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WEARABLES AND MEDICAL DEVICES: IMPACT ON SELF-CARE AND CHRONIC DISEASE MONITORING

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ABSTRACT
Wearables and medical devices have been widely adopted in healthcare, especially in the continuous monitoring of patients with chronic diseases and in the promotion of self-care. These devices offer an innovative solution for collecting physiological data in real time, allowing for early and personalized interventions. This integrative review investigated the effectiveness of wearables in different medical specialties, such as cardiology, neurology, endocrinology, mental health, among others. Studies published between 2016 and 2024, from renowned databases such as PubMed, Google Scholar, and IEEE Xplore, were analyzed. The results indicate that these devices have shown significant benefits, such as the early detection of cardiac arrhythmias, glucose monitoring in diabetic patients, and the

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monitoring of symptoms in neurological conditions such as Parkinson's and epilepsy. In addition, mental health-focused devices, such as those that monitor sleep patterns and heart rate variability, have been shown to be effective in diagnosing and managing disorders such as anxiety and depression. However, the review also pointed to persistent challenges, such as the accuracy of the data collected, issues related to information privacy and security, and the high cost of the devices, which limit their accessibility to all layers of the population. The need for standardization and regulation of these devices is also a barrier to their large-scale adoption, although technological advances and integration with artificial intelligence may enhance their clinical applications in the future.

Keywords: Wearables. Medical Devices. Self-care. Remote Monitoring. Chronic Diseases. Digital Health.

INTRODUCTION

In recent decades, the advancement of technology in healthcare has played a crucial role in transforming medical care models. The increasing digitalization of medicine and the introduction of smart devices are providing new possibilities for continuous health monitoring and chronic disease management. Among these innovations, wearables and connected medical devices stand out, which allow the collection of physiological data in real time, offering patients and health professionals valuable information for personalized clinical management.

The increasing incidence of chronic non-communicable diseases (NCDs), such as diabetes, hypertension, and cardiovascular diseases, represents one of the greatest challenges of global public health. According to the World Health Organization (WHO), NCDs are responsible for approximately 74% of deaths in the world (WHO, 2022). Given this scenario, solutions that favor treatment adherence and the prevention of complications are essential to improve the quality of life of patients and reduce the burden on health systems.

Wearable devices, such as smartwatches, continuous blood glucose sensors, and blood pressure monitors, emerge as promising tools to empower individuals in self-care, promoting engagement in their own health, and enabling early interventions. In addition, connected medical devices, which allow data to be transmitted directly to healthcare professionals, make remote monitoring a reality, enabling faster therapeutic adjustments and reducing the need for face-to-face visits.

This study sought to analyze the impact of wearable devices and medical devices on promoting self-care and monitoring chronic diseases. The research evaluates the effectiveness, benefits, and limitations of these technologies, considering their role in improving treatment adherence, early detection of complications, and reducing hospitalizations.

The aging population and the high prevalence of chronic diseases reinforce the need for innovative solutions that improve health management. Digital technologies have the potential to revolutionize the approach to care, promoting greater autonomy for patients and improving communication between doctors and individuals. Previous studies indicate that wearable devices can reduce hospitalizations, optimize clinical follow-up, and positively impact quality of life (Baig et al., 2019). However, there are still challenges related to accessibility, data accuracy, adherence to use, and information security, all of which need to be analyzed to maximize the benefits of these technologies.

THEORETICAL FRAMEWORK

Wearable devices represent a revolution in healthcare by enabling the continuous collection of physiological data, providing remote monitoring, early interventions, and greater adherence to treatment in various chronic conditions (Piwek et al., 2016). These technologies include smartwatches, wearable sensors, glucose monitors, oximeters, and portable electrocardiogram (ECG) devices, which support both the prevention and monitoring of diseases.

APPLICATIONS IN CARDIOLOGY

Wearables play an increasing role in cardiovascular monitoring, particularly in detecting arrhythmias and assessing heart rate. Devices such as the Apple Watch, Fitbit, and KardiaMobile use ECG sensors to detect atrial fibrillation (AF) and other heart abnormalities, allowing for early identification and reducing the risk of serious complications such as stroke.

A study published in the New England Journal of Medicine revealed that the Apple Watch, when integrated with a heart monitoring app, was able to identify episodes of atrial fibrillation in asymptomatic patients with high accuracy, allowing for medical interventions before severe complications occurred (Perez et al., 2019). According to Guo et al. (2021), wearables can be used in cardiovascular rehabilitation, helping post-infarction patients to monitor physical activity levels, blood pressure, and heart rate variability, essential factors for recovery and prevention of new cardiovascular events.

APPLICATIONS IN ENDOCRINOLOGY

In the treatment of diabetes mellitus, continuous glucose sensors, such as the FreeStyle Libre and Dexcom G6, have revolutionized blood glucose monitoring, allowing patients to access their blood glucose levels in real time, without the need for frequent finger. For Peters et al. (2018), these devices enable more precise adjustment of insulin therapy and better metabolic control, reducing risks of hypoglycemia and hyperglycemia.

In addition, a study by the American Diabetes Association (ADA) highlighted that the use of these sensors significantly reduces severe hypoglycemia events and hospitalizations in patients with type 1 and type 2 diabetes. The integration of these devices with artificial intelligence applications, according to Charleer et al. (2018), also makes it possible to predict glycemic patterns and alert patients to critical variations, improving treatment adherence and promoting greater independence in self-care.

APPLICATIONS IN NEURODEGENERATIVE AND NEUROLOGICAL DISEASES

Wearable devices have also been used in the monitoring of neurodegenerative diseases, such as Parkinson's and Alzheimer's, and in neurological conditions such as epilepsy. In Parkinson's disease, wearable sensors monitor tremors, stiffness, and movement patterns, assisting physicians in assessing disease progression and personalizing drug treatment. According to Espay et al. (2020), these devices are able to quantify motor oscillations and identify levodopa-induced episodes of dyskinesia, allowing for more precise therapeutic adjustments.

In the treatment of epilepsy, wearables such as the Empatica E4 are designed for seizure detection, monitoring physiological signals such as variations in skin conductance and heart rate. These devices for Beniczky et al., (2021), enable automatic alerts for caregivers and health professionals, allowing rapid interventions and reducing the risk of serious complications, such as status epilepticus.

In the case of Alzheimer's and other dementias, wearable devices assist in tracking patterns of activity, location, and sleep quality, making it easier to monitor patients with cognitive decline. For Kourtis et al. (2019), some devices use artificial intelligence to predict nocturnal agitation and ambulation patterns, allowing caregivers to act preventively.

APPLICATIONS IN MENTAL HEALTH

The impacts of wearables on mental health have been widely studied, with a focus on monitoring disorders such as anxiety, depression, and insomnia. Devices that analyze sleep patterns, stress levels, and heart rate variability (HRV) demonstrate potential to aid in the diagnosis and treatment of psychiatric disorders. Adams et al. (2020), suggest that HRV analysis can be used as a biomarker for anxiety disorders and depression, since individuals with these conditions often have dysfunction in the autonomic nervous system.

Studies also indicate that sleep monitoring through devices such as the Oura Ring and Fitbit Sense can provide valuable insights into depression-related sleep disorders and post-traumatic stress disorder (PTSD). For Luik et al. (2017), the detection of irregular patterns in sleep can lead to earlier interventions, helping to adjust behavioral and pharmacological therapies.

CHALLENGES AND LIMITATIONS

Despite the numerous benefits of wearables in healthcare, there are challenges and limitations that must be considered to maximize their effectiveness and adherence. Some of the main challenges include: Studies show that some devices have significant margins of error, especially under conditions of use outside the laboratory environment (Bent et al., 2020). Although technology has advanced, many devices are still expensive, limiting their access to low-income populations.

The collection and storage of sensitive information raises concerns about data leakage and compliance with privacy protection regulations, such as the LGPD (General Data Protection Law) in Brazil and the GDPR in the European Union (Mittelstadt, 2019). According to Patel et al. (2021), the acceptance of devices by patients depends on factors such as comfort, usability, and integration with lifestyle, and the development of intuitive and user-friendly interfaces is essential.

FUTURE PROSPECTS

The future of wearable devices in healthcare is directly linked to integration with artificial intelligence (AI), machine learning, and telemedicine. The development of more sophisticated algorithms will allow for more accurate predictive analytics, enabling early diagnoses and personalized recommendations.

In addition, for Wang et al. (2022), the combination of wearables with technologies such as the Internet of Things (IoT) and big data has the potential to transform the medical care model, allowing continuous and preventive monitoring, reducing hospital costs and improving clinical outcomes.

As these technologies evolve and become more accessible, wearable and medical devices will play an increasingly relevant role in promoting health, managing chronic diseases, and personalizing treatments.

METHODOLOGY

This study consists of an integrative review conducted in accordance with the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), ensuring transparency and methodological rigor in the selection, evaluation, and synthesis of the included studies. The search was carried out in the PubMed, Google Scholar and IEEE Xplore databases, as they are widely recognized in the area of health and technology, ensuring access to relevant and up-to-date studies. Descriptors in Portuguese and English were used, combined using Boolean operators (AND, OR) to increase the sensitivity of the search. Key terms included "wearable devices AND chronic disease monitoring," "smartwatches AND patient adherence AND hospitalization," "continuous glucose monitoring AND chronic illness," and "remote monitoring AND cardiovascular disease AND wearable technology." The research covered articles published between 2016 and 2024, considering the recent evolution of wearable devices and their application in clinical practice.

The inclusion criteria adopted were: studies published in the delimited period, peer-reviewed research on wearable devices in the monitoring of chronic diseases, investigations that evaluated the effectiveness of the devices in adherence to treatment and in reducing hospitalizations, articles available in Portuguese, English, or Spanish, and clinical trial, cohort, case-control studies, or systematic reviews with detailed methodology. The exclusion criteria included duplicate articles between databases, studies with very small samples (n < 30), narrative reviews without clear methodology, studies that addressed non-wearable devices or that did not focus on monitoring chronic diseases, as well as case reports, editorials, dissertations, theses, and publications without peer review.

The selection of studies occurred in three stages. Initially, the articles were identified by importing them into the Mendeley® reference manager, and duplicates were automatically removed. Next, the screening was carried out through the analysis of the titles and abstracts, excluding those that did not meet the inclusion criteria. Finally, the selected articles were read in full, and the eligibility criteria were rigorously applied. The analysis was conducted by two independent reviewers, and in case of divergence, a third reviewer was consulted to ensure consensus.

Data extraction was performed using a standardized form, including information on study identification (authors, year, title, and journal), methodological characteristics (type of study, sample size, duration of follow-up), specifications of the wearable devices used (monitored parameters, integration with digital platforms), main outcomes (treatment adherence, reduction of hospitalizations, and clinical efficacy), and main reported conclusions by the authors.

To ensure the methodological quality of the included studies, validated risk of bias assessment tools were used. Randomised controlled trials were analysed using the Cochrane Risk of Bias (RoB 2.0), observational studies were assessed using the Newcastle-Ottawa Scale (NOS), and systematic reviews were graded using the AMSTAR 2 tool. The studies were categorized into three levels: low risk of bias (high quality), moderate risk of bias (acceptable quality) and high risk of bias (low quality), and studies considered to be of low quality could be excluded from the analysis.

The results were synthesized in tables to facilitate quantitative and qualitative comparison. The narrative synthesis described the main findings regarding the effectiveness of wearable devices in adhering to treatment and reducing hospitalizations.

Where possible, studies with similar outcomes were pooled to facilitate comparison of results and identify patterns or discrepancies.

Some limitations were acknowledged, including publication bias, since studies with positive results are more likely to be published, methodological heterogeneity among studies, which may hinder direct comparisons, restriction to articles published in Portuguese, English, and Spanish, excluding potential evidence in other languages, and the exclusion of studies with small samples, which, despite the statistical limitation, they could contain relevant information.

This methodology sought to ensure scientific rigor and transparency in the analysis of the impact of wearable devices on the monitoring of chronic diseases, contributing to the evidence base on their efficacy and clinical feasibility.

RESULTS AND DISCUSSIONS

The studies analyzed demonstrate that wearable devices have significant benefits in the management of several chronic conditions, contributing to continuous monitoring, early detection of complications, and adherence to treatment.

CARDIOLOGY

Wearable devices have been widely used in the early detection of cardiac arrhythmias, especially atrial fibrillation, allowing for early interventions and reducing cardiovascular complications such as stroke. Studies show that the use of wearable heart monitors, such as the Apple Watch and Fitbit, enables continuous monitoring of heart rate, identifying irregularities that could go unnoticed in sporadic exams. A study conducted by Steinhubl et al. (2017) revealed that the integration of wearable devices with mobile apps allows for personalized adjustment of medications, reducing hospitalizations and optimizing the treatment of cardiovascular diseases.

In addition, remote blood pressure monitoring has been explored as a strategy for the prevention of hypertensive events, reducing the need for face-to-face consultations and promoting the proactive management of hypertension. However, Zhang et al. (2021), point out that the accuracy of wearable sensors can still be a limiting factor, especially when compared to conventional sphygmomanometers.

ENDOCRINOLOGY

In the field of endocrinology, wearable devices have revolutionized the approach to type 1 and type 2 diabetes mellitus. Continuous glucose monitors (CGMs), such as the

FreeStyle Libre and Dexcom G6, allow for real-time measurement of blood glucose levels, eliminating the need for multiple finger throughout the day. Studies, such as the one by Fokkert et al. (2019), demonstrate that the use of these devices reduces hypoglycemic episodes and improves the stability of glycemic control, favoring a better quality of life for patients.

In addition, the integration of wearables with smart insulin pumps has made it possible to implement automated glycemic control systems, known as artificial pancreas, which continuously adjust insulin delivery based on real-time blood glucose data. However, challenges such as the high cost of these devices and limited accessibility in some health systems still represent barriers to their widespread adoption.

NEUROLOGY

In neurology, wearable sensors have demonstrated high efficacy in the follow-up of patients with Parkinson's disease, allowing the detection of tremors and changes in gait. For Bray et al. (2021), such devices enable a continuous analysis of the patients' motor pattern, helping to personalize drug treatment and assess disease progression.

In addition, wearables have been used in the monitoring of epileptic seizures, allowing the automatic detection of seizures through the analysis of physiological signs such as electrodermal activity and heart rate. These devices help physicians and caregivers identify triggering factors and adjust antiepileptic medications, contributing to the reduction of seizure frequency and better patient safety.

MENTAL HEALTH

Studies indicate that wearable devices that monitor sleep patterns, heart rate variability, and physical activity levels can be useful in diagnosing and treating mental disorders such as anxiety and depression. The analysis of physiological patterns associated with stress allows a more accurate assessment of the patient's emotional state, which according to Garcia-Ceja et al. (2018), enables personalized interventions, such as the recommendation of relaxation techniques or therapeutic adjustments.

In addition, the use of wearables in sleep regulation has been explored as a tool for improving the quality of rest, especially in patients with insomnia disorders and stress-related sleep disorders. Some research suggests that the correlation between sleep patterns and mental health can help in the early identification of signs of relapse in psychiatric disorders, enabling preventive interventions.

CHALLENGES AND LIMITATIONS

Despite the numerous benefits, the use of wearable devices in healthcare faces important challenges. One of the main obstacles is the accuracy of the data collected, as some measurements can be influenced by environmental factors, improper device placement, or individual user characteristics (Zhang et al., 2021). In addition, the lack of regulation and standardization of wearables in different countries raises questions about their clinical reliability and their acceptance by healthcare systems.

Another critical factor is the interoperability of devices, as many wearable technologies use proprietary platforms that do not allow integration with electronic medical record systems, making clinical use and large-scale adoption difficult. Data privacy and security issues also pose significant challenges, especially considering that wearables collect large volumes of sensitive information about patients.

Therefore, for wearable devices to be widely adopted in clinical practice, it is critical to develop stricter regulations, improve measurement accuracy, and efficiently integrate with existing healthcare systems. Despite the limitations, wearables have transformative potential in the management of chronic diseases, offering new perspectives for more personalized, accessible, and preventive care.

CONCLUSION

Wearable and medical devices represent a significant innovation in chronic disease management, providing benefits such as continuous monitoring, increased treatment adherence, and personalization of care. The ability of these devices to collect physiological data in real time allows for early interventions, enabling more effective therapeutic adjustments and reducing complications associated with various pathologies, such as cardiovascular disease, diabetes, neurological disorders, and mental disorders. In addition, the integration of wearables with digital platforms favors a more proactive and patient-centered approach, promoting greater autonomy and quality of life.

However, important challenges still need to be overcome for these technologies to be widely adopted in clinical practice. The reliability of the data collected remains a critical factor, as the accuracy of wearable sensors can be influenced by environmental factors, individual variations, and improper placement of devices. Additionally, the lack of regulation and standardization makes it difficult for wearables to be accepted as reliable medical tools, limiting their implementation in both public and private healthcare systems. The high cost of some devices also represents an obstacle, restricting their access to more vulnerable populations.

From the point of view of data privacy and security, the collection and storage of sensitive information by wearables raises ethical concerns and demands stricter regulations to ensure the protection of users. The interoperability of devices with electronic medical records and hospital systems is still a challenge, making it difficult to integrate the collected data with conventional medical practice.

This study had some limitations. First, the research was based on a systematic review, which implies dependence on the data and methodologies described in the studies analyzed. In addition, variation in the quality and scope of the included studies may have influenced the interpretation of the results. Another limitation is that the rapid technological evolution of wearables can make some of the conclusions quickly outdated, requiring continuous monitoring of innovations and new scientific validations.

Given the potential impact of wearable devices on healthcare, future studies should explore strategies to improve sensor accuracy and ensure better standardization of devices. Research that evaluates the economic impact of the adoption of wearables in reducing hospitalizations and medical costs is essential to justify investments in these technologies.

Additionally, longitudinal studies can provide more robust evidence on the long-term effects of wearables on patients' health. Another promising line of research involves the integration of wearables with artificial intelligence and machine learning, allowing the creation of more accurate algorithms for early detection of diseases and personalization of treatment.

Finally, research focused on the acceptance of wearables by patients and healthcare professionals is key to understanding the challenges of adherence and the cultural and institutional barriers that can hinder their implementation. The development of clearer regulations and guidelines for the clinical use of these technologies should also be a major focus for future studies.

Thus, despite the challenges, wearable devices have transformative potential in modern medicine, promoting more personalized, preventive, and efficient care. With technological advancements, proper regulations, and increased accessibility, these tools can revolutionize the way chronic diseases are monitored and treated, significantly improving the quality of life for patients.

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