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Review Article

Artificial Intelligence in Ayurveda: A Comprehensive Review of Trends and Applications Abhijeet Kumar¹, Popu Ram², Ashwini Kumar Kushwaha^{3*}, Ambrish Kumar Singh⁴

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Ayurveda, the traditional Indian system of medicine, emphasizes holistic health management through personalized diagnosis and treatment based on individual constitution (Prakriti) and disease characteristics (Vikriti). The integration of Artificial Intelligence (AI) in Ayurveda has emerged as a promising approach to enhance diagnostic accuracy, optimize treatment strategies, and facilitate predictive healthcare. AI techniques, including machine learning, natural language processing, and expert systems, are being utilized to analyse complex Ayurvedic texts, patient data, and clinical outcomes. These technologies can identify patterns and correlations that are often challenging to discern through conventional methods, enabling more precise recommendations for herbal formulations, lifestyle modifications, and Panchakarma therapies. Additionally, AI-driven platforms support decision-making for practitioners by providing real-time insights, reducing human error, and enabling remote healthcare delivery. The application of AI in Ayurveda also extends to drug discovery, disease prediction, and validation of traditional therapies through evidence-based research. Despite these advancements, challenges such as data standardization, limited digitalization of Ayurvedic records, and integration of AI tools with traditional practices remain significant. Ethical considerations, patient privacy, and interpretability of AI models are also critical concerns that must be addressed. This review summarizes current research trends, applications, and limitations of AI in Ayurveda, highlighting its potential to revolutionize personalized healthcare and bridge the gap between traditional wisdom and modern technology. Future research should focus on developing robust AI frameworks tailored to Ayurvedic principles, promoting digitization of classical texts, and validating AI-assisted interventions through clinical trials to ensure safe and effective integration into mainstream healthcare.

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Introduction

Ayurveda is an ancient medical system with a history of 5,000 years. The major role of Ayurveda is to maintain balance among the Doshas (Vata, Pitta, and Kapha) through various treatments, including herbal medicines, lifestyle modifications, therapies, and dietary recommendations. In the present time, the world is rapidly developing in the field of technology, particularly Artificial Intelligence (AI). Almost every sector is embracing and adopting AI. Artificial Intelligence has permeated nearly every area of human endeavour and has revolutionized industries, transforming the way we live, work, and interacts with the world around us [1]. The Global Strategy on Digital Health 2020–2025 by the World Health Organization (WHO) emphasizes the growing role of Artificial Intelligence (AI) in strengthening healthcare systems through a wide range of applications. The strategy focuses on meeting the needs of patients, healthcare professionals, service providers, and the broader healthcare industry, with the aim of empowering individuals and advancing the goal of universal health coverage [2]. Although the concept of artificial intelligence originated in the 1950s, its capability to significantly influence and transform global healthcare has become much more apparent in recent years.

Ayurveda is a comprehensive and holistic medical system that has its origins in ancient India. In Ayurveda, the diagnosis and treatment of diseases are traditionally performed through classical methods such as Roga Pariksha and Rogi Pariksha, including Nadi Pariksha (pulse diagnosis). Ayurveda emphasizes personalized and holistic healthcare that is tailored to an individual's unique constitution and Dosha imbalances. Traditionally, Ayurvedic practitioners rely on their clinical observations, knowledge, and experience to diagnose and treat patients. The integration of Artificial Intelligence (AI) into Ayurveda has the potential to streamline and optimize various healthcare processes, resulting in more accurate, personalized, and effective treatments, as well as improved disease prevention. AI-driven tools can also assist in the discovery of new herbal formulations and their therapeutic applications, thereby expanding the scope of Ayurvedic treatments. Furthermore, the incorporation of AI in Ayurveda is transforming the way practitioners diagnose, treat, and manage a wide range of health conditions. AI has the potential to bring significant advancements in multiple sectors and can play a crucial role in the development of Ayurveda [3].

Material and Methods

A comprehensive literature search was performed to identify relevant studies and articles on the integration of AI with Ayurveda. This search encompassed databases such as PubMed, Google Scholar, and other pertinent journals. The retrieved data were systematically analysed to provide an extensive overview of the topic.

Artificial Intelligence

The Council on AI of the Organization for Economic Cooperation and Development (OECD) describes an AI system as a machine-based system designed to achieve human-defined objectives by generating predictions, recommendations, or decisions that affect real or virtual environments [4]. Artificial Intelligence (AI) refers to software technologies that possess at least one of the following capabilities: perception including audio, visual, textual, and tactile sensing (e.g., face recognition); decision-making (e.g., medical diagnostic systems); prediction (e.g., weather forecasting); automatic knowledge extraction and pattern recognition from data (e.g., identifying fake news networks on social media); interactive communication (e.g., social robots or chatbots); and logical reasoning (e.g., developing theories from given premises) [5].

Aim of Artificial Intelligence in Ayurveda

The application of Artificial Intelligence (AI) in Ayurveda is gradually increasing as modern healthcare systems continue to adopt advanced technologies. Efforts are being made to integrate AI with traditional medical systems such as Ayurveda. In the Ayurvedic context, three primary sources of data collectively referred to as trisutra can facilitate the use of AI. These include human physiological data, Ayurvedic treatment-related data, and disease-related information.

AI-based Identification of Prakriti.

Artificial intelligence is being used to identify an individual's Prakriti (body constitution) in Ayurveda. A study titled "Predicting Ayurveda-Based Constituent Balancing in Human Body Using Machine Learning Methods" successfully trained models to determine Prakriti. The performance of different algorithms was evaluated using metrics such as RMSE, precision, recall, F-score, and accuracy. Among them, the Cat Boost model

with hyper parameter tuning delivered the best performance, achieving an accuracy of 0.95. [6]

Personalized Treatment

Personalized treatment is an important aspect of Ayurveda, where therapies are designed according to an individual's constitution and bodily balance. An important consideration is whether Ayurvedic treatments can be customized to suit each patient's unique constitution. A secondary outcome measure evaluates whether such personalized approaches lead to better therapeutic results consistent with Ayurvedic principles. Ayurveda emphasizes that every person is unique, and therefore treatment should be adapted to meet individual requirements. AI-based systems can examine patient data, genetic details, and lifestyle patterns to generate treatment recommendations in line with Ayurvedic concepts [7]. This method helps practitioners design therapies that correspond to an individual's constitution (Prakriti) and existing imbalances (Vikriti). The findings suggest that AI-supported analysis can facilitate the development of personalized treatment strategies, thereby encouraging individualized patient care.

AI-driven Ayurveda Start-ups

Several emerging start-ups are combining artificial intelligence with Ayurveda to offer personalized healthcare solutions. One prominent example is Nirog Street, a technology-based platform that blends AI with Ayurvedic knowledge to deliver customized wellness recommendations. By analysing user data such as health conditions, lifestyle habits, and even genetic information, its AI system suggests tailored Ayurvedic treatments, including herbal formulations, dietary plans, and lifestyle changes [8]. Another notable company is CureMetrix, which initially focused on AI-driven medical imaging but has expanded its capabilities to analyze patient data for preventive and holistic healthcare approaches, incorporating Ayurvedic principles [9]. These examples highlight how AI can strengthen and personalize Ayurvedic therapies, making them more effective and accessible to a global population.

Integrating with Modern Medicine

AI can integrate therapeutic programs with traditional medical therapies, ensuring a comprehensive approach to patient care. By combining ideas from Ayurveda and modern medicine, AI can create well-rounded treatment strategies that take into account every aspect of a patient's

health. This cross-disciplinary integration gives an equitable approach to healthcare, boosting the general efficacy and personalization of treatment approaches. [10]

Ayurveda-Tech Collaborations

There are considerable collaborations between digital businesses and Ayurvedic institutes aimed at developing cutting-edge artificial intelligence apps for traditional treatment. By incorporating with AI ventures in health sector like IBM Watson Health, Deep Genomics, in silico Medicine etc., Ayurvedic institutions can develop novel and innovative ways to validate and test efficacy of Ayurvedic treatments, and aiding in global acceptance of Ayurveda. Similarly, Google Research India has teamed with Ayurvedic institutions to apply machine learning to investigate the effectiveness of traditional remedies and integrate these discoveries into modern healthcare systems [11].

NLP-Based Text Analysis

Classical Ayurvedic texts are primarily written in Sanskrit, which makes them challenging for modern practitioners and researchers to interpret and analyze. Natural Language Processing (NLP) can be applied to these ancient texts to facilitate their analysis and understanding. By processing Sanskrit and other traditional languages, NLP can help extract meaningful insights, enable accurate translation, and make traditional Ayurvedic knowledge more accessible to a wider audience. [12]

Medicinal Plant Identification

Accurate identification of medicinal plants remains a significant challenge in Ayurveda. Due to misidentification, the issue of drug adulteration has increased in the market, leading to various controversies in recent times. Although AI-based tools like Google Lens and similar applications can assist in plant identification to some extent, they are not yet fully reliable. Traditional identification methods mainly depend on manual observation, which is time-consuming, labour-intensive, requires expert knowledge, and is prone to human error. With the growing global demand for Ayurvedic products, ensuring the authenticity and quality of herbs has become crucial. AI-powered image recognition technologies can transform the identification process of medicinal plants. Additionally, techniques such as DNA analysis and spectral profiling enable AI systems to detect unique genetic and chemical fingerprints of each herb, ensuring precise identification and detecting adulterants.

Moreover, AI systems using Natural Language Processing (NLP) can extract relevant information from ancient Ayurvedic texts, further supporting the accurate recognition and classification of medicinal plants [12].

Diagnosis

In traditional Ayurveda, diagnosis is primarily based on the practitioner's expertise, clinical experience, and keen observation of the patient. However, the integration of Artificial Intelligence (AI) can significantly strengthen and modernize this diagnostic approach. AI has the potential to play a vital role in enhancing diagnostic accuracy within Ayurveda. Ayurvedic diagnosis typically involves a comprehensive assessment of an individual's Dosha (Vata, Pitta, Kapha), Prakriti (body constitution), and other clinical examinations such as pulse (Nadi Pariksha), tongue, and eye analysis [13]. With the help of machine learning and deep learning techniques, AI can process and interpret large volumes of data derived from these diagnostic methods. For example, AI systems can be trained to detect subtle patterns in pulse diagnosis that may not be easily perceived by human senses [14]. Similarly, image recognition technologies can assist in analyzing tongue and eye features to identify abnormalities and possible Dosha imbalances. This integration leads to more precise and early diagnosis, ultimately improving treatment effectiveness. Furthermore, AI can continuously track changes in Dosha imbalance and Vikriti (diseased state), thereby aiding in predicting the course and outcome of diseases, which enhances the accuracy of prognosis.

Preventive care & Health Monitoring

Ayurveda strongly focuses on prevention by promoting a balanced and healthy lifestyle to stop diseases before they develop. Artificial Intelligence can support this preventive approach by continuously tracking and evaluating an individual's daily habits, environmental influences, and genetic tendencies using wearable technologies and home-based monitoring systems. AI is capable of analysing real-time health data and providing instant feedback. When combined with Ayurvedic principles, this technology can generate personalized recommendations related to diet, physical activity, stress management, herbal remedies, and overall lifestyle changes. Such an integrated approach helps in maintaining holistic well-being and minimizing the risk of chronic illnesses. [12]

Discussion

Artificial Intelligence (AI) is emerging as a powerful tool in transforming Ayurveda by integrating traditional knowledge with modern computational techniques. The aim of AI in Ayurveda is to enhance accuracy, accessibility, and efficiency while preserving the holistic and personalized nature of this ancient system. AI seeks to support practitioners in diagnosis, treatment planning, drug discovery, and preventive healthcare, thereby bridging the gap between traditional wisdom and contemporary medicine. One of the most significant applications is identifying Prakriti (body constitution). AI models can analyse physical characteristics, genetic data, lifestyle habits, and clinical parameters to classify individuals into Vata, Pitta, or Kapha types. This reduces subjectivity and improves consistency in assessment, which is essential for effective Ayurvedic treatment. AI also plays a crucial role in personalized Ayurvedic treatment. By integrating patient-specific data such as diet, environment, medical history, and behavioural patterns, AI can generate customized recommendations for herbal medicines, dietary plans, and lifestyle modifications. This aligns closely with Ayurveda's individualized approach to healthcare. In recent years, several start-ups integrating AI and Ayurveda have emerged, developing platforms for digital consultations, automated Prakriti analysis, and AI-driven wellness recommendations. These innovations are making Ayurvedic healthcare more accessible and scalable, especially in remote and underserved areas. The integration with modern medicine is another important trend. AI enables the combination of Ayurvedic principles with biomedical data, fostering an integrative healthcare model. This approach can improve diagnosis, treatment outcomes, and patient monitoring by leveraging the strengths of both systems. AI-powered textual analysis using Natural Language Processing (NLP) is helping decode ancient Ayurvedic texts. By digitizing and interpreting classical literature, NLP makes traditional knowledge more accessible for research, validation, and clinical application, ensuring that valuable insights are preserved and utilized effectively. In the domain of medicinal plant recognition and identification, AI tools such as image recognition systems assist in accurately identifying herbs and detecting adulteration. This improves the quality and safety of Ayurvedic medicines, addressing a long-standing challenge in the field. AI is also enhancing diagnosis by analysing complex datasets, including patient symptoms, imaging, and clinical history. It supports practitioners in making

informed decisions and improves the accuracy and speed of disease detection. Furthermore, AI contributes significantly to preventive measures and health monitoring, which are central to Ayurveda. Wearable devices and health-tracking systems can continuously monitor physiological parameters and provide real-time insights. Based on this data, AI can suggest preventive strategies related to diet, exercise, stress management, and daily routines, promoting long-term wellness. Despite these advancements, challenges such as lack of standardized data, variability in individual treatments, ethical concerns (data privacy and transparency), and the need for validation of AI models remain significant. Maintaining the balance between technological support and traditional clinical expertise is essential.

Conclusion

Artificial Intelligence has immense potential to revolutionize Ayurveda by enhancing diagnostic accuracy, enabling precise Prakriti identification, supporting personalized treatments, and strengthening preventive healthcare. It also facilitates the preservation and analysis of classical texts, improves medicinal plant identification, and promotes integration with modern medical systems. However, the success of AI in Ayurveda depends on overcoming key challenges, including data standardization, ethical considerations, and scientific validation. It is crucial to ensure that AI complements rather than replaces the experiential knowledge of Ayurvedic practitioners. With continued research, interdisciplinary collaboration, and responsible implementation, AI can play a transformative role in advancing Ayurveda and making it a more effective, accessible, and globally relevant healthcare system.

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