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RESEARCH ARTICLE

REWRITING THE ADDICTION NARRATIVE THROUGH ARTIFICIAL INTELLIGENCE IN THE PREDICTION, SCREENING, AND TREATMENT OF SUBSTANCE USE DISORDERS AND BEHAVIOURAL ADDICTION

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Key words:-
Artificial Intelligence (Al), Machine Learning (ML), Substance Use Disorders (SUD)

Abstract

Background: Substance Use Disorders (SUD's) and Behavioural Addic tion are intricately related constructs that shed light on the coherent conceptual paradigm of addiction science which involve a shared patho logical disruption of neural mechanisms. SUD is a medical, psychiatric condition defined as a pattern of substance use leading to clinically significant impairment, characterized by compulsive consumption, and continued use despite harmful consequences. Behavioural addiction involves a compulsion to engage in a rewarding non drug - related behavior despite any negative consequences to the person's physical, mental, social, financial well-being. The use of artificial intelligence in the treatment, understanding of SUD and behavioral addictions is a pivotal advancement in the new era of data - driven therapeutic innovation.

Objective: This review synthesizes existing empirical studies examinin g the use of Al-based tools such as machine learning models, mobile health applications, and digital therapeutics in SUD care along with the advancements in clinical theories offering a foundation for more coherent development, evaluation along with possible uses and the challenges implementation of Al-supported interventions for SUDs and behavioural addiction.

Methods: A systematic search of major databases, including Science D irect, Springer Nature, Research Gate, Lancet, National Library of Med icine and Elsevier were conducted to identify relevant studies. Data extraction, quality assessment was performed using standardized tools.

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Result: Findings indicate that Al has been used primarily for relapse prediction, treatment personalization, patient monitoring with promising but heterogeneous results. Ethical challenges, methodological limitations were discussed. The review highlights the need for standardized evaluation methods and theory-informed development of Al interventions for SUDs.

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Introduction:-

Substance Use Disorder (SUD) is a chronic psychiatric disorder that leads to repeated relapses through its development from harmful alcohol and drug usage patterns which result in severe clinical disabilities and emotional distress. Substance use disorder causes severe physical and mental health problems which lead to decreased academic and work performance and create difficulties in relationships and result in lost ability to carry out vital life duties. The condition involves people who misuse both legally obtained and illegally obtained drugs which doctors used to call substance misuse and substance dependence. The development of SUD occurs through multiple factors which include interactions between genetic factors and neurobiological factors and psychological factors and environmental factors. Genetic predispositions influence susceptibility through neurochemical pathways that control the brain's reward and stress systems. Repeated exposure to drugs leads to brain changes which especially affect the dopaminergic and mesolimbic circuits and create a strong desire for drugs. Psychosocial determinants such as peer substance use, chronic stress, socioeconomic adversity, and early-life trauma significantly increase vulnerability to substance use disorder. The condition frequently co-occurs with psychiatric disorders, including major depressive disorder, ADHD, PTSD, and anxiety disorders, which may function as both precursors and consequences. Familial influences, particularly parental substance misuse, contribute through genetic predisposition and social learning, while dysfunctional family dynamics and poor coping mechanisms further exacerbate risk.

DSM-IV-TR Criteria for Substance Abuse:-

A maladaptive pattern of substance use leading to clinically significant impairment or distress, as manifested by one (or more) of the following, occurring within a 12-month period:

Criteria is as follows:-

- Recurrent substance use resulting in a failure to fulfil major role obligation at work, school or home.
- Recurrent substance use in situations in which it is physically hazardous.
- Recurrent substance-related legal problems
- Continued substance use despite having persistent or recurrent social or interpersonal problems caused or exacerbated by the effects of the substance.

AI in SUD:-

The process of Substance Use Disorder treatment requires special diagnostic studies which develop treatment plans because patients who suffer from this disorder also experience mental health issues and their social environment affects their condition. Through its capability to analyze vast amounts of clinical histories and behavioral patterns and treatment results the system enables clinicians to use it as an assistive "co-pilot" who helps them to forecast their patients' risk of relapse and determine which treatment methods will work best. AI uses its ability to analyze multiple data sources to create customized treatment plans which include both medication adjustments and behavior modification strategies to meet individual patient needs. The function of AI technology in healthcare requires it to serve as a supplementary instrument which enables doctors to maintain their role as decision makers. The AI system needs to provide transparent recommendation processes because doctors rely on these systems to maintain their clinical trust and achieve optimal patient treatment results.

Behavioural addiction, sometimes referred to as non-substance addiction, is a longterm mental health condition in which a person repeatedly engages in specific actions that offer immediate pleasure or relief but ultimately result in distress, reduced functioning, and an inability to stop. Unlike substance use disorders, it does not involve the consumption of drugs or chemicals. Instead, the addiction centres around behaviours such as gambling, gaming, internet use, shopping, or sexual activity. Despite the absence of psychoactive substances, these activities can activate the brain's reward system in ways comparable to addictive drugs, fostering persistent, hard-to-resist patterns.

This condition can lead to significant emotional, social, and practical difficulties. People may struggle with poor performance at work or school, face financial strain, experience relationship conflicts, and neglect personal duties. Over time, the behaviour often becomes a central focus in life, and efforts to cut back may trigger irritability, restlessness, or emotional discomfort. Key features include difficulty controlling the behaviour, continued engagement despite negative outcomes, and intense urges to repeat it.

The development of behavioral addiction occurs through the combined effects of biological and psychological and environmental risk factors. The dopamine system of the brain becomes activated through activities that provide rewards which include gaming and gambling and social media use. These activities create a loop of behavior which

can develop into compulsive problems. Genetic factors together with heightened reward sensitivity and impulsive behavior and emotional control problems and ineffective coping strategies create a higher risk of vulnerability while environmental factors including constant digital access and social pressure and continuous stress and negative childhood experiences create additional risk. People who develop behavioral addictions often experience psychiatric disorders which include depression and anxiety and ADHD and obsessive-compulsive tendencies. The use of these behaviors becomes harmful when people exceed their limits which leads to continuous behavior despite their attempts to control it, which triggers psychological dependency and disruption of everyday activities.

Several types of behavioural addiction have been identified through research and clinical observation:-

- **Gambling Disorder –** Characterized by ongoing, problematic gambling, this condition often leads individuals to keep betting despite mounting losses, sometimes increasing stakes in an attempt to recover money. It can result in serious financial trouble, debt, damaged relationships, and emotional turmoil. Currently, it is the only behavioural addiction officially recognized in diagnostic manuals like the DSM-5.
- **Internet and Gaming Addiction –** When excessive use of the internet or video games begins to interfere with sleep, real-world relationships, and responsibilities, it may become compulsive. Online games often use reward mechanics, achievements, and social competition that encourage repeated use. Over time, individuals may feel strong cravings, show withdrawal-like reactions when offline, and lose interest in other activities.
- **Compulsive Buying (Shopping Addiction) –** This involves an uncontrollable urge to purchase items, typically to relieve stress or boost mood. While buying brings short-term emotional relief, it is often followed by guilt, regret, or financial pressure. People may accumulate unused goods and face growing debt as the behaviour escalates and becomes harder to manage.
- **Social Media Addiction –** Constantly checking social media can become habitual due to the reinforcement from likes, comments, and social approval. Excessive use may reduce productivity, disturb sleep, and contribute to anxiety or lower self-worth, especially when feedback is negative or lacking.

Methods:-

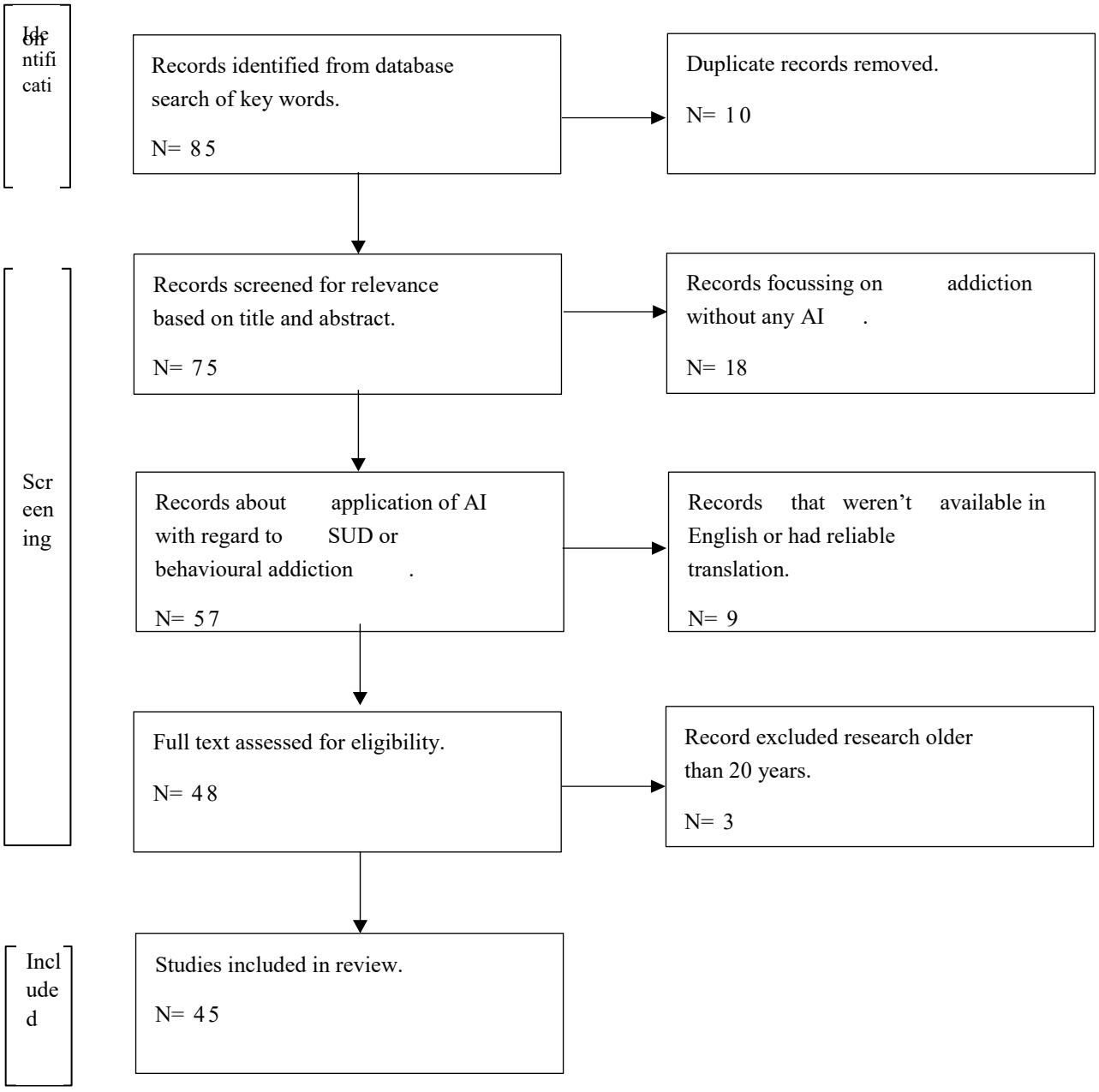
For the database searches, terms associated with Substance use disorders or :-

Behavioural addition and study design were combined with terms related to AI and Machine Learning. studies published between 1st January 2015 to 31st February 2026, were considered for this review. Keywords used for the search were Substance Use Disorders and Behavioural Addiction in corelation with Artificial intelligence, Machine learning and. The following databases were used for literature searches: ScienceDirect, Wiley, Springer Nature, ResearchGate, Lancet, National Library of Medicine, and Elsevier. This procedure was in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

The inclusion criteria were as follows: publications language must be English; original studies; case-control studies; Studies examining the application of Artificial Intelligence (AI), machine learning, deep learning, or predictive analytics in the prediction, screening, diagnosis, monitoring, or treatment of Substance Use Disorders (SUD) or behavioral addictions (e.g., gambling disorder, internet gaming disorder, social media addiction); Studies addressing substance-related addictions such as alcohol use disorder, opioid use disorder, nicotine dependence, cannabis use disorder, and other drug-related disorders; Studies addressing behavioral addictions including gambling, gaming, internet use, shopping addiction, or similar compulsive behaviors; Studies utilizing AI-based methods, including machine learning algorithms, neural networks, natural language processing, predictive modeling, decision-support systems, or AI-enabled digital health tools. Research investigating outcomes related to: risk prediction or early detection, screening and diagnostic assistance, relapse prediction, treatment planning or personalization and monitoring of treatment progress.

The exclusion criteria were as follows: studies focusing on addiction without any AI or computational modeling component, studies focusing on AI applications unrelated to addiction or mental health, Editorials, opinion papers, commentaries, letters to the editor, book reviews, and conference abstracts without full data or methodological detail, Studies addressing other psychiatric disorders (e.g., depression, anxiety, schizophrenia) unless addiction-related outcomes are directly analyzed, Studies lacking adequate description of AI methods, datasets, or outcomes, preventing evaluation of reliability, Publications written in languages other than English where translation resources are unavailable.

Prisma Flowchart



Review of Literature:-

The results of the study by Scarpa, Vanhée(2026) focuses on the aspect that Artificial Intelligence for Addiction, Substance Use, and Mental Health (AI for ASUM) has developed into a new scientific research domain which still requires additional research work to reach its full development. The field shows continuous growth according to the analysis of 1,889 publications which demonstrate that researchers have started using AI technologies especially through data-driven methods like machine learning and chatbots and virtual reality and smartphone-based tools and digital health applications for prevention and diagnosis and treatment support. The research landscape exists as a small field which remains divided into various disciplines while showing limited researcher dedicationG and collaboration patterns that vary between different scientific domains. The study demonstrates essential development possibilities through its identification of three key research areas which require further work to develop AI methods and to create sociotechnical and ethical research frameworks and to establish research centers and partnership networks which will enable ongoing progress in AI-based addiction and mental health research.

The study conducted by Callan, Cheng, Forster, Gordon (2025) focused on the Behaivior Recovery platform which showed potential to enhance substance use disorder treatment for U.S. military personnel and Veterans through its cloud-based system which combines artificial intelligence with smartwatch technology. The platform uses AI-based predictive algorithms to analyze biometric data which helps it identify relapse signs and health emergencies for delivering customized treatment and provider notifications. The system provides real-time monitoring and support which helps people sustain their behavior changes and comply with their treatment plans while decreasing their chances of substance use. The research shows that AI-powered digital health platforms have the potential to provide effective and scalable solutions which improve SUD recovery outcomes, but their long-term effectiveness and clinical use need to be tested through additional research.

The narrative review by Khakpaki, & Sepehri, H. (2025) shows that artificial intelligence (AI) can significantly enhance addiction treatment which remains a worldwide public health problem that needs to be solved. The research demonstrates that machine learning algorithms can successfully detect both substance use disorders and behavioral disorders whereas predictive analytics enables the identification of individuals who require early intervention because they are in danger of developing these disorders. Recovery support from wearable devices and mobile health applications works by tracking both behavioral and physiological signs to help users avoid relapse. The review established that educational programs for nurses lead to better understanding of AI technology which allows them to use it effectively in mental health and addiction treatment programs. AI research on eating addiction has identified key predictors which include hedonic hunger as essential factors that lead to this eating disorder. The study identifies three main restrictions which prevent healthcare organizations from adopting AI technology at a widespread level: data privacy and security issues and algorithmic bias and lack of standardization in AI implementation.

The review by Okposio et al. (2025) focuses on the findings that AI-based predictive analytics systems are revolutionizing mental health treatment and substance abuse prevention through their capacity to identify disorders early while delivering customized therapies and predicting relapses with high precision. AI models utilize multiple data sources which include neuroimaging and wearable device data and social media information to detect biomarkers and track behavioral changes and enable early clinical treatment methods. The technologies enhance diagnostic accuracy while enabling customized treatment development and improving public health initiatives that aim to decrease relapse rates and increase patient recovery results. The study identifies three main challenges which include data bias problems and privacy risk issues and regulatory compliance obstacles that must be solved through the development of ethical standards and the use of multiple data sources and the collaboration of different scientific disciplines to achieve fair and effective AI deployment in mental health treatment.

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The review by Okposio and Richard (2025) found that AI-powered predictive analytics will bring significant changes to mental health treatment because it enables early identification of psychiatric and neurodegenerative disorders and reveals essential biomarkers and helps create personalized treatment strategies and uses machine learning with multimodal data fusion to forecast substance use relapse. The research findings demonstrate that combining neuroimaging with wearable technology and digital behavioral data leads to better diagnostic results and enables customized treatment methods while decreasing relapse possibilities in a patient-centered framework. The review identifies persistent issues which include data bias problems and privacy violations and ethical dilemmas and regulatory boundaries, so researchers need to establish diverse data collections and interdisciplinary partnerships and create fair research systems. The research demonstrates that AI-based systems enhance mental health disorder prevention and diagnosis and long-term treatment when they undergo careful implementation without any bias.

Kenne, Jin, Maharjan, Zhu in December 2025 computed a large-scale computational analysis of hundreds of millions of publicly available social media posts (2019-2021) explored associations between the Big Five

personality traits and substance use (SU) discourse during the COVID-19 pandemic. 29). , social drinking) and affiliative rather than solitary or intrapersonal by employing natural language processing, deep learning, and statistical modeling, Together, these results imply that at least in online settings and the current pandemic period, the driving forces behind substance use discussion revolve more around social connection and prosocial traits rather than negative emotions, suggesting an urgent need for socially-minded intervention approaches and digital public health surveillance.

The study conducted by Haedo-Cruz, Jiang, Lee, Miranda, Wang in November 2025 Researchers created the BiPETE deep learning model which uses Transformer architecture to forecast alcohol and substance use disorder risks through electronic health records of patients who have depression and PTSD. The model utilized a bi-positional embedding approach which enables better analysis of patient data through its ability to capture the timing and sequence of clinical visits. BiPETE achieved a 34% prediction performance improvement over baseline models in the depression cohort while achieving a 50% improvement in the PTSD cohort and the model successfully identified high-risk patients with 90% accuracy for both AUROC and AUPRC metrics. The model determined crucial clinical markers which demonstrated ASUD risk association through inflammatory and metabolic and hematologic indicators together with specific medications and comorbidities. The research results demonstrate that transformer-based AI models can accurately forecast substance use disorder risk while assisting with early detection and tailored treatment strategies.

The study by Lande in August 2025 stated that AI technology shows great potential as a valuable resource for addiction treatment according to studies which demonstrate its ability to enhance early diagnosis and risk assessment and create individualized treatment strategies and prevent relapse in patients with substance use disorders. Despite its slower adoption rate in behavioral health compared to other medical specialties, which results from concerns about data privacy and ethical challenges and the difficulties in analyzingbehavioral health information, current research demonstrates that AI-based solutions improve medical decisionmaking and increase patient access to treatment when combined with standard treatment methods. AI technology can substantially improve addiction treatment results through prevention and treatment and recovery processes according to research evidence which demonstrates that AI implementation requires both ethical protection measures and collaborative research and specific implementation methods.

The results of the research by Ajayi in January 2025 aimed to examine how artificial intelligence can enhance the understanding, diagnosis, and treatment of behavioural addictions and other mental health disorders. The AI technologies of machine learning and natural language processing and predictive analytics and chatbots and wearable monitoring devices can analyze extensive datasets to achieve early detection and enhanced diagnostic accuracy and personalized treatment development and relapse risk prediction. The study establishes that emerging tools including virtual reality and augmented reality can develop new therapeutic methods while AI delivers scalable data-driven solutions for addiction and mental health treatment, which requires successful implementation through strong ethical regulations and interdisciplinary teamwork and patient-centered system design.

The research by Chen and Su conducted in February 2025 demonstrated that artificial intelligence (AI) and digital therapies and neuromodulation techniques show potential for enhancing addiction treatment and improving social work practices. The research demonstrates that AI and machine learning technologies enable early detection of addiction patterns which help in creating better individual treatment strategies. Digital therapies which include mobile health applications and online cognitive behavioral therapy (CBT) and gamification and virtual reality technology enable better treatment access while patients become more involved in their recovery process. Neuromodulation techniques which include transcranial magnetic stimulation (TMS) and transcranial electric stimulation (TES) and deep brain stimulation (DBS) offer a solution to decrease cravings and prevent relapses by changing the brain functions that are linked to addiction. The research demonstrates that combining these technological systems leads to better addiction treatment results while ethical requirements and data protection and long-term effectiveness research restrictions continue to create obstacles.

The study by Alag, Dadzie, Patil, Shimu, Tesfaye &Więckiewicz (2024) emphasized that health informatics together with artificial intelligence (AI) can effectively enhance the prevention and monitoring and treatment of drug addiction. Technologies such as electronic health records and telemedicine and clinical decision support systems and prescription monitoring programs permit the monitoring of patient information and the discovery of addiction risk factors and the improved management of prescriptions for addictive substances including opioids. AI and machine learning technologies enable healthcare professionals to analyze extensive healthcare databases which help them

identify addiction patterns and create customized treatment plans according to each person's risk assessment and medical history. The research demonstrates that health informatics systems can improve substance use disorder prevention methods while enhancing treatment success rates but the system needs to resolve data privacy issues and system interoperability challenges and fair access requirements for successful implementation.

The review conducted by Beg and Verma in December 2024 examined 23 studies published between 2009 and May 2024 to evaluate the effectiveness of digital therapies in psychotherapy for individuals with disorders such as Attention Deficit Hyperactivity Disorder, Obsessive-Compulsive Disorder, Schizophrenia, and Substance Use Disorder. The review assessed the effectiveness of digital tools which included chatbots and internet-based therapeutic platforms for managing symptoms and enhancing patient functionality. The authors found that digital therapies increased access to treatment through their customized intervention methods while helping patients achieve more effective symptom control. The authors need to conduct additional research to determine the long-term impact of their study while they study ethical data usage and assess the way patients interact with technological systems which replace human therapy.

The research conducted by Unlu and Subasi in December 2024 used machine learning and deep learning techniques to create models which predicted substance use disorder patterns related to cannabis ecstasy amphetamine cocaine and non-prescribed medication use. The researchers used 76 demographic and experiential and health and social characteristics to test three models LSTM and BiLSTM and Recursive LSTM together with SHAP analysis which determined important predictors and SMOTE function which handled data imbalance.

The findings demonstrated that machine learning and deep learning models achieved accurate SUD risk predictions while BiLSTM and LSTM models successfully captured complex behavioral patterns which linked to vulnerability. The method proved superior to traditional machine learning models but showed only minor improvement. The research demonstrated that different substances possess distinct key risk predictors which create unique SUD risk profiles that need specific prevention and early detection methods. The research shows that AI-driven data-based methods can identify SUD risk early while they also help develop public health initiatives which follow scientific evidence.

Ahmed, Choudhari, Kumar, Leszkowitz Panta, Poudel (August 2024) conducted a systematic review that demonstrates that artificial intelligence (AI) offers considerable potential for addiction medicine because it enhances early identification and correct diagnosis and accurate prediction of addiction-related disorders. Clinicians can use machine learning algorithms to find patterns in large databases, enabling them to identify different addiction types and forecast treatment success with greater precision than traditional diagnostic methods. AI systems will enable doctors to create customized treatment plans which will help their patients achieve better results. The review shows that researchers must validate their findings across different population groups while developing solutions to data access issues and ethical dilemmas and clinical implementation challenges before medical professionals can start using artificial intelligence for addiction treatment.

The review by Banoon, Hassan, Rashid, Sammany (July 2024) indicates that artificial intelligence (AI) has major potential to enhance drug addiction prediction and diagnosis and treatment processes. AI models and deep learning techniques can analyze large and complex datasets to enable early detection of substance abuse, relapse prediction, risk identification, and personalized treatment planning. The research shows that AI can help identify behavioral and neurobiological patterns that genetic studies alone cannot explain, which includes modeling synaptic changes in the central nervous system caused by psychoactive drugs. The research shows that combining AI with traditional and complementary treatment methods will improve addiction treatment results, but researchers need to study more to understand and develop AI-based addiction medicine treatments.

The research by by Acharya, Ally, Kar, Soar in February 2024 used Automated Machine Learning (AutoML) to forecast coexisting mental health (MH) and substance use disorder (SUD) cases in women based on a dataset which included 497,175 admissions from the 2020 Treatment Episode Data Set Admissions (TEDS-A) study. A super learning model which combined Random Forest and XGBoost outperformed all other tested machine learning algorithms in this study. The model demonstrated strong predictive ability with AUC = 0.817, accuracy = 0.751, precision = 0.743, recall = 0.926, and F1 score = 0.825, indicating it could effectively identify women at risk of having both MH and SUD conditions. The results indicate that AutoML serves as an effective early detection method which allows healthcare professionals to provide timely personalized treatment methods while fulfilling ethical practices, protecting data privacy, and promoting healthcare stakeholder collaboration.

The article "Artificial Intelligence-Driven and Technological Innovations in the Diagnosis and Management of Substance Use Disorders" (2024) by Aniela Lé Tassinari, Maria Olivia Pozzolo Pedro, Manoela Pozzolo Pedro, André Brooking Negrão, Ricardo Abrantes do Amaral, André Malbergier, Douglas Henrique Crispim and João Maurício Castaldelli-Maia aimed to examine how artificial intelligence and emerging technologies can improve the diagnosis and management of Substance Use Disorder. The research results demonstrate that technological advancements which include Functional Magnetic Resonance Imaging biomarker-based blood tests AI-driven behavioural assessment natural language processing pharmacogenetics mobile applications and wearable devices will enable earlier detection of substance use patterns while they create personalized treatment plans which enable real-time recovery monitoring and relapse risk reduction. The study demonstrates that AI-based tools have substantial capability to improve clinical decision-making together with patient outcomes however the study stresses that patient privacy must be protected while they access these technologies.

Baird and Kursuncu and Xia conducted their study to determine if machine learning models could forecast patient length of stay during Substance Use Disorder treatment according to Treatment Episode Data Set–Discharges (TEDS-D) data analysis. The study results showed that ML predictive models help clinicians make better treatment duration decisions which benefits both inpatient and outpatient care planning and resource allocation efforts. The study results demonstrated that the models displayed systematic and social biases which originated from factors including race, geographical location, substance type, clinical diagnosis, and insurance status. The research therefore highlights the requirement for bias detection and ethical AI design and policy safeguards to achieve fair and equal healthcare results for patients who receive SUD treatment.

The review by by Ramos, Soto, Unger, West in March 2022 showed that American Indian and Alaska Native (AIAN) populations face major problems with substance use and behavioral addictions which include alcohol and tobacco and opioids and stimulants and gambling. The study found that historical trauma and life stressors and poverty and family history of substance use and restricted access to culturally appropriate healthcare create multiple risk factors which increase addiction susceptibility. The main protective factors which establish resilience and aid in recovery include strong ethnic identity and family and community support and traditional cultural practices. The research shows a major research gap concerning behavioral addictions which exist in AIAN communities beyond gambling while showing the need for culturally based prevention and treatment programs which combine Indigenous healing methods with community-based treatment methods.

The study by Berner, Fiore, Kato, Morita,Ognibene, Parvaz, Shimomura, Morita in Dec 2022 how computational psychiatry models--which include reinforcement learning, Bayesian inference, and neural dynamic simulations--explain the cognitive and neural mechanisms that underlie Pathological Gambling and Internet Gaming Disorder. The study found that behavioral addictions and Substance Use Disorder share common biological mechanisms which includes impaired reward learning and increased model-free decisionmaking and decreased model-based planning and enduring neural activity patterns. The research shows that neurocomputational models deliver better predictions of clinical status and relapse probability than standard assessment techniques, which underscores their capability to enhance diagnostic accuracy while creating specific treatment protocols for behavioral addiction disorders.

The research study by Baiocchi, Chieng, Kendra, Pajarito, Prochaska, Vogel, Robinson in March 2021 showed that Woebot, an AI-based digital therapy system that uses cognitive behavioural therapy (CBT) for its treatment, serves as a viable and acceptable and safe treatment option for patients with substance use disorders (SUD). The program uses a fully automated conversational agent to deliver customized support and psychoeducation which enables users to control their cravings and substance consumption patterns. The study showed major decreases in both substance use and cravings which happened during the difficult period of the global pandemic. The results demonstrate that AI-powered conversational agents deliver mental health services that can be scaled up and accessed easily while showing potential to decrease the treatment gap in SUD care which requires further research to assess its long-term effectiveness and user acceptance and societal impact.

The research study by Tara Beaulieu, Rod Knight, Seonaid Nolan, Oliver Quick &Lianping Ti used gray literature from 2013 to 2019 to discover new artificial intelligence solutions for treating Opioid Use Disorder through their study which examined those materials. The review identified 70 citations and 29 AI-based interventions which included smartphone applications, healthcare data systems, biosensors, and digital or virtual tools. The study results demonstrate that most of the tested methods have not undergone complete testing yet their ability to detect increased

opioid use and predict overdose risks and assist in treatment decisions and identify respiratory depression from opioid use demonstrates AI's developing capacity to enhance OUD prevention and treatment methods.

The study "Knowledge and Utilization of Technology-Based Interventions for Substance Use Disorders: An Exploratory Study among Health Professionals in the European Union" (2018) by Gianluca Quaglio, Alessandro Pirona, Giovanni Esposito, Theodoros

Karapiperis, Helmut Brand, Geert Dom, Luigi Bertinato, Linda Montanari, Falk Kiefer, and Giuseppe Carrà aimed to assess the level of knowledge, usage, and perceived effectiveness of technology-based interventions (TBIs) for treating Substance Use Disorder among health professionals across six European Union countries. The study used an online survey of 311 addiction specialists to assess TBI awareness and clinical usage which showed low levels of both (23% reported good knowledge and 12% used them in practice) despite the fact that many professionals believed TBI helps treatment access and other healthcare services. The major barriers that were identified included absence of technical support and inadequate infrastructure and restricted digital literacy which demonstrated the requirement for advanced training programs and public awareness initiatives and policy backing to increase TBI application in addiction treatment.

In 2024, Mohit Suva and Gayatri Bhatia published Artificial Intelligence in Addiction: Challenges and Opportunities, examining the role of artificial intelligence in addiction psychiatry. The study aimed to review current applications, potential benefits, and limitations of AI in addressing substance use disorders and behavioral addictions. The authors found that AI contributes to healthcare through precision medicine, improved service delivery, and enhanced research processes. In mental health, AI applications include predictive diagnostic tools, screening systems, telepsychiatry, and digital therapeutic support. However, the use of AI in addiction psychiatry remains limited despite the large global burden of addiction. Reports estimate that more than 250 million people worldwide use drugs, with over 35 million affected by substance use disorders. Treatment gaps remain significant, particularly in countries such as India. Current studies mainly use machine learning and natural language processing to predict substance use risk, treatment outcomes, and relapse. While results show promising predictive capabilities, most research relies on small samples and limited populations. The study concludes that AI has potential for addiction identification, treatment planning, and relapse prevention, but further large-scale research and stronger ethical frameworks are necessary for clinical integration.

Discussion:-

The research analysis showed that artificial intelligence (AI) has become a major technological advancement which transforms methods for preventing and diagnosing and treating substance use disorders (SUD) and behavioral addictions. Multiple investigations proved that AI-based analytical systems could handle extensive and intricate data sets which came from electronic health records and neuroimaging results and wearable device data and behavioral indicators to discover addiction risk factors and create customized treatment plans. The evidence demonstrated that AI technologies had started to transform addiction research and clinical practice by delivering better diagnostic results and enhancing relapse prediction accuracy and enabling personalized recovery methods.

The research showed that AI technology provides accurate early diagnosis and prediction capabilities for detecting substance use disorders. The systematic review conducted by Poudel and colleagues (2024) reported that machine learning algorithms had successfully identified patterns within extensive clinical datasets which enabled clinicians to detect addiction-related disorders and predict treatment outcomes with greater precision than conventional diagnostic procedures. The review by Hassan and associates (2024) demonstrated that deep learning models had analyzed complex behavioral and neurobiological datasets to identify early indicators of substance abuse and forecast relapse risks. The findings indicated that AI-based predictive systems could enhance diagnostic systems used in addiction medicine.

The neuroimaging studies provided strong evidence which showed that artificial intelligence systems can successfully diagnose patients. Zhang et al. (2023) utilized machine learning techniques to examine multimodal MRI data for the purpose of distinguishing cocaine users from non-users through their brain connectivity pattern changes. The study discovered that subcortical frontoparietal and insular brain networks directly linked to craving control and impulsive behavior and relapse risk. The research conducted by Chhetri and his team in 2023 discovered that machine learning models which used EEG signals and behavioral assessments and kinematic data succeeded in finding early signs of substance abuse. AI-based neurocomputational research provided scientists with greater understanding about how addiction-related brain functions operate.

The research demonstrated how artificial intelligence technology could help find potential relapse situations while developing customized treatment strategies. The study conducted by Lee and his team in 2025 introduced the BiPETE deep learning model which used transformer-based architecture to analyze electronic health records and predict alcohol and substance use disorder risks. The model showed substantial enhancements in predictive performance because it tracked clinical event timelines which enabled identification of highrisk patients at an early stage. The study by Unlu and Subasi in 2024 showed that deep learning models LSTM and BiLSTM could accurately predict substance use trends based on demographic and social and health-related data. The combination of these studies showed how predictive AI models enabled clinicians to develop treatment plans which matched the specific risk factors of individual patients.

The research identified a critical discovery which showed how AI-powered digital health platforms and wearable monitoring systems functioned to prevent relapses while providing recovery assistance. The study by Forster and his team (2025) investigated the Behavior Recovery platform which combined artificial intelligence with biometric data collection from smartwatches. The system operated by monitoring physiological measurements through continuous real-time analysis while it generated alerts for early relapse signs and health emergencies. The healthcare system used continuous monitoring to enable medical teams to provide immediate healthcare services together with customized treatment modifications. The narrative review conducted by Khakpaki and Sepehri H. (2025) showed that wearable devices and mobile health applications successfully monitored behavioral and physiological signals which indicated relapse risk while they delivered digital support throughout the recovery journey.

Addiction treatment accessibility can benefit from digital therapeutic interventions and artificial intelligence-based conversational agents which serve as effective solutions. Prochaska and his team conducted their study in 2021 to evaluate W-SUDs which used an AIbased chatbot intervention to deliver cognitive behavioral therapy and dialectical behavior therapy and motivational interviewing treatment. The study results showed that participants achieved both reduced substance use and diminished craving intensity and anxiety and depression symptoms. Prochaska and his team developed the AI-based conversational system Woebot in 2021 which reduced substance use and cravings through its psychoeducational dialogue and personalized behavior recommendations. The research demonstrated that AIpowered digital therapeutics could enhance addiction treatment service delivery through greater access and operational reach.

The studies showed that AI techniques helped researchers study addiction problems and public health surveillance systems. Maharjan and his research team used computational methods to analyze499 million social media posts which they used to study the relationship between personality traits and substance use conversation during the COVID-19 pandemic. The findings demonstrated that social connections and the desire to connect with others served as the primary drivers behind conversations about substances instead of negative emotional states which people experience. AI digital surveillance together with natural language processing systems created fresh methods to track substance consumption patterns and develop public health intervention plans.

The research studies showed that artificial intelligence programs had proven value through their successful application in multiple areas. The research team led by Kursuncu (2024) found that machine learning systems which predicted treatment duration for substance use disorder treatment showed systemic biases which depended on patient demographic factors including race and geographic location and insurance type. The biases created critical issues which affected AI systems used for clinical decision-making by compromising both fairness and clinical decision-making reliability. The review conducted by Okposio and his team (2025) demonstrated that organizations face major obstacles because they need to manage three data privacy risks and algorithmic bias problems and face restrictions from regulatory bodies which makes it essential to create strong ethical governance systems and interdisciplinary scientific partnerships. The research field of Artificial Intelligence for Addiction Substance Use and Mental Health remains an emerging and fragmented domain according to the bibliometric analysis results that Scarpa and Vanhée conducted in their 2025 study. The research study examined almost 2000 academic articles which showed that different academic fields maintained limited collaborative networks while using various research methods. The authors proposed that upcoming research activities should focus on three main areas which included building interdisciplinary research partnerships and creating dedicated research facilities and developing sociotechnical systems and ethical standards to support responsible AI research integration in addiction treatment.

The evidence which scientists collected showed that artificial intelligence brought major advantages for developing methods to prevent and diagnose and treat substance use disorders. AI-based predictive modeling combined with

neuroimaging analytics and digital therapeutics and wearable monitoring systems enabled clinicians and researchers to identify risk factors and track behavioral changes and create personalized treatment plans. The research field needed more empirical evidence about its existing state because it required validation through large clinical trials and ethical implementation of the research findings. The future research direction needed to establish strong research methods which would help to achieve fair algorithm outcomes and foster teamwork between different scientific disciplines to unlock artificial intelligence medical applications in addiction treatment and psychological studies.

Conclusion:-

Substance Use Disorders (SUD) and behavioral addictions aresignificant global public health issues, impactingphysical health, mental well-being, and social functioning. SUD involves a persistent pattern of usingpsychoactive substances such as alcohol, opioids, cannabis, or stimulants thatresults in clinicalimpairment, loss of control, tolerance, withdrawal, and continueduse despite clear harm. In contrast, behavioral addictions involve compulsiveparticipationin non-substance activitieslikegambling, internet gaming, online shopping, or excessive social media use.Whilethese behaviors don't involve consuming substances, they trigger similar psychological patterns, including cravings, reinforcement, diminished self-regulation, and ongoing engagement even when negative consequences arise.

Artificial intelligence (AI) is emerging as an important technological approach in addiction research and clinical care. Studies examining AI applications in addiction medicine indicate strong potential to improve the detection, prediction, and management of both substance use disorders and behavioral addictions. However, current evidence remains limited because of methodological constraints, and further systematic research is needed before AI tools are widely integrated into routine clinical practice.

One of the main strengths of AI lies in its predictive capabilities. Machine learning and deep learning models analyse large, complex datasets to identify patterns associated with substance use behaviours. Research shows that these models predict the onset of substance use, treatment outcomes, and relapse risk with considerable accuracy. For example, predictive systems analyse adolescent behavioural indicators to estimate vulnerability to substance use, while other models examine electronic health records or social media language patterns to detect alcohol misuse or substance-related behaviours.

AI systems also show strong performance in diagnostic and monitoring tasks. Deep neural networks classify drinking patterns using clinical data with high accuracy, and computer vision technologies identify intoxicated individuals through thermal imaging of facial features. These capabilities highlight AI's ability to detect behavioral and physiological signals related to substance use, which may support earlier identification of risk factors.

Another significant application involves early detection and personalized treatment planning. By integrating diverse data sources, such as medical history, psychological characteristics, genetic information, and behavioral patterns, AI systems help clinicians design individualized treatment strategies. Personalization is particularly important in addiction treatment because addictive behaviors result from complex interactions among biological, psychological, and social factors.

AI-powered digital tools also support relapse prevention and recovery monitoring. Some applications use location tracking and behavioral analysis to identify high-risk situations and send alerts when individuals approach environments associated with substance use. Chatbots and virtual assistants provide continuous psychological support through coping strategies, motivational guidance, and crisis intervention, improving access to care, especially in regions with limited treatment resources.

Limitations:-

- Small sample sizes: Many studies include few participants, which weakens confidence in results and increases the risk that findings reflect random variation rather than reliable patterns.
- Limited geographic and demographic diversity: Research often involves similar populations from specific regions. AI models trained on such data might perform poorly in different cultural, social, or healthcare contexts.

- Focus on prediction rather than intervention: Most research evaluates AI's ability to predict substance use, relapse, or treatment outcomes. Evidence on the effectiveness of AI as a direct treatment or therapeutic tool remains limited.
- Data quality and availability issues: Reliable AI systems require large, wellstructured datasets. In addiction research, clinical records, behavioral data, and patient interactions are often incomplete, inconsistent, or difficult to access due to privacy restrictions.
- Privacy and ethical concerns: Sensitive data related to substance use and mental health raise concerns about confidentiality, informed consent, and secure data handling, especially when shared with technology developers.

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