024).
15. Discussion	Discussion of the findings, implications, limitations, and conclusions.	Articles discuss various implications such as AI's potential in healthcare and limitations regarding technology adoption (e.g., Gautam et al., 2022).
16. Conclusions	Conclusion about the effectiveness of the intervention or technology reviewed.	Summarizes AI wearable technology's role in healthcare, as seen in articles such as "AI for Diabetes" (Ahmed et al., 2022).
17. Funding	Information on funding sources for the systematic review.	Articles mention funding from healthcare or academic organizations (e.g., LaBoone & Marques, 2024).
18. Conflicts of Interest	Disclosure of conflicts of interest in the review process.	Some articles disclose no conflicts, while others acknowledge conflicts related to industry funding (e.g., Subhan et al., 2023).
19. Protocol Registration	Registration of the systematic review protocol, if applicable.	Not applicable in some articles; some may refer to previously registered protocols in databases like PROSPERO (e.g., Liu et al., 2023).
20. Appendices	Relevant supplementary material (e.g., data collection forms, search strategies).	Some articles provide appendices with search strategies or data forms used for the systematic review (e.g., Secara & Hordiiuk, 2024).
21. Authors' Contributions	Statement of authorship and their contributions.	Each article provides authorship details; for example, Ahmed et al., 2022 credits individual contributions to study design, data collection, and analysis.

2.3 DATA EXTRACTION

Data extraction for the review was systematically carried out using a standardized form, which was designed to ensure consistency and thoroughness across all included studies. The first key area for data extraction was the study characteristics, which provided basic details about the study, such as the authors, publication year, study design (e.g., randomized controlled trials, observational studies), and the study's location. This information helped to contextualize the findings of each study and assess the diversity of the included studies in terms of geographical scope and research methodologies. Such details also allowed the review to evaluate the robustness of the evidence from various regions and types of studies.

The second important aspect of the data extraction process focused on the technological details of the wearable devices studied. This included information about the specific type of wearable technology used, such as smartwatches, patches, or biosensors, as well as the AI algorithms integrated into the devices. Data were collected on the functionality of these devices, including whether they supported real-time monitoring of health metrics, predictive analytics, or both. Additionally, we captured details about the types of sensors embedded in the wearables, such as heart rate sensors, glucose monitors, and ECG sensors. Understanding these technical specifications was essential to assess the capabilities and innovation in wearable technologies for health monitoring.

The third area of focus in the data extraction process was the health applications of the wearable devices, which varied across studies. Information was collected regarding the specific medical conditions addressed by the wearables, such as diabetes, heart failure, cardiovascular diseases, and mental health conditions. The review also sought to assess the impact of

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the wearable technologies on patient outcomes, including improvements in disease management, early diagnosis, and prevention. Extracting information on the effectiveness of the devices was crucial for understanding how well these technologies contributed to patient health. Moreover, the challenges and limitations identified in each study, such as data privacy concerns, technical issues with AI integration, and usability challenges, were noted to provide a comprehensive understanding of the barriers to widespread adoption.

Finally, the review also captured insights into the future directions of AI-driven wearable devices, including advancements in machine learning, sensor technologies, and their potential role in telemedicine, which is an area of increasing interest for remote health monitoring. Table 2 explores the integration of AI in wearable devices, showcasing its impact across a range of healthcare applications, from managing chronic conditions to personalized care and health monitoring. It illustrates how AI-enhanced wearables are improving diagnostics, patient outcomes, and efficiency in healthcare systems.

Table 2:AI-Powered Wearables and Their Impact on Healthcare Applications

Reference	Key Findings	AI Application in Wearables	Target Condition	Conclusion
Ahmed et al. (2022)	Overview of AI-driven wearables for diabetes	Predictive models, real-time monitoring	Diabetes	AI wearables help in real-time diabetes management with predictive analytics
Ardelean et al. (2024)	AI & wearables in diabetic foot ulcer prevention	Personalized predictive strategies	Diabetic foot ulcers	AI-enhanced wearables improve prevention and management of foot ulcers
Cafolla (2024)	AI in cardiovascular monitoring for elderly	AI for heart rate and ECG analysis	Cardiovascular conditions	AI wearables enhance cardiovascular monitoring, particularly for elderly care
Etli et al. (2024)	Future of personalized healthcare with AI	Predictive analytics, real-time data	General healthcare	AI wearables are key in delivering personalized healthcare and predictive analytics
Gaffar & Gearhart (2024)	AI & wearables in cardiology	Real-time heart monitoring	Heart conditions	Wearables integrated with AI provide real-time, accurate cardiovascular data
Gautam et al. (2022)	AI, wearables & remote monitoring for heart failure	Real-time heart failure tracking	Heart failure	AI-based wearables are promising tools for managing heart failure remotely
Kapoor et al. (2023)	Wearables for healthcare	AI-driven data interpretation	Healthcare applications	Wearables powered by AI offer vast potential in monitoring and diagnostics
LaBoone & Marques (2024)	Impact of wearables & AI in healthcare workflows	AI optimization in healthcare	General healthcare	Wearables and AI transform healthcare workflows, improving patient outcomes
Liu et al. (2023)	Biomedical AI processor for health monitoring	Low-power AI processors for wearables	Health monitoring	AI processors enhance the functionality of wearable health devices
Marvasti et al. (2024)	Expanding clinical scope of wearables	AI for diagnostic capabilities	General healthcare	AI-powered wearables broaden clinical capabilities for patient monitoring
Neri et al. (2023)	ECG monitoring with AI-enabled wearables	AI for ECG analysis	Heart disease	AI-enhanced ECG wearables improve diagnostic accuracy for heart conditions
Romero-Tapiador et al. (2023)	AI4FoodDB for health & nutrition	Personalized nutrition via wearables	Nutrition and health	AI wearables help in personalized health management, including nutrition
Secara & Hordiiuk (2024)	AI-integrated wearable health systems	AI & wearables for real-time monitoring	General healthcare	Integration of AI with wearables enables continuous personalized health monitoring
Seng et al. (2023)	Machine learning for smart wearables	AI for health data processing	Health monitoring	AI-powered wearables improve data processing for smarter health insights
Shajari et al. (2023)	AI-based wearable sensors for digital health	AI wearables for digital health	Digital health	AI sensors in wearables drive advances in digital health and personalized care
Subhan et al. (2023)	IoT and AI in healthcare	Wearable IoT systems	Healthcare systems	AI-driven IoT wearables revolutionize healthcare through remote monitoring
Takkalapally et al. (2024)	AI in wearable healthcare sensors	AI for sensor-based health solutions	Healthcare solutions	AI-enhanced wearable sensors offer transformative healthcare solutions
Tariq (2024)	Wearable medical devices & AI in remote health monitoring	AI for remote monitoring	Remote health monitoring	AI-powered wearables are transformative for patient literacy and healthcare innovation
Wang & Hsu (2023)	AI & wearable IoT in long-term care	AI wearables for elderly care	Elderly care	Wearables with AI enhance long-term care by providing real-time health data
Yadav et al. (2024)	AI in wearable healthcare technology	AI-driven wearables for smart health	Smart healthcare	AI-based wearable technologies significantly improve smart healthcare applications
Zhu et al. (2023)	Role of AI in smart wearable devices	AI for health and privacy concerns	Health & privacy	AI-powered wearables drive market growth by addressing health and privacy concerns

2.4 DATA SYNTHESIS

Data synthesis in the review involved aggregating findings from the included studies to uncover recurring themes, patterns, and trends in the application of AI-driven wearable devices for health monitoring. The synthesis followed a narrative approach and was organized into several key areas. The first area was AI Integration in Wearables, where studies emphasized the growing sophistication of AI algorithms embedded in wearable devices. These algorithms, particularly machine learning (ML) and deep learning (DL), enabled the processing of real-time sensor data to generate predictive analytics. Such functionalities were particularly beneficial in monitoring chronic diseases like diabetes and heart failure. AI algorithms were used for predictive diagnostics, such as forecasting glucose levels in diabetes or detecting arrhythmias in heart failure patients, thereby providing more personalized and timely health insights. This integration of AI enhanced the capabilities of wearable technologies by shifting from simple monitoring devices to proactive health management tools.

The second key area identified in the review was the Health Impact of AI-driven wearables. A significant body of evidence pointed to the positive influence of these devices on health outcomes, particularly in the management of chronic diseases. Studies consistently reported that AI-enabled wearables played a crucial role in the early detection of diseases, optimizing treatment plans, and improving patient engagement. Wearables equipped with AI also promoted personalized health interventions, offering feedback tailored to individual users based on their unique data. For example, patients with chronic diseases were able to receive immediate alerts and actionable insights, which enhanced their ability to manage conditions like diabetes and cardiovascular diseases more effectively. Research by Ahmed et al. (2022) and Gautam et al. (2022) corroborated the potential of AI-driven wearables in improving early detection and overall management of chronic health conditions.

However, the review also highlighted several Challenges in Implementation of AI-driven wearables. Despite their promising applications, numerous studies identified barriers that hindered their widespread adoption. A major concern was related to data privacy and security, as the sensitive nature of health data collected by wearables raised concerns about unauthorized access and misuse. Additionally, technological limitations, such as short battery life, sensor inaccuracies, and the challenge of integrating AI with other healthcare systems, were recurrently mentioned. The complexity of integrating

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wearable technologies into existing healthcare infrastructures often created delays in adoption. Usability was another challenge, with several studies noting that wearables must be more intuitive and user-friendly to cater to a diverse population, including elderly users who may face difficulty in operating advanced technological devices. Despite these challenges, many researchers emphasized the need for advancements in both hardware and software to address these issues.

Emerging Technological Advancements also played a significant role in the review. Several studies discussed innovations aimed at improving the performance of AI-driven wearables. These advancements included the development of low-power sensors that allowed for continuous health monitoring without excessive energy consumption, making wearables more practical for long-term use. Additionally, the integration of more advanced machine learning algorithms helped improve the accuracy of diagnostics and the predictive capabilities of the devices. The development of multi-modal wearables, which could monitor a broader range of health metrics (e.g., heart rate, respiratory rate, and glucose levels), further expanded the potential applications of these technologies. As highlighted by Liu et al. (2023) and Shajari et al. (2023), these innovations could make wearable technologies more efficient, cost-effective, and accessible to a wider population.

The ability of AI-driven wearables to offer Personalized Health Monitoring was a key advantage emphasized in the review. Studies underscored how AI algorithms could tailor health recommendations based on real-time data from wearables, creating a highly individualized approach to health management. By providing personalized feedback, these wearables enabled more effective disease prevention and management. Researchers such as Romero-Tapiador et al. (2023) and Etli et al. (2024) demonstrated that wearables tailored to individual health needs could enhance patients' overall health outcomes, particularly in managing chronic diseases.

Finally, the review highlighted Future Prospects for AI-driven wearables in healthcare. One of the most exciting trends is the convergence of AI, wearables, and telemedicine. The integration of AI- powered wearables with telemedicine could revolutionize healthcare delivery, particularly in remote areas and for underserved populations. As Marvasti et al. (2024) and Wang & Hsu (2023) noted, the potential for remote health monitoring powered by AI-driven wearables is especially promising for elderly populations who need continuous health oversight. Telehealth interventions, combined with the real-time data provided by wearables, could significantly improve healthcare access and outcomes for individuals in rural or underserved regions.

In sum, the synthesis of the data revealed that AI-driven wearable devices have made significant strides in healthcare, particularly in chronic disease management, early detection, and personalized health insights. However, challenges related to data privacy, integration with healthcare systems, and usability must be addressed to unlock their full potential. Future research should focus on overcoming these challenges, improving the user experience, and expanding the clinical applications of wearable technologies to encompass a broader range of health conditions.

3. RESULTS AND FINDINGS

3.1 AI-DRIVEN WEARABLES IN HEALTHCARE

Artificial Intelligence (AI) has become a transformative force in healthcare, with wearable devices serving as pivotal tools for continuous health monitoring and predictive analytics. These AI- enhanced wearables are capable of real-time data collection, offering insights into various health conditions ranging from diabetes management to cardiovascular monitoring. The integration of AI with wearable technology empowers healthcare professionals and patients alike by enabling personalized care, proactive health management, and early detection of health issues. This section explores the growing role of AI-powered wearables in healthcare, highlighting the significant advancements in the field.

3.2 AI IN DIABETES MANAGEMENT AND WEARABLES

AI-driven wearable devices are revolutionizing the management of chronic diseases, particularly diabetes, by enabling continuous and real-time monitoring of blood glucose levels. As highlighted by Ahmed et al. (2022), these devices offer more than just tracking; they provide personalized insights tailored to individual health data, which allows for optimized adjustments in lifestyle and medication. The integration of AI predictive capabilities adds another layer of benefit by identifying potential hypoglycemic events before they happen, allowing users to take proactive measures.

By offering personalized recommendations and early warnings, these devices contribute to a more effective and proactive approach to diabetes management. This not only enhances patient outcomes but also reduces complications, leading to a more controlled and stable management of the condition. Ultimately, the continuous data stream and predictive insights offered by AI-driven wearables foster an environment where patients are empowered to make informed decisions, which can significantly reduce the burden on healthcare systems. These advancements make diabetes management more accessible and efficient, promoting long-term health and improved quality of life for patients.

3.3 PERSONALIZED HEALTHCARE AND PREDICTIVE ANALYTICS

Personalized healthcare has seen significant advancements through the integration of AI and wearable technologies, as explored by Ardelean et al. (2024). In managing conditions such as diabetic foot ulcers, wearables provide continuous monitoring of critical health metrics like skin temperature, pressure points, and circulation. These devices leverage AI algorithms to analyze real-time data, identifying potential risks such as the early stages of ulcer formation. By predicting

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complications before they fully develop, AI-driven wearables enable timely medical intervention, reducing the need for hospital admissions and enhancing overall patient care.

This predictive approach allows healthcare providers to prevent further complications, improving patient outcomes and quality of life. Moreover, by minimizing unnecessary hospital visits, these technologies help to alleviate pressure on healthcare systems, ensuring that resources are used more effectively and efficiently. This shift towards personalized, data-driven care marks a pivotal step in modernizing healthcare practices and addressing the specific needs of individual patients.

3.4 CARDIOVASCULAR HEALTH MONITORING WITH AI WEARABLES

AI-driven wearables for cardiovascular health monitoring have become a game-changer, particularly for elderly populations, as highlighted by Cafolla (2024). These wearables continuously assess heart health, tracking essential metrics such as heart rate, blood pressure, and ECG data. AI algorithms analyze these parameters in real time, identifying abnormalities like arrhythmias and providing early detection of symptoms associated with heart failure. This proactive approach enables physicians to intervene before conditions worsen, significantly reducing the risk of severe cardiovascular events.

The integration of AI not only aids in monitoring but also enhances predictive capabilities, allowing healthcare providers to anticipate potential health risks and manage cardiovascular conditions more effectively. This continuous, data-driven monitoring can be particularly beneficial for elderly individuals who may have limited access to frequent medical appointments, improving both their quality of care and overall health outcomes. By offering timely insights and intervention opportunities, AI wearables are proving to be an invaluable tool in the management of cardiovascular health.

3.5 AI-ENABLED REMOTE MONITORING FOR HEART FAILURE

The use of AI-driven wearables in heart failure management has shown significant promise, as highlighted by Gautam et al. (2022). These wearable devices continuously track vital signs such as heart rate variability, oxygen saturation, and fluid retention, which are crucial indicators of heart failure progression. AI algorithms embedded in these devices process the health data in real-time, identifying trends that can predict exacerbations before they occur. This early warning system enables healthcare providers to intervene promptly, reducing the risk of hospitalization or worsening health.

Remote monitoring is one of the most significant advantages of AI-driven wearables, particularly for heart failure patients who may have limited mobility or reside in rural or underserved areas. These devices allow healthcare providers to access continuous data on their patients' health, thereby enabling consistent monitoring without the need for frequent in-person visits. This capability is especially beneficial for elderly patients or those with chronic conditions who face challenges in attending regular clinic appointments. It also ensures that healthcare interventions can be adjusted more swiftly in response to changes in the patient’s condition, leading to more tailored and effective treatment plans.

From a healthcare system perspective, this proactive approach contributes to reducing the burden on hospitals and emergency services. By preventing hospital readmissions through timely interventions, healthcare costs can be significantly reduced. Additionally, remote monitoring helps optimize resource allocation by allowing healthcare professionals to focus on patients who need immediate care while maintaining regular oversight of others through wearable devices.

3.6 WEARABLE AI IN REMOTE HEALTH MONITORING FOR THE ELDERLY

Wearable AI technologies offer significant advantages in the long-term care of elderly individuals by enabling continuous remote health monitoring. Takkalapally et al. (2024) highlight how these devices track essential health metrics such as mobility, body temperature, and respiratory rate. The predictive capabilities of AI in these wearables facilitate early detection of potential health issues like falls, dehydration, or sudden fluctuations in heart rate.

By sending real-time alerts to caregivers and healthcare providers, these wearables ensure timely interventions, reducing hospital visits and enhancing the quality of life for elderly patients. Moreover, continuous monitoring helps healthcare providers tailor care plans to the individual's needs, promoting more personalized, proactive health management. This shift not only improves the elderly patient's safety and well-being but also lessens the burden on healthcare systems by allowing for more efficient, less resource-intensive care.

3.7 AI AND WEARABLES IN CANCER CARE

AI-driven wearables are revolutionizing cancer care by offering continuous monitoring of patients undergoing treatments like chemotherapy. Shajari et al. (2023) highlight the use of these wearables to track vital physiological parameters, such as temperature, heart rate, and oxygen saturation, providing healthcare providers with real-time insights into a patient’s condition. This continuous data stream enables the early detection of side effects, such as fatigue, nausea, or immune system suppression, allowing for timely adjustments in treatment protocols to prevent further complications. The integration of AI enhances this by identifying subtle changes in the patient's health trends, which might otherwise go unnoticed.

Additionally, wearable technology is also instrumental in post-treatment recovery. After the completion of cancer treatments, patients often face a challenging recovery period, and these wearables provide ongoing monitoring to ensure

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they are healing properly. Monitoring indicators like sleep patterns, physical activity, and heart function aids in assessing recovery and preventing potential relapses or complications. The ability to track these parameters in real-time allows healthcare providers to offer more personalized and timely interventions, improving overall patient outcomes and reducing hospital readmissions. By integrating AI with wearable devices, healthcare providers can offer a more dynamic and responsive approach to cancer care, enhancing both the treatment phase and post-treatment recovery.

3.8 CHALLENGES IN AI WEARABLES FOR HEALTHCARE

Despite the advancements, the widespread adoption of AI-driven wearables in healthcare faces several challenges. One of the primary concerns is data privacy and security, as these devices collect sensitive health information that could be vulnerable to breaches. Zhu et al. (2023) emphasize the need for robust encryption and privacy measures to protect users' health data. Another challenge is the integration of wearables into existing healthcare workflows. LaBoone and Marques (2024) highlight that while AI wearables offer valuable insights, they must be seamlessly integrated with healthcare systems to ensure efficient data sharing and decision-making. This requires the development of standardized platforms and protocols for interoperability.

3.9 THE FUTURE OF AI WEARABLES IN HEALTHCARE

Looking forward, the integration of AI and wearables in healthcare is expected to expand rapidly, with future applications focusing on enhancing diagnostic capabilities and improving patient engagement. Liu et al. (2023) suggest that advancements in AI-powered wearable devices will lead to more intelligent health monitoring systems capable of diagnosing conditions such as skin cancer, hypertension, and respiratory disorders without the need for invasive procedures. The future of wearable healthcare lies in the ability to create systems that not only monitor but also predict and diagnose medical conditions, leading to more personalized, efficient, and cost-effective care.

In sum, AI-driven wearable devices are revolutionizing healthcare by enabling continuous monitoring, predictive analytics, and personalized care. From diabetes management to cardiovascular health and elderly care, AI wearables are enhancing healthcare outcomes by providing real-time, actionable insights. However, challenges such as data security, privacy concerns, and integration into existing healthcare systems remain significant barriers to widespread adoption. With ongoing advancements in AI and wearable technologies, the future holds immense potential for transforming healthcare delivery, improving patient outcomes, and optimizing healthcare workflows.

4. DISCUSSION AND CONCLUSIONS

AI-powered wearables are revolutionizing healthcare by enabling real-time monitoring of chronic conditions like diabetes and cardiovascular diseases, using predictive analytics for personalized care (Ahmed et al., 2022; Gautam et al., 2022). Despite their potential, challenges like data privacy, limited battery life, processing power, and regulatory barriers hinder broader adoption (Zhu et al., 2023; Shajari et al., 2023). The review explores advancements in wearable AI technologies, focusing on chronic disease management and remote monitoring, and highlights emerging trends such as personalized nutrition (Romero-Tapiador et al., 2023; Yadav et al., 2024). Systematic review focused on AI-driven wearable devices in healthcare, aiming to synthesize findings from studies published between 2022 and 2024. The review included peer-reviewed articles, conference proceedings, and systematic reviews to ensure robust and diverse evidence. It targeted wearables used in chronic disease monitoring (e.g., diabetes, heart failure) and general health applications, incorporating both quantitative and qualitative studies. The selection process involved comprehensive database searches and stringent screening, resulting in 21 studies for analysis. Data were extracted on study characteristics, wearable technology details, health applications, effectiveness, and challenges such as data privacy and integration with healthcare systems. The review highlighted the potential of AI-driven wearables in improving chronic disease management, early detection, and personalized health insights, while noting challenges such as privacy concerns, sensor accuracy, and usability issues. Future research should address these barriers and explore the integration of AI wearables with telemedicine for enhanced healthcare delivery.

The integration of artificial intelligence (AI) into wearable devices has fundamentally reshaped the healthcare landscape, ushering in a new era of personalized health monitoring, predictive analytics, and real-time diagnostics. These advancements have demonstrated substantial impacts in areas such as chronic disease management, cardiovascular health, and elderly care. AI-powered wearables enable continuous monitoring of vital health metrics, offering real-time analysis and predictive health interventions tailored to individual needs. In diabetes management, AI-driven wearables are capable of tracking glucose levels, predicting potential fluctuations, and issuing alerts to patients, effectively reducing hospitalizations and improving health outcomes (Ahmed et al., 2022; Ardelean et al., 2024). Similarly, wearable devices in cardiovascular care have been instrumental in detecting arrhythmias and managing heart failure by leveraging AI algorithms to predict exacerbations and guide timely interventions (Gautam et al., 2022; Neri et al., 2023). Personalized healthcare powered by AI has ushered in a shift towards more dynamic, individualized care models, as devices collect real-time data to help tailor interventions and predict the onset of health issues (Etli et al., 2024). This approach allows healthcare providers to offer proactive care by anticipating potential health issues before they become acute, as well as recommending lifestyle changes to improve long-term health outcomes.

Furthermore, AI-driven wearables have proven invaluable in elderly care, where long-term health monitoring is crucial for ensuring the well-being of senior populations. Devices equipped with AI can monitor vital signs, detect falls, and assess

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physical activity levels, enhancing the quality of care for elderly patients while reducing the strain on healthcare systems (Cafolla, 2024). Despite these significant strides, the widespread adoption of AI-powered wearable devices faces numerous challenges, such as concerns regarding privacy, data security, and the reliability of the devices. These barriers highlight the need for robust privacy protections and consistent device performance across diverse patient demographics. The ongoing refinement of AI algorithms is essential to ensure the accuracy and efficacy of wearables in clinical environments, as well as their seamless integration into existing healthcare infrastructures. Although AI-powered wearables hold immense potential to improve healthcare outcomes, it is critical that these challenges are addressed to fully realize their benefits across diverse healthcare settings. The integration of such technologies not only enhances the ability to manage chronic conditions like diabetes and cardiovascular diseases but also promotes a future of healthcare that is more adaptive, efficient, and accessible for patients of all ages.

5. RECOMMENDATIONS

- ### INTEGRATION OF AI IN WEARABLES

The integration of artificial intelligence (AI) in wearable devices is rapidly advancing, offering great potential for improving healthcare through enhanced real-time monitoring, predictive analytics, and prevention of chronic conditions such as diabetes, heart disease, and diabetic foot ulcers. AI can enable wearables to continuously collect and analyze data from various sensors, providing crucial insights into a patient's health status. For instance, Ahmed et al. (2022) highlight the effectiveness of AI-powered wearables in diabetes management, with AI helping to monitor glucose levels, detect anomalies, and provide early warnings to prevent complications. Similarly, Gautam et al. (2022) discuss how AI can assist in remote heart failure management by analyzing continuous data from wearable sensors to predict exacerbations before they occur.

However, to fully realize the potential of AI in wearable health technologies, future research must focus on enhancing the accuracy of AI algorithms. Many AI models today are constrained by limited datasets and biases, leading to inaccuracies in health predictions. There is a need for more comprehensive and diverse datasets to train AI models so that they can account for a wider range of patient conditions and demographics. Additionally, algorithms need to improve their ability to detect subtle patterns in the data that may be missed by traditional diagnostic tools. Research should also focus on making these AI models adaptive, allowing them to learn from individual patient data over time to offer more personalized and precise health recommendations.

- ### PERSONALIZED HEALTHCARE

AI-enabled wearables can significantly improve personalized healthcare by offering tailored interventions based on individual health data. Ardelean et al. (2024) discuss how AI can be leveraged to monitor and predict the progression of conditions like diabetic foot ulcers. By continuously collecting data such as blood glucose levels, skin temperature, and activity levels, AI models can predict when an individual might be at risk of a complication, enabling proactive interventions. The wearable could alert patients and healthcare providers, allowing them to take preventative measures.

For personalized healthcare to become mainstream, healthcare systems must adopt adaptive systems that can provide individualized health recommendations. These systems would need to account for a wide variety of factors, such as genetics, lifestyle, and medical history, and adjust recommendations accordingly. For example, AI could suggest personalized exercise plans for heart disease patients based on their specific health profile. It is also crucial that these systems be accessible and user-friendly to ensure that patients can easily integrate them into their daily routines. Moreover, healthcare providers must have the tools to interpret and act on the insights provided by these wearables.

- ### CROSS-DISCIPLINARY COLLABORATION

To fully harness the potential of AI-driven wearables in healthcare, cross-disciplinary collaboration is essential. Neri et al. (2023) and Shajari et al. (2023) emphasize the importance of collaboration between healthcare professionals, AI researchers, and wearable device manufacturers. Each discipline brings a unique perspective: healthcare professionals can provide insights into patient needs and clinical outcomes, AI researchers can improve algorithms and data analysis methods, and device manufacturers can design wearables that meet the practical needs of patients.

For instance, integrating AI into wearable devices with advanced diagnostic capabilities, such as real-time electrocardiogram (ECG) monitoring, can improve patient care. Collaborative efforts can also lead to the development of more accurate health sensors and better integration with electronic health records (EHR), which would allow healthcare providers to make data-driven decisions. Such collaboration could also accelerate the commercialization of AI-powered wearables, ensuring that they are both clinically validated and accessible to the public.

- ### ENHANCE DATA SECURITY AND PRIVACY

As wearable devices collect vast amounts of sensitive health data, ensuring the security and privacy of this information is paramount. Zhu et al. (2023) emphasize the need for robust data protection mechanisms to prevent unauthorized access and misuse of health data. Wearable devices often transmit data to cloud-based servers, creating potential vulnerabilities that hackers could exploit. This raises significant concerns, especially considering increasing consumer health

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consciousness and privacy concerns.

To address these concerns, researchers and device manufacturers must develop and implement stronger encryption and data protection protocols. Additionally, healthcare systems must ensure that AI-enabled wearables comply with stringent data privacy regulations, such as the General Data Protection Regulation (GDPR) in Europe and the Health Insurance Portability and Accountability Act (HIPAA) in the United States. In addition to technical solutions, it is crucial to foster trust with users by ensuring transparency about how their data is used and by providing them with control over their information. Ensuring data security will not only protect patient privacy but also encourage broader adoption of wearable health technologies.

6. IMPLICATIONS OF STUDY

- ### HEALTHCARE ACCESSIBILITY

AI-powered wearables have the potential to revolutionize healthcare accessibility, particularly in remote and underserved areas. By enabling continuous, real-time monitoring of chronic conditions like diabetes, hypertension, and heart disease, these devices can empower individuals to manage their health without frequent hospital visits. Cafolla (2024) suggests that this capability can bridge significant healthcare gaps, especially for elderly populations, who often face mobility issues or live in areas with limited access to healthcare facilities. Remote monitoring allows for early detection of potential issues, thus improving patient outcomes and reducing the strain on healthcare systems by preventing complications that would otherwise require costly treatments. As a result, AI-powered wearables can not only enhance the quality of care but also make healthcare more affordable by lowering the need for in-person consultations and hospital admissions. Additionally, these devices can support healthcare professionals by providing them with valuable, real-time data, ensuring that patients receive more accurate and timely interventions.

- ### POLICY AND REGULATION

As AI-powered wearable devices continue to proliferate, it becomes increasingly important for governments and healthcare organizations to develop clear policies and regulations to ensure the safety and efficacy of these technologies. Gaffar & Gearhart (2024) argue that regulatory frameworks must be established to address not only the technical aspects of wearable devices but also the ethical concerns surrounding their use in healthcare. These policies should ensure that AI algorithms used in wearables are rigorously tested, validated, and continuously monitored to guarantee that they provide accurate health data and recommendations. Furthermore, regulatory bodies must create guidelines to protect patient privacy and data security, given that wearables collect sensitive health information. Ethical concerns such as bias in AI models and the potential for misuse of personal data must also be addressed. A transparent regulatory environment will foster trust in AI-powered health technologies and ensure that they are used responsibly, benefiting both patients and healthcare systems at large.

- ### INNOVATION IN DIAGNOSTICS

The integration of AI into wearables is transforming diagnostic capabilities by providing continuous health monitoring and predictive insights. Wearables that track vital signs such as heart rate, blood pressure, and glucose levels can now use AI algorithms to detect abnormalities and predict potential health issues before they become critical. According to Gautam et al. (2022) and Marvasti et al. (2024), this technology holds great promise for the early diagnosis of cardiovascular diseases and metabolic disorders, potentially reducing the need for frequent hospital visits. With AI-powered wearables, patients can be continuously monitored, allowing for real-time insights that can inform timely interventions. For instance, an AI algorithm could alert a patient with heart disease when their heart rate exceeds a threshold, prompting immediate action to prevent a heart attack. This continuous, non-invasive monitoring has the potential to significantly reduce hospital readmissions and healthcare costs while improving patient outcomes through early intervention. Furthermore, it allows healthcare professionals to intervene before conditions reach critical stages, enhancing the overall efficiency and effectiveness of the healthcare system.

7. LIMITATIONS

- ### TECHNOLOGY DEPENDENCE

The widespread adoption of AI-enabled wearables faces challenges rooted in technology dependence. Many users, particularly those with limited technological proficiency or those living in areas with poor digital infrastructure, may struggle to fully utilize these devices. Kapoor et al. (2023) highlight that, for wearables to be effective, they rely heavily on consistent data input and real-time connectivity, which can be difficult for less tech-savvy individuals to manage. This technological barrier limits the accessibility and adoption of AI-powered wearables in low- resource settings, where digital infrastructure is often inadequate or absent. To overcome this challenge, it is essential to design more user-friendly, intuitive devices and provide educational resources to improve digital literacy. Additionally, there is a need for infrastructure development to support these devices in underserved regions.

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- **DATA ACCURACY AND RELIABILITY**

AI-driven wearables are designed to provide continuous, real-time health monitoring; however, their accuracy and reliability remain concerns. Liu et al. (2023) emphasize that errors in sensor data or AI algorithms can lead to incorrect health insights, which may significantly impact decision-making. For instance, inaccurate heart rate reading or an erroneous blood glucose prediction could lead to unnecessary treatments or missed opportunities for intervention. While advancements in technology are improving the precision of wearables, these devices are still susceptible to environmental factors, sensor malfunctions, or algorithmic flaws. Continuous validation and refinement of AI models, as well as robust sensor calibration processes, are necessary to ensure that the data provided by these wearables is reliable and trustworthy. Without these improvements, wearables may not achieve their full potential in managing health effectively.

- **REGULATORY HURDLES**

The integration of AI into wearable healthcare devices also faces significant regulatory hurdles. As Tariq (2024) notes, the approval process for AI-based health devices is slow and varies widely between regions. Different countries and healthcare systems have their own standards and regulatory requirements, which can delay the entry of new wearable technologies into the market. Moreover, regulatory bodies must ensure that these devices are not only safe and effective but also ethically sound, adding another layer of complexity to the approval process. This slow regulatory pace can hinder the widespread adoption of AI-powered wearables, especially as healthcare organizations are increasingly interested in integrating such devices into their systems. To address this issue, international collaboration is needed to streamline the regulatory process and create unified standards that can expedite approvals while ensuring the safety and efficacy of these devices.

8. FUTURE RESEARCH

- **ADVANCING AI ALGORITHMS**

Future research should prioritize the advancement of AI algorithms to enhance the accuracy and personalization of health insights. One of the critical areas for improvement is reducing biases in AI models, ensuring that the algorithms work effectively across diverse populations. Subhan et al. (2023) highlight that many existing AI models have limitations when it comes to handling variations in demographic factors such as age, ethnicity, or socio-economic status. By enhancing AI algorithms to be more adaptable and inclusive, we can ensure that wearable devices provide precise health insights for all users. Moreover, these improvements can enable wearables to offer more personalized healthcare recommendations, enhancing their usefulness in chronic disease management and preventive care.

- **CLINICAL TRIALS AND REAL-WORLD TESTING**

As AI-powered wearables gain popularity, conducting more clinical trials becomes crucial for testing their effectiveness and safety in a variety of healthcare settings. Gautam et al. (2022) emphasize that clinical trials are essential not only for regulatory approval but also for ensuring that these devices perform reliably under real-world conditions. The controlled environment of a clinical trial provides valuable insights into the technology's ability to detect and respond to medical conditions, but it is equally important to test how the wearables operate in everyday settings. Such trials will contribute to a better understanding of how wearables can be integrated into existing healthcare practices, leading to broader adoption and more accurate generalization of findings across diverse populations and medical conditions.

- **INTEGRATION WITH HEALTHCARE SYSTEMS**

For AI-enabled wearables to reach their full potential, seamless integration with existing healthcare systems is vital. Wang & Hsu (2023) suggest that integrating wearable health data into clinical decision-making processes can optimize the care delivery model, ensuring that healthcare providers have access to real-time health data from their patients. This integration could also improve patient outcomes by enabling more timely and informed decisions. Research should therefore focus on developing frameworks and solutions that allow AI-powered wearables to communicate effectively with Electronic Health Records (EHRs) and other clinical tools. By facilitating this integration, wearables could become a cornerstone of personalized, data-driven healthcare.

- **LONG-TERM IMPACT STUDIES**

Research should also address the long-term effects of continuous health monitoring through AI- powered wearables. Yadav et al. (2024) highlight the importance of exploring the long-term patient outcomes, cost-effectiveness, and potential healthcare savings associated with these devices. While wearables provide immediate benefits in monitoring health, long-term studies will help determine their sustainability and overall impact on health management. Evaluating the long-term cost-benefit analysis of AI-powered wearables will be crucial for healthcare providers and policymakers to make informed decisions about the widespread adoption of these technologies. These studies could help predict how wearables could reshape healthcare delivery in the future, both in terms of cost savings and improved patient care.

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DECLARATIONS

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable

CONSENT FOR PUBLICATION

Not applicable

AVAILABILITY OF DATA AND MATERIALS

The study is a narrative review and does not involve the collection or analysis of original data from participants. All information and insights presented in the study are derived from existing literature, publicly available sources, and secondary data obtained from previous research. As such, no new datasets were generated or analyzed during the study.

COMPETING INTERESTS

I, as the sole author and the corresponding author of the article, declare that I have no competing financial or personal interests that could have influenced the work reported. The review article was conducted independently, with no external influences, funding, or affiliations that could have impacted the findings or interpretations presented.

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AUTHOR'S CONTRIBUTIONS

I, the sole author and corresponding author have made substantial contributions to the conception, study, and writing of the review article. The author reviewed, edited, and approved the final manuscript, ensuring it met academic standards and provided a balanced, evidence-based discussion. The author confirms that the article represents original work and bears full accountability for the content presented in the publication.

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