Chapter 2
Artificial Intelligence in Chronic Pain Management

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ABSTRACT

Chronic pain affects over 20% of the global population, causing significant physical, psychological, and socioeconomic impacts. Conventional pain management methods often fail to address its complexity and variability. Artificial Intelligence (AI) presents a transformative opportunity by leveraging advanced algorithms to analyze diverse data, enhance diagnostic accuracy, enable objective pain assessment, and personalize treatment. AI technologies, such as machine learning, deep learning, and wearable devices, facilitate real-time monitoring, predictive modeling, and tailored interventions. Applications include facial expression analysis, biometric data evaluation, and digital patient support tools. Despite challenges like data inconsistency, ethical concerns, and technical limitations, advancements in data integration, explainable AI, and regulatory frameworks are set to enhance AI's role in chronic pain management, promoting more effective, equitable, and patient-centered care.

INTRODUCTION

Chronic pain is a widespread and intricate condition that significantly impacts individuals, healthcare systems, and societies worldwide. Unlike acute pain, which serves a protective role, chronic pain persists beyond its biological purpose, resulting in profound physical, emotional, and social challenges. Addressing this multifaceted issue necessitates innovative and effective strategies that surpass traditional methods. Artificial Intelligence (AI) represents a groundbreaking opportunity in this context, introducing advanced tools and methodologies to revolutionize chronic pain management. By harnessing its capacity for data analysis, pattern recognition, and personalized intervention, AI holds the potential to transform the way chronic pain is diagnosed, treated, and ultimately prevented, improving patient outcomes and empowering healthcare professionals.

Definition and Significance of Chronic Pain

Chronic pain is one of the greatest challenges of modern medicine. It is defined as pain that lasts beyond the typical recovery period or for more than three to six months, depending on the cause and context. While acute pain serves as a warning mechanism for tissue damage, chronic pain loses its biological usefulness, turning the body into a continuous "transmitter" of pain signals (Treede et al, 2019).

The significance of chronic pain extends beyond the individual, affecting families, communities, and healthcare systems. The significance of chronic pain, extends beyond the individual; impacting families, communities, and healthcare systems. Conditions such as fibromyalgia, arthritis, neuropathic pain, and chronic lower back disorders are merely examples of pathologies characterized by persistent symptoms (Smith & Torrance, 2012). For patients, this pain is associated with limited mobility, loss of autonomy, and deteriorating mental health.

Epidemiological Data and Socioeconomic Impacts

According to the World Health Organization (WHO), chronic pain affects over 20% of the global population, with a significant burden on vulnerable groups such as the elderly, women, and those in countries with insufficient healthcare services. In Europe, approximately 80 million people live with chronic pain, 34% of whom report that their daily life is "unbearable" (Hagen et al., 2020).

The socioeconomic impacts are equally dramatic:

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