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THE ROLE OF TELEMEDICINE AND WEARABLE DEVICES IN HEALTHCARE DELIVERY AND PHYSICAL ACTIVITY PROMOTION: A NARRATIVE REVIEW

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ABSTRACT

Objective: This narrative review aims to evaluate the role of telemedicine and wearable devices in healthcare delivery and physical activity promotion, highlighting applications across multiple medical specialties and their impact on patient monitoring, rehabilitation, and chronic disease management.

Methods: Relevant publications from 2018 to 2025 were retrieved from PubMed, Scopus, and Google Scholar. Included studies addressed the development, clinical utility, and behavioural impact of telemedicine platforms and wearable sensors within healthcare and exercise-related contexts.

Key findings: Telemedicine and wearable devices are increasingly incorporated across diverse medical domains. In cardiovascular and sports medicine, they support exercise monitoring, early detection of physiological changes, and post-injury rehabilitation. In oncology and chronic disease management, these technologies enable remote symptom monitoring, adherence to therapy, and personalized care plans. Wearable devices provide continuous physiological data, enhancing individualized recommendations, safety, and motivation. Telemedicine contributes to promoting physical activity through real-time feedback and remote supervision. Limitations include device accuracy, data interpretation challenges, digital literacy barriers, and regulatory and privacy concerns. Future perspectives suggest hybrid care models and artificial intelligence integration to optimize monitoring and patient outcomes.

Conclusion: Telemedicine and wearable technologies offer scalable, effective solutions for improving healthcare delivery and promoting physical activity. Their integration into clinical workflows, supported by hybrid models and equitable access strategies, has the potential to enhance monitoring, engagement, and overall health outcomes.

KEYWORDS

Telemedicine, Wearable Devices, Healthcare Delivery, Physical Activity Promotion, Remote Patient Monitoring, Digital Health

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Introduction

Over the past two decades, digital transformation has profoundly reshaped modern healthcare, introducing innovative methods of diagnosis, monitoring, and treatment delivery that transcend traditional boundaries of time and geography.[1] Telemedicine and wearable devices have become central components of this transformation, offering innovative solutions for both clinical care and the promotion of physical activity. These tools allow health professionals to access real-time physiological data, support long-term disease management, and provide guidance across distances that previously required in-person consultations. [4]

The COVID-19 pandemic served as a major catalyst accelerating the global adoption of telehealth solutions. Lockdowns, hospital overload and the necessity for social distancing, prompted an unprecedented shift toward remote consultations and digital monitoring.[8]. At the same time, the public's perception of digital health shifted - from skepticism to widespread acceptance - as both patients and providers recognized its potential for safety, efficiency, and convenience.[1] In many healthcare systems, telehealth transitioned from an auxiliary service to a mainstream mode of care, supported by policy adaptations and reimbursement models.[5] Among the most significant outcomes of this transformation are telemedicine and wearable health technologies, which together form a cornerstone of the emerging paradigm of connected and data-driven medicine.[1]

Initially developed to improve healthcare accessibility for remote populations, telemedicine now encompasses a wide range of services including virtual consultations, remote patient monitoring, teleradiology, telepathology, and telepsychiatry.[16] Similarly, wearable medical devices—such as smartwatches, fitness trackers, biosensors, and implantable devices—enable continuous assessment of vital parameters like heart

rate, oxygen saturation, physical activity, and even biochemical markers.[6] Such real-time datasets can provide early warnings for acute exacerbations, optimize chronic disease management, and facilitate preventive healthcare.[15] For instance, heart rate variability and sleep quality monitoring can inform stress and cardiovascular risk assessments, while glucose and activity tracking systems aid in glycemic control for diabetic patients.[6]. The resulting data loop not only empowers patients to engage in self-management but also supports clinicians in making data-informed decisions tailored to individual needs. The integration of these technologies with electronic health records and decision-support systems has created a dynamic ecosystem where patients and clinicians can interact in real time to manage health conditions more effectively.[14]

Despite these benefits, the rapid digitalization of healthcare also introduces new challenges related to data privacy, interoperability, and regulatory compliance.[16]. The exponential increase in data volume generated by wearable sensors and telemonitoring platforms demands robust frameworks for cybersecurity and ethical data handling.[6] Additionally, disparities in digital literacy and technological infrastructure may perpetuate inequalities unless addressed through targeted public health strategies.[5] Thus, while telemedicine and wearable devices hold transformative potential, their implementation must be guided by principles of safety, inclusivity, and sustainability. Telemedicine and wearable technologies is redefining healthcare delivery by bridging physical, informational, and temporal gaps between patients and providers. This synergy represents not merely a technological innovation but a systemic transformation toward continuous, patient-centered, and data-driven medicine.[1],[14],[15],[21] As the field matures, it is imperative to evaluate current applications, quantify their benefits, and critically examine existing limitations.[6][14],[17] Therefore, the objective of this narrative review is to synthesize the available literature on telemedicine and wearable health devices, highlighting their current clinical applications, demonstrated advantages, existing challenges, and future directions for integration into mainstream healthcare practice.

Methodology

This narrative review was based on a literature search performed in PubMed, Scopus, and Google Scholar databases for the years 2018–2025. The keywords used included „telemedicine,” „wearable devices”, „healthcare delivery”, „physical activity promotion”, „remote patient monitoring” and „digital health”. Only peer-reviewed English-language articles were included. Studies discussing the use, development, or evaluation of telemedicine and wearable technologies in healthcare were selected. Editorials, conference papers, and non-medical applications were excluded.

Current applications of telemedicine and wearables across medical fields

Telemedicine and wearable health technologies have become integral components of clinical care across a broad range of medical specialties. This section summarizes the most relevant clinical applications, focusing on cardiovascular medicine, sports medicine, diabetes and metabolic disorders, athlete monitoring, oncology and hematology, postoperative and rehabilitative care, and emerging uses in other fields such as urology and ophthalmology.

Cardiovascular disorders and exercise monitoring

Cardiovascular diseases remain the leading cause of morbidity and mortality worldwide, prompting an urgent need for effective monitoring and prevention strategies. Telemedicine is rapidly reshaping cardiovascular medicine by enabling clinicians to deliver care beyond traditional in-person visits.[36,40] Wearable devices such as smartwatches, chest straps, and patch-based ECG monitors have revolutionized cardiac care by enabling continuous rhythm surveillance and blood pressure tracking outside clinical settings.[7] Recent reviews indicate that wrist-worn heart rate monitors have become one of the most commonly used wearable tools for tracking cardiovascular responses during exercise. [59] These technologies can detect arrhythmias, including atrial fibrillation, and provide early warnings for ischemic episodes, allowing timely medical intervention.[32,59] This innovative approach supports more individualized treatment, broadens access to exercise monitoring outside laboratory, helps patients better understand and manage their conditions, and may contribute to fewer emergency visits and hospital readmissions. Furthermore, telemedicine can improve access to cardiovascular care for people living in remote or underserved areas, where availability of specialists is limited.[40]Telemedicine platforms complement these tools by offering virtual consultations, remote cardiac rehabilitation programs, and AI-driven decision support for clinicians.[30],[34]. In hypertension management, home-based telemonitoring supported by cloud-connected sphygmomanometers has demonstrated improved adherence and blood pressure control compared to standard care.[31],[33] Such interventions reduce outpatient visits, hospital readmissions, and healthcare costs while maintaining high

patient satisfaction rates.[31] The most established applications of telemedicine include remote follow-up of patients with cardiac rhythm management devices such as pacemakers and implantable cardioverter-defibrillators, where continuous data transmission allows earlier identification of arrhythmic events, device malfunction, or battery depletion. Telemedicine is also emerging as a valuable tool in the management of chronic heart failure, supporting early detection of decompensation through remote monitoring of physiological parameters and thereby helping to reduce hospitalizations. [42],[59] Another growing field is tele-rehabilitation and secondary prevention after acute cardiovascular events, where digital platforms can deliver structured exercise programs, symptom tracking, and education while maintaining close supervision by clinical teams.[42] Moreover, post-myocardial infarction and heart failure patients benefit from hybrid care models that combine teleconsultations with wearable-based monitoring. Real-time heart rate, weight, and oxygen saturation tracking enable early detection of decompensation, reducing acute admissions and improving outcomes.[7],[34] These findings collectively support the growing consensus that digital cardiovascular care is not merely an adjunct but a core component of modern cardiology practice.[34]

However, the broader integration of telemedicine into cardiology brings important considerations. While remote care offers convenience, flexibility, and reduced strain on healthcare resources, several barriers remain. It must be noticed that not all patients have equal access to reliable internet, adequate devices, or the digital literacy required to use telemedical services effectively.[41] There are also concerns about the potential loss of diagnostic information that normally comes from physical examination, which can make certain assessments less precise. Issues such as data security, patient privacy, and the need for well-defined clinical protocols also complicate the widespread adoption of telemedicine. Despite these challenges, the authors argue that telemedicine has the potential to significantly enhance cardiovascular care if technological, ethical, and logistical obstacles are systematically addressed. When implemented thoughtfully, it can become a complementary tool that strengthens patient monitoring, continuity of care, and overall clinical outcomes. [41],[42],[59]

Sports medicine and athlete monitoring

Telemedicine has increasingly been adopted in sports medicine as a complementary model of care that supports clinical decision-making, injury management and athlete follow-up beyond traditional in-person settings. Survey-based evidence demonstrates high acceptance of telemedical consultations among both athletes and healthcare professionals, particularly for follow-up visits, injury assessment and treatment monitoring. Remote care models reduce logistical barriers, improve access to sports medicine specialists and enable continuity of care during training cycles and competitive seasons.[60] The integration of telemedicine with wearable devices has further strengthened remote athlete monitoring by enabling continuous, objective assessment of physiological responses to training and rehabilitation. Wearable sensors commonly capture parameters such as heart rate, heart rate variability, physical activity levels, sleep patterns and movement metrics, which can be transmitted in real time or asynchronously to medical teams. When incorporated into telemedicine platforms, these data provide clinicians with longitudinal insights into training load, recovery status and potential early indicators of overuse or injury, supporting individualized and data-informed decision-making. [60,61] Tele-rehabilitation systems in orthopedics and sports medicine increasingly combine wearable motion sensors with mobile applications and virtual environments to guide exercise execution and monitor adherence. These approaches allow clinicians to remotely adjust rehabilitation intensity, identify compensatory movement patterns and optimize return-to-play strategies while maintaining clinical supervision outside traditional healthcare settings. [61] Wearable-supported telemedicine has also proven particularly valuable in sports performed under extreme or remote conditions, where direct medical access is limited. Portable sensors, mobile imaging solutions and secure data transmission technologies enable real-time physiological monitoring and remote expert consultation during endurance events, expeditions and high-risk sporting activities. Such systems enhance medical safety by facilitating early recognition of physiological strain and timely clinical intervention, even in geographically isolated environments.[62]

Overall, the integration of telemedicine with wearable devices in sports medicine supports a shift toward continuous, personalized and preventive care. By combining remote clinical oversight with real-time physiological and biomechanical data, these technologies contribute to safer training practices, improved injury management and sustained promotion of physical activity across diverse athletic populations.[60-62]

Diabetes, metabolic disorders and CGM in physically active individuals

Diabetes management has been one of the most rapidly evolving areas for telemedicine and wearable devices, offering tools that support early detection of complications, continuous physiological monitoring, and more individualized patient engagement. Continuous glucose monitors (CGMs), insulin pumps, and smart applications now provide an integrated feedback loop between patients, clinicians, and data systems.[37],[38] These devices transmit glucose readings to mobile platforms, enabling automated insulin dosing recommendations and facilitating clinician review through teleconsultations.[39] Telemedicine-based diabetes care has been shown to improve glycemic control, treatment adherence, and patient empowerment.[39] During the COVID-19 pandemic, remote glucose monitoring platforms proved crucial for maintaining continuity of care in patients unable to attend regular appointments.[37] Furthermore, the combination of wearable activity trackers and dietary logging applications supports lifestyle modification programs aimed at reducing insulin resistance and obesity.[38] In type 2 diabetes, remote digital technologies are particularly valuable because many patients develop cognitive impairment that often goes unrecognized until it is advanced. Recent work demonstrates that wearable devices, passive activity sensors, and smartphone-based cognitive assessments can continuously collect data relevant to cognitive functioning and identify subtle declines much earlier than traditional clinic-based evaluations.[37] These remote systems draw on approaches initially developed for neurodegenerative diseases and adapt them for the metabolic and vascular characteristics of diabetes, providing a scalable framework for proactive monitoring of at-risk individuals [37],[39] As such technologies mature, they may enable clinicians to intervene earlier, tailor treatment plans, and better track the cognitive consequences of long-standing metabolic dysregulation.[37],[38] Telemedicine also plays a significant role in the management of gestational diabetes, where timely and precise glucose control is essential for maternal and fetal health. Digital health platforms equipped with machine-learning algorithms can integrate large volumes of glucose measurements, dietary information, and behavioral data to generate personalized insights for both patients and clinicians. [38] These systems provide automated feedback, prediction of glucose excursions, and alerts aimed at preventing episodes of hyperglycemia. By reducing the delays associated with traditional paper logs or infrequent clinic visits, remote monitoring enhances decision-making during pregnancy and helps ensure that individuals with gestational diabetes maintain safer glycemic profiles.[38] This digital infrastructure also supports more efficient communication between patients and healthcare providers, which is crucial in managing a time-sensitive condition.[37]

Another important contribution of telemedicine in diabetes relates to its ability to support behavior change, an essential but often difficult component of long-term glycemic control. Continuous glucose monitoring (CGM) systems, now increasingly integrated into telehealth platforms, provide users with immediate feedback regarding how diet, physical activity, stress, and sleep patterns affect glucose levels throughout the day. Regular physical activity offers numerous benefits for glycemic control, insulin sensitivity, and cardiovascular health, but it can also introduce risks such as hypoglycemia or hyperglycemia if glucose levels are not closely monitored. [63] CGM devices enable athletes and healthcare professionals to track glucose trends dynamically, adjusting carbohydrate intake, insulin dosing, or exercise intensity accordingly. Research indicates that integrating CGM into training routines allows for personalized strategies that optimize performance while minimizing metabolic risks. [63]

A recent systematic review and meta-analysis of randomized controlled trials found that CGM use can meaningfully enhance self-regulatory behaviors and motivation, improving glycemic outcomes not only in individuals with established diabetes but also in populations without diabetes who are seeking to modify lifestyle habits. [39] These findings highlight the potential of modern CGM tools as broader digital health interventions capable of encouraging healthier behavior patterns and empowering both elite athletes and recreationally active individuals through real-time data. [37],[39]

Undoubtedly telemedicine is reshaping diabetes management across diverse clinical contexts. Whether through early detection of cognitive decline in type 2 diabetes, machine-learning-supported glucose monitoring in pregnancy, or behaviorally focused CGM feedback, telemedicine enables more continuous, personalized, and proactive care. [37] As digital technologies continue to advance, they offer opportunities to reduce clinical burden, improve patient engagement, and support earlier, data-driven interventions that would be difficult to achieve through traditional models of diabetes care.[37]

Beyond diabetes, telehealth has also demonstrated benefits in metabolic diseases management, allowing clinicians to adjust pharmacotherapy and monitor adherence through digital biomarkers. Wearable technologies, in particular, play a central role by providing continuous, objective data on physical activity, energy expenditure, heart rate, and sometimes even dietary habits. Evidence shows that these devices can

promote healthier behaviors and assist patients in maintaining long-term adherence to physical activity and nutrition-related goals, which are essential components of managing chronic metabolic conditions such as obesity, metabolic syndrome, and type 2 diabetes.[11] By enabling remote tracking and real-time feedback, wearables allow clinicians to monitor progress more closely and adjust interventions without requiring frequent in-person visits, thereby enhancing patient engagement and facilitating more responsive care.[11],[29]

Telemedicine also supports personalized nutritional management in patients with rare diseases, such as leukodystrophies, and neuromuscular disorders. Digital platforms enable specialized dietary counseling, remote assessment of nutritional intake, and timely adaptation of individualized meal plans—features that are particularly important for patients who require highly specific dietary regimens to control metabolic imbalances or prevent disease complications. These telehealth systems offer structured communication channels between patients, dietitians, and multidisciplinary care teams, ensuring that guidance can be delivered consistently even in settings where regular access to specialized nutrition services is limited. Emerging evidence suggests that such digital approaches can improve adherence, reduce the burden of travel, and enhance overall quality of life for individuals with rare metabolic diseases.[29] Together, these developments illustrate how telemedicine fosters more accessible, data-driven, and patient-centered strategies for addressing a broad spectrum of metabolic disorders. These advances mark a fundamental transition from episodic clinical assessments to continuous, patient-driven metabolic surveillance, promoting better long-term outcomes.[11],[29]

Oncology and hematology

In oncology, telemedicine plays a pivotal role in continuity of care, particularly for immunocompromised patients and those living far from specialized centers.[3],[26] Recent research has further expanded the evidence base for remote monitoring and wearable technologies in cancer care, demonstrating a range of practical applications across treatment phases and patient populations.[48] Wearable sensors and consumer activity trackers have been widely used to obtain objective measures of physical activity, sleep, and heart-rate variability, enabling clinicians to follow functional recovery during and after treatments such as chemotherapy, radiotherapy, hematopoietic cell transplantation, and CAR-T cell therapy. These continuous data streams make it possible to characterise symptom trajectories (for example, treatment-related fatigue), detect early deviations from expected recovery, and tailor rehabilitation plans remotely, thereby supporting more proactive symptom management and individualized care pathways.[48],[49] Wearable devices are increasingly used in oncology to monitor treatment-related side effects such as fatigue, mobility impairment, and cardiotoxicity.[3] Several studies have documented the feasibility and clinical value of using wearables to monitor vital signs that are relevant to oncology patients. Continuous temperature and multi-vital monitoring have been piloted as tools for early identification of febrile episodes and neutropenic complications, offering the potential to shorten the time to clinical review in high-risk patients and possibly to reduce morbidity associated with delayed fever detection. Similarly, ambulatory heart-rate and activity data have been applied to detect early signs of deconditioning or physiologic stress that may presage complications, enabling clinicians to intervene before deterioration necessitates hospital admission.[50] In hematology, remote monitoring of post-bone marrow transplant patients using wearables and teleconsultations has improved early detection of complications such as graft-versus-host disease.[25] By integrating data from accelerometers and biosensors, clinicians can objectively assess functional decline and intervene earlier. This patient-generated health data enriches traditional outcome measures and facilitates value-based oncology models.[26] Telemedicine platforms have also been coupled with structured telerehabilitation programs and remote symptom-reporting systems to support recovery and preserve quality of life.[51] Video consultations, symptom-reporting mobile apps, and home-based monitoring reduce unnecessary hospital visits while maintaining close follow-up.[25] Randomized and observational work suggests that remote exercise prescriptions, supervised virtually, and digital symptom monitoring are feasible in oncology populations and can improve adherence to rehabilitation regimens, mitigate functional decline, and reduce symptom burden when compared with usual care alone. These interventions are particularly relevant for patients who face mobility constraints or who are immunocompromised and thus benefit from reduced travel to clinic.[51],[52] Patient experience studies highlight generally positive attitudes toward telehealth and wearables in cancer care, while also identifying practical barriers that must be addressed for broader adoption. Many patients appreciate the convenience and reduced travel time offered by virtual consultations and remote monitoring, yet technical difficulties, device usability, and the perceived burden of continuous monitoring can limit sustained engagement.[53] Preferences are nuanced: patients commonly accept telemedicine for routine follow-ups, medication reviews, or review of test results, but prefer face-to-face visits for initial diagnoses, complex decision-making, or sensitive discussions. These insights point to the importance of hybrid care models that combine remote monitoring and virtual visits with in-person encounters when clinically indicated.[52] [53]

Despite these promising developments, the literature consistently emphasises implementation challenges. Heterogeneity in device accuracy, lack of standardized data formats, and poor interoperability with electronic health records create obstacles for clinical integration and data-driven decision making.[54],[55] In addition, several studies note the need for robust analytic pipelines and validated algorithms to turn high-volume sensor data into actionable clinical signals; without such validation, the clinical utility of many wearable-derived metrics remains limited.[46],[54] Ethical and equity concerns also arise: the digital divide and variability in patient digital literacy may exacerbate disparities unless programs include targeted solutions for access and training. Finally, regulatory, reimbursement, and workflow integration issues continue to constrain large-scale deployment, highlighting that technology alone is insufficient without supportive policy and infrastructure.[55]

Taken together, current evidence supports a growing role for telemedicine and wearables in oncology and hematology - from early detection of adverse events and continuous vital-sign surveillance to remote rehabilitation and patient-centered follow-up - but also underscores that careful validation, user-centred design, interoperability and equitable implementation are essential prerequisites for translation into routine practice.[25],[48],[50],[51] These findings emphasize that telemedicine should complement rather than replace traditional oncology care, with its greatest value emerging when incorporated into thoughtfully structured hybrid care pathways. [26]

Postoperative and rehabilitative care

The postoperative period represents a critical window for monitoring complications, pain management, and functional recovery. Telemedicine has become an increasingly central component of postoperative and rehabilitative management, offering clinicians the ability to monitor recovery trajectories while reducing the burden of in-person visits.

Wearable sensors and tele-rehabilitation platforms allow clinicians to track mobility, wound healing, and physiological recovery in real time. They also support patient engagement by offering feedback about daily activity goals during the vulnerable early postoperative period.

For example, in patients recovering from cardiac surgery, wearable activity monitors have been used to track step counts, mobility patterns, and overall physical activity, providing objective indicators of recovery quality and revealing deviations that may signal delayed healing or complications.[12] Similarly, remote physiologic and therapeutic monitoring platforms have gained traction in orthopedic surgery. After total knee arthroplasty, wearable motion sensors combined with tele-rehabilitation programs enable continuous assessment of joint movement, range of motion and quality of walking. Such remote systems have been also associated with improved rehabilitation adherence. Moreover, studies demonstrate that remote physiotherapy programs yield outcomes comparable to in-person rehabilitation while offering greater convenience and lower cost.[35] Data transmitted to rehabilitation teams via telemedicine interfaces enable individualized adjustments to therapy intensity.[12],[35] Additionally, telehealth supports remote pain management and early detection of surgical site infections through symptom-reporting apps and connected sensors.[12] These interventions not only streamline postoperative care but also offer a practical solution for patients who encounter logistical barriers to attending frequent rehabilitation sessions.[35]

Recent research further expands the scope of telemedicine in surgical recovery. Mobile-health-based postoperative monitoring for thoracic surgeries has shown that digital platforms can reliably capture pain scores, wound photographs, vital signs, and early symptom changes, enabling faster detection of surgical-site infections and complications such as dehydration or pulmonary decline [12],[58]. Studies evaluating smartphone-integrated wound assessment tools demonstrate good patient acceptance and high diagnostic concordance with in-person evaluations, underscoring their utility as adjuncts to routine follow-up.[12],[56] Tele-rehabilitation protocols incorporating real-time video feedback and app-guided exercise regimens have also proven effective across orthopedic, neurologic, and cardiovascular populations, improving functional outcomes, reducing hospital readmissions, and supporting long-term self-management.[12],[35],[57] Despite variability in available technologies, the overarching evidence suggests that remote monitoring and digital rehabilitation pathways enhance postoperative safety, promote timely recognition of complications, and encourage active patient participation in recovery. As surgical care increasingly moves toward shorter hospital stays and early discharge models, telemedicine offers an important framework to maintain continuity of care while supporting efficient resource use and personalized rehabilitation planning.[12],[35] This approach aligns with the principles of enhanced recovery after surgery, emphasizing early mobilization and patient engagement.[35] All things considered, the result of incorporating digital medicine into rehabilitative care is shorter recovery times, reduced hospital stays, and improved patient satisfaction.[12]

Urology, ophthalmology and other specialties

Beyond major chronic disease areas, telemedicine and wearable technologies are expanding into diverse clinical domains. In urology, teleconsultations facilitate preoperative counseling, postoperative follow-up, and chronic condition management such as incontinence or erectile dysfunction.[23] Wearable urination sensors and connected pelvic floor training devices enhance adherence and provide objective feedback for rehabilitation.[28] In ophthalmology, teleophthalmology programs employing retinal imaging and cloud-based diagnostics have improved access to screening for diabetic retinopathy, glaucoma and age-related macular degeneration, particularly in underserved populations. AI-driven diagnostic systems offer multimodal learning approaches, integrating imaging data such as fundus photography and OCT with clinical parameters, enhance the early detection of retinal diseases. According to recent studies, these algorithms are capable of identifying subtle structural abnormalities that may be overlooked in routine clinical assessment, improving the detection of ophthalmic conditions.[27]

Machine-learning-assisted image interpretation enables earlier detection of pathology and triaging of patients requiring in-person care, with both acute and chronic eye conditions.[29] Emerging areas also include teledermatology, telepsychiatry, and remote respiratory monitoring. Smart patches measuring oxygen saturation and respiratory rate are being used to manage patients with chronic obstructive pulmonary disease or asthma at home.[30] Collectively, these multidisciplinary applications demonstrate the scalability and adaptability of digital health technologies across medical specialties.[29]

Benefits- how can telemedicine promote physical activity?

Integrating telemedicine into mainstream clinical practice provides a holistic view of patient health. This innovative approach supports both disease-specific and general wellness interventions. By combining remote monitoring, personalized feedback and real-time data analysis, telemedicine plays a growing role in promoting and sustaining physical activity.

First, telemedicine improves accessibility and continuity of care, particularly for patients living in remote or underserved regions. Numerous studies emphasize that virtual consultations and remote monitoring reduce travel time, waiting lists, and treatment interruptions, while maintaining quality and safety comparable to in-person visits.[1,14,15] During the COVID-19 pandemic, telehealth systems proved essential in ensuring uninterrupted care delivery.[8] Second, combining telemedicine with wearable devices enhances early diagnosis and disease management. Continuous physiological monitoring—such as of heart rate, rhythm, blood pressure, glucose, or physical activity—enables rapid clinical intervention, lowering the risk of complications in cardiovascular, metabolic, and respiratory diseases.[7],[31],[37] In diabetes care, remote glucose monitoring and digital coaching have been linked to improved glycaemic control and treatment adherence.[38] Third, these technologies bring economic and organizational benefits. Digital follow-up and remote supervision reduce the number of unnecessary in-person appointments and hospital readmissions, lowering healthcare costs and optimizing resource allocation.[16,21] Tele-rehabilitation and postoperative telemonitoring have achieved similar or better clinical outcomes compared to traditional models, with added convenience for both patients and providers.[12] Fourth, wearables foster greater patient engagement and self-management. Continuous feedback on daily activity, diet, and vital signs encourages behavior change and supports long-term lifestyle improvement.[11] Patients become more aware of their condition and take an active role in decision-making, contributing to personalized and preventive care.

Finally, data from wearable sensors contribute to the advancement of precision medicine. Leveraging artificial intelligence and machine learning enables the analysis of these complex datasets, uncovering patterns that can improve diagnosis, prognosis, and treatment decisions beyond conventional approaches. AI applications span multiple medical domains, including cardiology, sports medicine, neurology, and immunology, where it can enhance diagnostic accuracy and reduce error rates.[2],[9],[29]

Future perspectives of telemedicine and wearable technologies

In the near future, telemedicine and wearable-based healthcare are expected to evolve toward more integrated, intelligent, and patient-centered systems. Technological progress in flexible sensors, nanomaterials, and miniaturized electronics will make devices more accurate, comfortable, and capable of long-term physiological and biochemical monitoring.[4,10,13] Artificial intelligence will play a key role by enabling predictive analytics and automated clinical alerts. AI algorithms analyzing continuous data streams may forecast decompensation in chronic diseases or optimize therapy according to real-time parameters.[2],[9] Machine learning techniques are particularly effective at detecting intricate relationships within diverse data types—numerical, visual, or textual—and can rapidly process large-scale datasets, facilitating personalized and population-level insights. In parallel, *in silico* modeling and virtual clinical trials allow the simulation of

patient populations, including underrepresented groups, improving trial design and potentially reducing the need for extensive real-world testing. [29] The fusion of multimodal data—including genomics, metabolomics, and patient generated health data—offers a future in which therapeutic choices are dynamically adjusted to the patient’s real-world phenotype. [9] Collectively, these advancements highlight the transformative potential of integrating telemonitoring, AI, and wearable devices to support proactive, data-driven, and precision healthcare. [14,29] Care models are expected to shift toward hybrid approaches, combining remote monitoring with targeted face-to-face visits. Rather than replacing face-to-face interactions, telemedicine is likely to be embedded in mixed pathways where in-person, virtual, and automated monitoring modalities are organized according to clinical need. [5],[14] Such hybrid models can optimize resource allocation: routine surveillance and lifestyle support occur remotely, while episodic or complex evaluations remain in person. [17,18] Early evidence supports hybrid programs for chronic disease management, postoperative recovery, and oncology follow-up. [3],[12] However, the expansion of digital health requires progress in data interoperability, cybersecurity, and ethical regulation. Establishing common standards for data exchange, validation, and privacy protection is crucial for safe clinical use. [16] At the same time, healthcare systems must address digital inequities, ensuring that elderly, low-income, or technologically inexperienced patients also benefit from these solutions. [15]

The scale of impact of telemedicine in the future will be determined by interoperability, standards, and regulations. For wearable-derived data to be clinically actionable, devices and platforms must adhere to interoperable protocols, validated performance metrics, and regulatory approvals that protect patients while enabling innovation. [16],[20] Progress in standardizing data formats and clinical-grade validation frameworks will facilitate integration into electronic health records and decision-support pipelines. [9],[10] Future research should focus on evaluating long-term outcomes, cost-effectiveness, and patient satisfaction across diverse clinical settings. Particular attention should be given to the use of telemedicine in cardiology, diabetes management, oncology, and nutritional therapy for rare diseases, which already demonstrate promising clinical and economic results. [7],[29] Overall, the synergy between telemedicine, wearable technologies, and AI-based analytics is reshaping healthcare delivery - shifting the paradigm from reactive treatment toward proactive, data-driven, and personalized care.

Limitations and challenges

Despite substantial technological progress, several critical challenges hinder the full integration of telemedicine and wearable health solutions into clinical practice. One key issue is the absence of standardized regulations governing digital health tools, coupled with disparities in technological infrastructure and persistent concerns regarding data privacy and security. While artificial intelligence and machine learning offer considerable potential to enhance remote care, their broad implementation in clinical settings necessitates rigorous validation to guarantee accuracy, reliability, and adherence to ethical standards. [29] From a systems perspective, a lack of interoperability and standard protocols across digital health and clinical platforms also slows broader implementation. Many wearable devices cannot seamlessly integrate with electronic health records or other healthcare IT systems, which makes data sharing and clinical decision-making more difficult. Regulatory uncertainty compounds these problems: heterogeneous or vague guidelines for telemedicine and wearable device use can delay clinical approvals, slow adoption, and complicate reimbursement strategies [46]

Technical constraints represent a major barrier, particularly in rural or underserved areas where access to stable internet connections and high-quality broadband is limited. [29] Such deficiencies reduce the quality of remote interactions and restrict patients’ access to consistent and effective healthcare services. This infrastructure gap undermines consistent, high-quality teleconsultations and contributes to inequities in health service delivery. [45] In addition, socioeconomic factors—including patients’ education level, income, and familiarity with digital technologies—play a significant role in the adoption and effective use of telemedicine. [29] Furthermore, user-related factors impede adoption: individuals with limited digital literacy or less confidence in using technology often struggle to engage with telemedicine platforms or wearable devices. The challenge is particularly acute when interfaces are not intuitive or require frequent manual input, discouraging sustained use of remote monitoring tools. [29],[45] Geographical inequalities further complicate the deployment of telehealth services. Regions with limited infrastructure or economic disadvantages frequently face challenges in providing high-quality digital care, as reliable connectivity between healthcare providers and patients is essential for the success of telemedicine interventions. [24,29] Data security and patient privacy remain pressing concerns, especially given the extensive personal and health information collected by healthcare applications and mobile health platforms. Wearables and mobile health tools continuously generate sensitive personal data, and the absence of robust, universally adopted security standards places patient

confidentiality at risk. [29],[43] The sensitive nature of these data underscores the urgent need for clear, uniform regulations to protect patient confidentiality.[29] Moreover, practitioners often face difficult trade-offs between usability and data protection, especially when working with vulnerable populations.[43] The massive volume of data generated by wearable devices also poses a logistical challenge: clinicians may be overwhelmed with analytics, lacking standardized guidelines on how to interpret or action data streams. Without clear clinical pathways and validated protocols, the potential of wearables for real-world decision-making remains underutilized. [46] Moreover, telemedicine inherently limits certain aspects of care. crucial diagnostic components-such as detailed physical examinations, auscultation, or in-person diagnostic tests-cannot always be replicated virtually, which may lead to misdiagnosis or incomplete assessments.[44] The inability to conduct comprehensive physical examinations and the difficulties associated with managing urgent or emergent situations illustrate the challenges of delivering fully holistic care solely through digital means.[23,29] In acute situations, the remote format may further hinder urgent interventions or decisions that would normally require immediate, hands-on care.[44] Finally, sustainable deployment of telemedicine and wearables is questioned by financial and training burdens. Establishing a remote care service requires not only investments in secure platforms and broadband infrastructure, but also continuous training for healthcare professionals in using, interpreting, and responding to remote health data. Without well-defined and properly funded organizational models, telemedicine initiatives risk being patchy, inconsistent, and hard to scale.[47]

These factors highlight that, while telemedicine and wearable devices offer substantial benefits, careful consideration of technical, ethical, and practical limitations is essential for their safe and effective integration into healthcare systems.[21,22,29]

Discussion

Telemedicine and wearable technologies have evolved from complementary digital tools into increasingly strategic components of modern healthcare delivery. Evidence drawn from the broad interdisciplinary literature demonstrates that these technologies are now embedded across a wide range of major medical domains, including cardiology and screening for athlete cardiac risk, sports medicine and post-injury sports rehabilitation, oncology, ophthalmology, primary care and perioperative medicine, but also in promoting physical activity and remote patient monitoring. Despite the diversity of clinical contexts, several overarching themes consistently emerge across studies: improved access, enhanced continuity of care, earlier detection of clinical deterioration, heightened patient engagement and a structural shift toward proactive, data-driven medicine. At the same time, persistent limitations—including technological inequality, data management burdens, regulatory fragmentation, concerns about accuracy and privacy-mean that the full potential of these tools has yet to be realized. Telemedicine proved especially valuable during the COVID-19 pandemic, maintaining continuity of care across specialties such as pulmonology, gastroenterology and oncology when routine in-person visits became difficult or unsafe [8,24]. Beyond emergency contexts, scoping studies show that telemedicine remains clinically effective and cost-effective across a variety of chronic diseases, including cardiovascular conditions, diabetes and cancer survivorship [16,19,21]. These findings collectively underline a transition from episodic, clinic-centered care to ongoing, remote-supported disease management. Oncology is one of the fastest-growing fields for digital health innovation. Telemedicine in cancer care has been shown to improve patient satisfaction, facilitate communication, and reduce logistical burdens during demanding treatment schedules [25,26,52]. Wearable devices enable continuous assessment of fatigue, cardiorespiratory parameters, athlete monitoring, sleep quality and behavioral patterns, offering new ways to evaluate treatment tolerance and recovery outside hospital settings [49,50,54,55]. Remote rehabilitation through telemedicine and mobile applications has also demonstrated benefits for survivors, supporting long-term physical functioning and quality of life [51]. Together, these developments point toward a hybrid oncology care model that integrates periodic in-person visits with remote monitoring to achieve more personalized, responsive treatment planning [53]. Similarly, telemedicine supports early detection in oral oncology by enabling remote triage and specialist consultations, often reducing delays in diagnosis within underserved regions [47]. The continuous expansion across such highly specialized fields underscores the adaptability of digital technologies to diverse diagnostic and therapeutic needs. Although the integration of artificial intelligence and telemedicine is transforming healthcare delivery, these innovations must be adopted critically. Technical challenges - such as unstable connectivity, limited interoperability between systems, and variable sensor accuracy—are frequently cited as barriers to effectiveness and consistency [10,11,20,43]. Patients and clinicians report issues with device usability, digital literacy and reliability, which can affect adherence and perceived value. Privacy and cybersecurity concerns remain among the most significant

obstacles, particularly given the volume and sensitivity of data generated by wearables and remote monitoring platforms [43,45]. Large-scale reviews during and after the COVID-19 pandemic highlight persistent disparities in telehealth adoption, driven by socioeconomic status, age, geographic region and digital skill level [14,44]. Without targeted interventions, these disparities risk reinforcing existing inequalities in healthcare access and outcomes. Ultimately, telemedicine and wearable technologies do not replace traditional medicine; instead, they extend its reach, enhance its precision and deepen its responsiveness. With appropriate implementation, they can support a healthcare system that is more personalized, predictive and participatory. Continued interdisciplinary research, patient-centered design, and equitable access initiatives will be crucial to ensure that these innovations fulfill their potential and contribute to a more resilient, accessible and efficient global healthcare landscape.

Conclusions

Telemedicine and wearable technologies represent powerful and complementary tools for promoting physical activity and advancing health monitoring across diverse populations. By enabling continuous data collection, personalized feedback and remote supervision, these solutions support sustained engagement in physical activity while improving the safety and effectiveness of care for both the general population and individuals living with chronic disease. The reviewed evidence indicates that telemedicine-based models can improve healthcare efficiency, reduce hospital utilization and expand access to medical expertise, particularly in underserved and geographically remote settings. Wearable devices further enhance these models by providing real-time physiological insights that facilitate earlier detection of clinical deterioration, more precise chronic disease management and improved rehabilitation outcomes. Despite their demonstrated benefits, the successful integration of telemedicine and wearables remains constrained by technological, organizational and ethical challenges, including data overload, interoperability limitations, regulatory uncertainty and persistent inequalities in digital access. Addressing these barriers will be essential to ensure that digital health innovations translate into equitable and sustainable improvements in population health. Overall, this narrative review highlights telemedicine and wearable technologies as central components of the evolving digital healthcare ecosystem. Their continued development-supported by responsible implementation of artificial intelligence, hybrid models of care and patient-centered design-has the potential to reshape healthcare delivery toward a more proactive, personalized and participatory system.

Disclosure

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REFERENCES

1. Ezeamii, V. C., Okobi, O. E., Wambai-Sani, H., Perera, G. S., Zaynieva, S., Okonkwo, C. C., Ohaiba, M. M., William-Enemali, P. C., Obodo, O. R., & Obiefuna, N. G. (2024). Revolutionizing Healthcare: How Telemedicine Is Improving Patient Outcomes and Expanding Access to Care. *Cureus*, 16(7), e63881. <https://doi.org/10.7759/cureus.63881>
2. Babu, M., Lautman, Z., Lin, X., Sobota, M. H. B., & Snyder, M. P. (2024). Wearable Devices: Implications for Precision Medicine and the Future of Health Care. *Annual review of medicine*, 75, 401–415. <https://doi.org/10.1146/annurev-med-052422-020437>
3. Hurtado, L., Gonzalez Concepcion, M., Flix-Valle, A., Ruiz-Romeo, M., Gonzalez-Rodriguez, S., Peña, M., Paviglianiti, A., Pera Jambrina, M. A., Sureda, A., Ochoa-Arnedo, C., & Mussetti, A. (2024). Telemedicine With Wearable Technologies in Patients Undergoing Hematopoietic Cell Transplantation and Chimeric Antigen Receptor T-Cell Therapy (TEL-HEMATO Study): Prospective Noninterventional Single-Center Study. *JMIR formative research*, 8, e55918. <https://doi.org/10.2196/55918>
4. Lu, L., Zhang, J., Xie, Y., Gao, F., Xu, S., Wu, X., & Ye, Z. (2020). Wearable Health Devices in Health Care: Narrative Systematic Review. *JMIR mHealth and uHealth*, 8(11), e18907. <https://doi.org/10.2196/18907>
5. Hackl, W. O., Neururer, S. B., & Pfeifer, B. (2023). Telemedicine Research from Big Bang to 2022. *Studies in health technology and informatics*, 301, 220–224. <https://doi.org/10.3233/SHTI230043>
6. Rowan, C., & Hirten, R. (2022). The future of telemedicine and wearable technology in IBD. *Current opinion in gastroenterology*, 38(4), 373–381. <https://doi.org/10.1097/MOG.0000000000000845>
7. Hughes, A., Shandhi, M. M. H., Master, H., Dunn, J., & Brittain, E. (2023). Wearable Devices in Cardiovascular Medicine. *Circulation research*, 132(5), 652–670. <https://doi.org/10.1161/CIRCRESAHA.122.322389>
8. Ding, X., Clifton, D., Ji, N., Lovell, N. H., Bonato, P., Chen, W., Yu, X., Xue, Z., Xiang, T., Long, X., Xu, K., Jiang, X., Wang, Q., Yin, B., Feng, G., & Zhang, Y. T. (2021). Wearable Sensing and Telehealth Technology with Potential Applications in the Coronavirus Pandemic. *IEEE reviews in biomedical engineering*, 14, 48–70. <https://doi.org/10.1109/RBME.2020.2992838>
9. Leclercq, C., Witt, H., Hindricks, G., Katra, R. P., Albert, D., Belliger, A., Cowie, M. R., Deneke, T., Friedman, P., Haschemi, M., Lobban, T., Lordereau, I., McConnell, M. V., Rapallini, L., Samset, E., Turakhia, M. P., Singh, J. P., Svennberg, E., Wadhwa, M., & Weidinger, F. (2022). Wearables, telemedicine, and artificial intelligence in arrhythmias and heart failure: Proceedings of the European Society of Cardiology Cardiovascular Round Table. *Europace : European pacing, arrhythmias, and cardiac electrophysiology : journal of the working groups on cardiac pacing, arrhythmias, and cardiac cellular electrophysiology of the European Society of Cardiology*, 24(9), 1372–1383. <https://doi.org/10.1093/europace/euac052>
10. Vaghasiya, J. V., Mayorga-Martinez, C. C., & Pumera, M. (2023). Wearable sensors for telehealth based on emerging materials and nanoarchitectonics. *Npj flexible electronics*, 7(1), 26. <https://doi.org/10.1038/s41528-023-00261-4>
11. Natalucci, V., Marmondi, F., Biraghi, M., & Bonato, M. (2023). The Effectiveness of Wearable Devices in Non-Communicable Diseases to Manage Physical Activity and Nutrition: Where We Are?. *Nutrients*, 15(4), 913. <https://doi.org/10.3390/nu15040913>
12. Edney, J., McDonall, J., Khaw, D., & Hutchinson, A. F. (2024). Use of wearable devices to monitor post-operative activity following cardiac surgery: a systematic scoping review. *European journal of cardiovascular nursing*, 23(7), 697–710. <https://doi.org/10.1093/eurjcn/zvae054>
13. Roh, K. M., Awosika, A., & Millis, R. M. (2024). Advances in Wearable Stethoscope Technology: Opportunities for the Early Detection and Prevention of Cardiovascular Diseases. *Cureus*, 16(12), e75446. <https://doi.org/10.7759/cureus.75446>
14. Walter, J. R., Xu, S., & Rogers, J. A. (2024). From lab to life: how wearable devices can improve health equity. *Nature communications*, 15(1), 123. <https://doi.org/10.1038/s41467-023-44634-9>
15. Shende, V., & Wagh, V. (2024). Role of Telemedicine and Telehealth in Public Healthcare Sector: A Narrative Review. *Cureus*, 16(9), e69102. <https://doi.org/10.7759/cureus.69102>
16. Eze, N. D., Mateus, C., & Cravo Oliveira Hashiguchi, T. (2020). Telemedicine in the OECD: An umbrella review of clinical and cost-effectiveness, patient experience and implementation. *PloS one*, 15(8), e0237585. <https://doi.org/10.1371/journal.pone.0237585>
17. Thomson, K. L., Morrison, L., Cooper, M., & Johnston, B. (2025). Exploring the benefits and limitations of using telemedicine in unscheduled care. *Emergency nurse : the journal of the RCN Accident and Emergency Nursing Association*, 33(2), 28–34. <https://doi.org/10.7748/en.2024.e2210>
18. Beheshti, L., Kalankesh, L. R., Doshmangir, L., & Farahbakhsh, M. (2022). Telehealth in Primary Health Care: A Scoping Review of the Literature. *Perspectives in health information management*, 19(1), 1n. <https://doi.org/10.29173/phim198>

19. Singhal, A., Riley, J. P., & Cowie, M. R. (2023). Benefits and challenges of telemedicine for heart failure consultations: a qualitative study. *BMC health services research*, 23(1), 847. <https://doi.org/10.1186/s12913-023-09872-z>
20. Juhra C. (2023). Telemedizin [Telemedicine]. *Orthopadie (Heidelberg, Germany)*, 52(7), 560–566. <https://doi.org/10.1007/s00132-023-04396-0>
21. Lebieczik, M., Turečková, K., Majerova, I., Nevima, J., Hradská, K., Popková, T., Skořupová, M., & Hájek, R. (2023). An economic evaluation of the effectiveness of telemedicine in hematooncology. *PloS one*, 18(11), e0291143. <https://doi.org/10.1371/journal.pone.0291143>
22. Hoffman, A. M., Lapcharoensap, W., Huynh, T., & Lund, K. (2019). Historical Perspectives: Telemedicine in Neonatology. *NeoReviews*, 20(3), e113–e123. <https://doi.org/10.1542/neo.20-3-e113>
23. Talyshinskii, A., Naik, N., Hameed, B. M. Z., Khairley, G., Randhawa, P., & Somani, B. K. (2024). Telemedicine in Endourology for Patient Management and Healthcare Delivery: Current Status and Future Perspectives. *Current urology reports*, 25(11), 299–310. <https://doi.org/10.1007/s11934-024-01224-6>
24. Monteleone, G., Terzulli, G., Cefaloni, F., Bonini, M., & Richeldi, L. (2023). The Impact of Telemedicine during Severe Acute Respiratory Syndrome Coronavirus 2 Pandemic and Future Perspectives: A Systematic Review. *Respiration; international review of thoracic diseases*, 102(10), 879–890. <https://doi.org/10.1159/000533621>
25. Boucher, A. A., Jewett, P. I., Holtan, S. G., Lindgren, B. R., Hui, J. Y. C., & Blaes, A. H. (2023). Adult Hematology/Oncology Patient Perspectives on Telemedicine Highlight Areas of Focus for Future Hybrid Care Models. *Telemedicine journal and e-health : the official journal of the American Telemedicine Association*, 29(5), 708–716. <https://doi.org/10.1089/tmj.2022.0331>
26. Doshi, S. D., Charvadeh, Y. K., Seier, K., Bange, E. M., Daly, B., Lipitz-Snyderman, A., Polubriaginof, F. C. G., Buckley, M., Kuperman, G., Stetson, P. D., Schrag, D., Morris, M. J., & Panageas, K. S. (2024). Perspectives on Telemedicine Visits Reported by Patients With Cancer. *JAMA network open*, 7(11), e2445363. <https://doi.org/10.1001/jamanetworkopen.2024.45363>
27. Li, J. O., Liu, H., Ting, D. S. J., Jeon, S., Chan, R. V. P., Kim, J. E., Sim, D. A., Thomas, P. B. M., Lin, H., Chen, Y., Sakamoto, T., Loewenstein, A., Lam, D. S. C., Pasquale, L. R., Wong, T. Y., Lam, L. A., & Ting, D. S. W. (2021). Digital technology, tele-medicine and artificial intelligence in ophthalmology: A global perspective. *Progress in retinal and eye research*, 82, 100900. <https://doi.org/10.1016/j.preteyeres.2020.100900>
28. Fedorowicz, S. A., Suława, A., Tomkalski, W., & Michalik, T. (2025). Telemedycyna w opiece urologicznej nad seniorami – korzyści, wyzwania i perspektywy [The role of telemedicine in urological care for the elderly - benefits, challenges, and future perspectives]. *Medycyna pracy*, 76(3), 223–231. <https://doi.org/10.13075/mp.5893.01632>
29. Eletti, F., Tagi, V. M., Greco, I. P., Stucchi, E., Fiore, G., Bonaventura, E., Bruschi, F., Tonduti, D., Verduci, E., & Zuccotti, G. (2025). Telemedicine for Personalized Nutritional Intervention of Rare Diseases: A Narrative Review on Approaches, Impact, and Future Perspectives. *Nutrients*, 17(3), 455. <https://doi.org/10.3390/nu17030455>
30. Soliman A. M. (2020). Telemedicine in the Cardiovascular World: Ready for the Future?. *Methodist DeBakey cardiovascular journal*, 16(4), 283–290. <https://doi.org/10.14797/mdcj-16-4-283>
31. Kario K. (2020). Management of Hypertension in the Digital Era: Small Wearable Monitoring Devices for Remote Blood Pressure Monitoring. *Hypertension (Dallas, Tex. : 1979)*, 76(3), 640–650. <https://doi.org/10.1161/HYPERTENSIONAHA.120.14742>
32. Gill J. (2023). Implantable Cardiovascular Devices: Current and Emerging Technologies for Remote Heart Failure Monitoring. *Cardiology in review*, 31(3), 128–138. <https://doi.org/10.1097/CRD.0000000000000432>
33. Hajduczuk, A. G., Muallem, S. N., Nudy, M. S., DeWaters, A. L., & Boehmer, J. P. (2022). Remote monitoring for heart failure using implantable devices: a systematic review, meta-analysis, and meta-regression of randomized controlled trials. *Heart failure reviews*, 27(4), 1281–1300. <https://doi.org/10.1007/s10741-021-10150-5>
34. Joury, A., Bob-Manuel, T., Sanchez, A., Srinithya, F., Sleem, A., Nasir, A., Noor, A., Penfold, D., Bober, R., Morin, D. P., & Krim, S. R. (2021). Leadless and Wireless Cardiac Devices: The Next Frontier in Remote Patient Monitoring. *Current problems in cardiology*, 46(5), 100800. <https://doi.org/10.1016/j.cpcardiol.2021.100800>
35. Sodhi, N., Hameed, D., Barrack, R. L., Schneider, A. M., Bhave, A., & Mont, M. A. (2023). Use of Remote Physiologic and Therapeutic Monitoring Following Total Knee Arthroplasty. *Surgical technology international*, 42, 321–328. <https://doi.org/10.52198/23.STI.42.OS1681>
36. Ono, M., & Varma, N. (2018). Remote Monitoring for Chronic Disease Management: Atrial Fibrillation and Heart Failure. *Cardiac electrophysiology clinics*, 10(1), 43–58. <https://doi.org/10.1016/j.ccep.2017.11.005>
37. DuBord, A. Y., Paolillo, E. W., & Staffaroni, A. M. (2024). Remote Digital Technologies for the Early Detection and Monitoring of Cognitive Decline in Patients With Type 2 Diabetes: Insights From Studies of Neurodegenerative Diseases. *Journal of diabetes science and technology*, 18(6), 1489–1499. <https://doi.org/10.1177/19322968231171399>
38. Lu, H. Y., Ding, X., Hirst, J. E., Yang, Y., Yang, J., Mackillop, L., & Clifton, D. A. (2024). Digital Health and Machine Learning Technologies for Blood Glucose Monitoring and Management of Gestational Diabetes. *IEEE reviews in biomedical engineering*, 17, 98–117. <https://doi.org/10.1109/RBME.2023.3242261>

39. Richardson, K. M., Jospe, M. R., Bohlen, L. C., Crawshaw, J., Saleh, A. A., & Schembre, S. M. (2024). The efficacy of using continuous glucose monitoring as a behaviour change tool in populations with and without diabetes: a systematic review and meta-analysis of randomised controlled trials. *The international journal of behavioral nutrition and physical activity*, 21(1), 145. <https://doi.org/10.1186/s12966-024-01692-6>
40. Kędzierski, K., Radziejewska, J., Sławuta, A., Wawrzyńska, M., & Arkowski, J. (2022). Telemedicine in Cardiology: Modern Technologies to Improve Cardiovascular Patients' Outcomes-A Narrative Review. *Medicina (Kaunas, Lithuania)*, 58(2), 210. <https://doi.org/10.3390/medicina58020210>
41. Gerges, S., & Hallit, S. (2022). Pros and cons of telemedicine: implications in cardiology and cardiovascular medicine. *Future cardiology*, 18(11), 843–847. <https://doi.org/10.2217/fca-2022-0065>
42. Gruska, M., Aigner, G., Altenberger, J., Burkart-Küttner, D., Fiedler, L., Gwechenberger, M., Lercher, P., Martinek, M., Nürnberg, M., Pözl, G., Porenta, G., Sauermann, S., Schukro, C., Scherr, D., Steinwender, C., Stühlinger, M., Teubl, A., & Working Group Rhythmology of the Austrian Cardiological Society (2020). Recommendations on the utilization of telemedicine in cardiology. *Wiener klinische Wochenschrift*, 132(23-24), 782–800. <https://doi.org/10.1007/s00508-020-01762-2>
43. Iwaya, L. H., Ahmad, A., & Babar, M. A. (2020). Security and privacy for mHealth and uHealth systems: a systematic mapping study. *IEEE Access*, 8, 150081–150112. <https://doi.org/10.48550/arXiv.2006.12069>
44. Ftouni, R., AlJardali, B., Hamdanieh, M., Ftouni, L., & Salem, N. (2022). Challenges of Telemedicine during the COVID-19 pandemic: a systematic review. *BMC medical informatics and decision making*, 22(1), 207. <https://doi.org/10.1186/s12911-022-01952-0>
45. Kemp, M., Rising, K. L., Laynor, G., Miao, J., Worster, B., Chang, A. M., Monick, A. J., Guth, A., Esteves Camacho, T., McIntosh, K., Amadio, G., Shughart, L., Hsiao, T., & Leader, A. E. (2025). Barriers to telehealth uptake and use: a scoping review. *JAMIA open*, 8(2), ooaf019. <https://doi.org/10.1093/jamiaopen/ooaf019>
46. Ghadi, Y. Y., Shah, S. F. A., Waheed, W., Mazhar, T., Ahmad, W., Saeed, M. M., & Hamam, H. (2025). Integration of wearable technology and artificial intelligence in digital health for remote patient care. *Journal of Cloud Computing*, 14(1), 39. <https://doi.org/10.1186/s13677-025-00759-4>
47. Andrian, R., Müller, A., Solá, J. M. P., Ávila, I. M., & Gilligan, G. (2024). Development of a telemedicine network for early oral cancer diagnosis: the Argentine Patagonia experience—a perspective through a pilot study. *Exploration of Digital Health Technologies*, 2(5), 279-290. <https://doi.org/10.37349/edht.2024.00028>
48. Ortiz, B., Gupta, V., Kumar, R., Jalin, A., Cao, X., Ziegenbein, C., Singhal, A., Tewari, M., & Choi, S. (2024). Data preprocessing techniques for AI and machine learning readiness: Scoping review of wearable sensor data in cancer care. *JMIR mHealth and uHealth*, 12, e59587. <https://doi.org/10.2196/59587>
49. Barillaro, A., Feoli, C., Tramontano, A., Comerci, M., Caroprese, M., Cuocolo, R., Tamburis, O., Petrazzuoli, M., D'Arienzo, M. A., Farella, A., Oliviero, C., Clemente, S., Cella, L., Magliulo, M., Conson, M., & Pacelli, R. (2024). Fatigue trajectories by wearable remote monitoring of breast cancer patients during radiotherapy. *Scientific reports*, 14(1), 27276. <https://doi.org/10.1038/s41598-024-78805-5>
50. Farner, L., König, C., Rössler, J., Schneider, C., Wyss, J., Ammann, R. A., & Brack, E. (2025). Vital signs continuously monitored by two wearable devices in pediatric oncology patients, NCT04914702. *Scientific data*, 12(1), 807. <https://doi.org/10.1038/s41597-025-05081-x>
51. Goncalves Leite Rocco, P., Reategui-Rivera, C. M., & Finkelstein, J. (2024). Telemedicine applications for cancer rehabilitation: Scoping review. *JMIR Cancer*, 10, e56969. <https://doi.org/10.2196/56969>
52. Stuijt, D. G., et al. (2024). Remote patient monitoring using mobile health technology in cancer care and research: Patients' views and preferences. *JCO Clinical Cancer Informatics*, 8, e2400092. <https://doi.org/10.1200/CCI.24.00092>
53. Annunziata, C. M., Dahut, W. L., Willman, C. L., Winn, R. A., & Knudsen, K. E. (2024). Reflections on the state of telehealth and cancer care research and future directions. *JNCI Monographs*, 2024(64), 100–103. <https://doi.org/10.1093/jncimonographs/lgae008>
54. Cloß, K., Verket, M., Müller-Wieland, D., et al. (2024). Application of wearables for remote monitoring of oncology patients: A scoping review. *Digital Health*, 10. <https://doi.org/10.1177/20552076241233998>
55. Pappot, H., Steen-Olsen, E. B., & Holländer-Mieritz, C. (2024). Experiences with Wearable Sensors in Oncology during Treatment: Lessons Learned from Feasibility Research Projects in Denmark. *Diagnostics*, 14(4), 405. <https://doi.org/10.3390/diagnostics14040405>
56. Khani, P., Rostamnia, L., Jalali, R., Darabi, B., & Salari, N. (2025). The impact of smartphone-based wound follow-up on surgical site infection detection: A quasi-experimental study. *American journal of infection control*, S0196-6553(25)00577-2. Advance online publication. <https://doi.org/10.1016/j.ajic.2025.09.002>
57. Tchero, H., Tabue Teguo, M., Lannuzel, A., & Rusch, E. (2018). Telerehabilitation for Stroke Survivors: Systematic Review and Meta-Analysis. *Journal of medical Internet research*, 20(10), e10867. <https://doi.org/10.2196/10867>
58. Ferrari-Light, D., Geraci, T. C., Chang, S. H., & Cerfolio, R. J. (2020). Novel Pre- and Postoperative Care Using Telemedicine. *Frontiers in surgery*, 7, 596970. <https://doi.org/10.3389/fsurg.2020.596970>

59. Terada, T., Hausen, M., Way, K. L., O'Neill, C. D., Marçal, I. R., Dorian, P., & Reed, J. L. (2025). Wearable Devices for Exercise Prescription and Physical Activity Monitoring in Patients with Various Cardiovascular Conditions. *CJC open*, 7(5), 695–706. <https://doi.org/10.1016/j.cjco.2025.02.017>
60. Hertling, S., Loos, F. M., & Graul, I. (2021). Telemedicine as a Therapeutic Option in Sports Medicine: Results of a Nationwide Cross-Sectional Study among Physicians and Patients in Germany. *International journal of environmental research and public health*, 18(13), 7110. <https://doi.org/10.3390/ijerph18137110>
61. Lal, H., Mohanta, S., Kumar, J., Patralekh, M. K., Lall, L., Katariya, H., & Arya, R. K. (2022). Telemedicine-Rehabilitation and Virtual Reality in Orthopaedics and Sports Medicine. *Indian journal of orthopaedics*, 57(1), 7–19. <https://doi.org/10.1007/s43465-022-00766-6>
62. Pegoraro, N., Rossini, B., Giganti, M., Brymer, E., Monasterio, E., Bouchat, P., & Feletti, F. (2023). Telemedicine in Sports under Extreme Conditions: Data Transmission, Remote Medical Consultations, and Diagnostic Imaging. *International journal of environmental research and public health*, 20(14), 6371. <https://doi.org/10.3390/ijerph20146371>
63. Bowler, A. M., Whitfield, J., Marshall, L., Coffey, V. G., Burke, L. M., & Cox, G. R. (2022). The Use of Continuous Glucose Monitors in Sport: Possible Applications and Considerations. *International journal of sport nutrition and exercise metabolism*, 33(2), 121–132. <https://doi.org/10.1123/ijsnem.2022-0139>