Innovative Rehabilitation Strategies for Chemical Dependency: Integrating Biochemical Insights and Psychosocial Approaches

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Abstract

Background: The increasing prevalence of substance use disorders underscores the need for a deeper understanding of the biochemical mechanisms underlying addiction, especially their impact on blood and genetic health. Chemical dependency not only affects physiological processes but also interacts with genetic predispositions, influencing the course and complications of addiction. Methods: This study investigates the relationship between chemical dependency, biochemical factors, and their implications for blood composition and genetic health. We examined how substance use disorders alter hematological profiles, affect hematopoiesis, and interact with genetic factors. The research involved analyzing changes in blood markers and genetic expressions related to addiction and recovery. Progressive rehabilitation techniques were evaluated for their effectiveness in addressing these issues. Results: Our findings reveal that chemical dependency significantly impacts blood composition, including alterations in hematological markers and disturbances in hematopoietic processes. Genetic factors were found to play a role in exacerbating addiction risks and health complications. Progressive rehabilitation techniques incorporating advancements in genetics and biochemistry were shown to improve outcomes by providing personalized interventions that address both physiological and psychological aspects of recovery. Conclusion: The study highlights the importance of integrating biochemical and genetic assessments into rehabilitation programs to enhance the effectiveness of treatment. Personalized approaches that address the interplay between addiction, blood health, and genetic predispositions promote better psychosocial adaptation and biochemical stabilization. This comprehensive understanding contributes valuable insights into developing more effective rehabilitation practices, ultimately supporting improved mental health and overall well-being.

Keywords: Chemical Dependency, Biochemical Factors, Psychosocial Rehabilitation, Neurotransmitters, Personalized Interventions

Significance | This review describes the understanding of biochemical and psychological factors in addiction to enhance rehabilitation strategies, leading to more effective treatments and improved recovery outcomes.

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Introduction

Chemical dependency remains a significant medical challenge, impacting individuals, their families, and society at large. As the prevalence of substance use disorders continues to rise, there is an increasing interest in exploring the psychological and biochemical connections underlying addiction. Addiction profoundly alters one's physiological state through chemical dependency or the use of

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psychotropic drugs, affecting overall well-being, mental stability, and social relationships. Thus, developing innovative rehabilitation methods for both physical and mental dependence is crucial, alongside adopting new psychosocial approaches to address the human aspects of addiction (Aghenitei & Galateanu, 2023).

Advancements in understanding the biochemical factors contributing to addiction are shedding light on how these changes influence behavior and treatment responses. Factors such as neurotransmitter imbalances and genetic predispositions can make individuals susceptible to both initiating and maintaining addictive behaviors (Alvarez-Monjaras et al., 2019). Recognizing these influences enables the development of biochemically and genetically informed rehabilitation pathways, complementing traditional therapeutic approaches (Blum et al., 2023).

This study explores progressive rehabilitation strategies incorporating recent clinical research on biochemical factors related to chemical dependency, brain function effects, and emotional intelligence development. Evidence-based practices, including mindfulness, experiential learning, and personalized interventions, are vital for creating effective treatment strategies. These approaches address issues such as stress, relationship challenges, anger, and character defects that contribute to poor resilience, while simultaneously working to build resilience (Cernasev et al., 2021; Evans & Kim, 2010).

Understanding the interplay between chemical dependency and mental health is essential, as long-term substance use can exacerbate psychiatric and psychological disturbances. Recognizing chemical dependency and engaging in recovery interventions can transform misunderstandings and ambiguity into a clearer appreciation of recovery. Combining emotional and psychological support with an awareness of biochemical factors can empower individuals in recovery to better navigate life's challenges (Henderson, 2009; Rice, 2017).

Ultimately, balancing the contributions of chemical dependency and biochemical chemistry can open new avenues for rehabilitation, focusing on the overall health of individuals with substance use disorders. A comprehensive approach that integrates social and emotional factors with biochemical insights will enhance recovery efforts and offer a more promising future in addressing drug addiction (Room, 2006).

2. Theoretical Background

It is crucial for each of us to take responsibility for our own future as well as the future of others. Unfortunately, not everyone is currently prepared to fulfill this responsibility. This has led to the emergence of various self-destructive behaviors, resulting in destructive behavior and diseases. The issue of dependency is both urgent and relevant today, given its widespread prevalence and the challenges associated with overcoming it. Dependency is often understood as a form of subjugation to external forces, where an individual yields to the will or power of others, lacking independence and freedom (Hegewald, 2022). In a broader context, dependency denotes an individual's compulsion toward someone or something in pursuit of satisfaction or adaptation (Bornstein, 2012).

The psychological mechanism underlying dependency involves a desire to escape from reality by artificially altering one's mental state through the consumption of psychoactive substances or engagement in specific activities that elicit intense emotions (Henderson, 2009). It is essential to recognize that while addictions typically carry negative connotations, they are not solely detrimental in nature. Humans naturally depend on essential elements for survival, such as food, water, air, and social connections. These dependencies include physiological needs as well as the need for belonging, love, and respect, which form the foundation of human existence and personal and professional development (Baumeister & Leary, 2017).

However, excessive dependencies can lead to destructive behaviors and reinforce patterns of dependency. In both scientific literature and practice, there is a term "addiction" which is widely utilized alongside "dependency" (West & Brown, 2013); these concepts relate to harmful passions or habitual behaviors (Rice, 2017). According to Rosenthal & Faris (2019) a historical analysis of the term "addiction" traces its roots to Latin, where "addictus" referred to individuals bound by debts or condemned to slavery as a result of those debts. Fundamentally, the terms "dependency" and "addiction" can be considered synonymous, both defining similar phenomena.

The primary motive driving individuals prone to addiction is the desire to alter an unsatisfactory mental state—often described in terms such as "gray," "boring," "monotonous," or "apathetic" (Smolkin, 2018). Almost everyone has experienced feelings of dissatisfaction or indifference at some point, fueling a strong urge to change their condition. In healthy individuals, constructive behavioral strategies are typically employed to address these feelings without leading to the formation of dependencies. However, when the desire to escape from reality becomes the dominant motivation, it can overshadow other thoughts and desires, greatly increasing the risk of developing addictions (Taipale, 2017).

Dependencies, or addictions, can take numerous forms and can be systematized based on their sources—primarily chemical and non-chemical (Maremmani et al., 2019). Focusing on chemical dependency in this study, we recognize that it encompasses issues such as drug addiction, alcoholism, smoking, and substance abuse (Watson et al., 2015). Multiple approaches or models exist to explain the essence of addictive behavior, including:

The Moral Model views addiction as a manifestation of sinfulness and moral failing, drawing from religious traditions such as Orthodox Christianity, Protestantism, Islam, Buddhism, Confucianism, and yoga (Bowen, 2019). In contrast, the Disease Model frames addiction as a chronic illness that requires medical treatment and intervention, emphasizing a more clinical approach (Carreno et al., 2023). The Symptomatic Model suggests that addictive behavior is a learned response, with treatment aimed at modifying the symptoms associated with the habit (Rosenberg, 2014). The Psychoanalytic Model focuses on personal dynamics and emotional conflicts, positing that disruptions in these areas are central to understanding addiction (Alvarez-Monjaras, 2019). Lastly, the System-Personality Model explores the breakdown of significant relationships between an individual and society, examining how interpersonal, occupational, and familial dimensions contribute to dependency (Cervone et al., 2008).

According to Hunt (201) today, the biopsychosocial model of addictive behavior has gained significant recognition as a comprehensive framework that considers disruptions within the complex system of "organism-personality-society" as pivotal mechanisms contributing to the development of addiction. The existence of diverse models of addiction underscores its intricate and multifaceted nature while highlighting the urgent necessity for a collaborative approach among various specialists to address the pressing challenges posed by addictive behavior.

DiClemente (2018) states that like many other socially detrimental phenomena, dependency (or addictive) tendencies do not emerge overnight; rather, they develop gradually over time. These tendencies have varying etiologies, dynamics, prognoses, and consequences for both the individual's physical health and personal development.

The most prevalent socially harmful phenomena are forms of dependency, with addiction to psychoactive substances being the most dangerous. In the late XX and early XXI centuries, there has been an epidemic of drug abuse and other psychoactive substance addictions (Greydanus & Merrick, 2013). According to the World Health Organization (2022), over 500 million people suffer from diseases caused by drug use, such as HIV infection, hepatitis, and venereal diseases. The mortality rate among drug addicts due to overdose, somatic complications, and suicide is twenty times higher than that of the general population (Vallersnes et al., 2019). The majority of drug addicts are aged between fifteen and twenty-five, and the age at which individuals start using drugs has decreased to twelve years (Johnston et al., 2022). There has been a significant increase in drug-related crimes, including the sale, production, and other offenses committed under the influence of drugs. Hence, the exploration of chemical dependency, its biochemical underpinnings, and the effectiveness of innovative rehabilitation strategies has garnered increasing attention from researchers across various domains.

2.1 Understanding Chemical Dependency

Chemical dependency, commonly known as substance use disorder (SUD), represents a multifaceted health issue characterized by the compulsive use of substances despite the negative consequences that often accompany such behaviors (O'Connor & Kenny, 2022). It is more than mere compulsive behavior — the substance changes their brain and affects their ability to make decisions, their self-control, and even how they can feel pleasure without the substance. Substance use disorder can present in many ways, such as with dependence on alcohol, prescription medications, and illicit drugs. However, SUD is defined by the frequency of behavioral and physiological indicators outlined in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) (Kopak & Hoffmann, 2024). These include a spectrum of SUD symptoms such as unsuccessful attempts to curtail use, lack of control or reduction of use, allocation of considerable time toward procuring or using the substance, and cravings and strong desires to use the substance. Despite adverse consequences to social, occupational, and recreational developmental domains, continued use is also a hallmark of SUD (Hasin & Larson, 2021).

The degree of severity can be classified as mild, moderate, or severe, depending on the number of criteria met, thereby providing a road map to understand the depth of the disorder and direction for treatment approaches. Volkow & Blanco (2022) note that chemical dependency is a chronic, relapsing brain disease for which causation is the result of a complex interplay of genetic, environmental, and psychological factors. This complexity reveals that addiction isn't simply an individual disorder but a family disorder or even a community disorder'. Some central elements are:

Genetic Factors: One aspect of risk attributed to genetic factors is the large body of evidence from twin and adoption studies showing that genetic predisposition accounts for an estimated 40-60% of liability for the development of SUD. This is due to a wide array of genetic variations that impact an individual's response to a substance by influencing how they metabolise a substance, and how they respond to such substances. This, in turn, contributes to their propensity for addiction (Goldman et al., 2005).

Environmental Influences: The environment is critical to the outcome of addiction. Some vital environmental contributors include family dysfunction, peer pressure, socioeconomic status, and prevalent substance use in one's environment.

Psychological biomarkers: The most severe mental health disorders, such as depression, anxiety, and post-traumatic stress disorder, co-occur with SUD and, reciprocally, can make treatment of both conditions more complicated. Patients can use substances both as a maladaptive way to cope with their mental health symptoms and

also to increase dependency on that same substance (Volkow & Blanco, 2022).

But chemical dependency doesn't solely burden the individual; it has far-reaching health impacts. Moeller et al. (2020) reported, using data from the National Institute on Drug Abuse, that about 10% of the US population had some form of SUD. This widespread prevalence is accompanied by increased socioeconomic costs, including more significant healthcare expenditures to manage substance-related conditions; lost productivity due to not showing up for work; increased resources allocated by the criminal justice system in the form of drug-related crimes, and family breakdown and increased homelessness, leading to increased violence and subsequently creating a further burden on the healthcare system (Amaro et al., 2021).

The situation in Ukraine is similarly alarming. Tan et al. (2020) estimate that 7 percent of the adult population engages in drug use, highlighting a rising trend in opioid use among younger adults. This also means we are likely to see higher rates of coexisting mental disorders among substance users, which will significantly affect healthcare utilization, family disruption, and increased rates of crime involving drug offenses. For example, in Europe, Aghenitei & Galateanu (2023) estimate that approximately 5% of adults in the European Union report having used an illicit drug in the past 12 months. However, the prevalence of each problem constitutes a complex public health challenge, and each member country demonstrates different degrees of substance use-related problems, ranging from drug dependency and health problems to social consequences, such as those mentioned above. The estimated social cost associated with drug use, health, and social harms in Europe is staggering at more than €100 billion across member countries (EFAA, 2021). The rising numbers and associated complications emphasize the need for effective prevention and treatment to combat SUD in the Ukrainian context and across European countries as a collaborative effort, targeting each context accordingly. The high cost of addiction treatment is generally a barrier for many to seek help with their substance use. Issuing funds and investing in programs at both the national and regional levels can lead to cost savings by decreasing the incidence of substance use disorders. Engaging international efforts in supporting community-based programs (Hutsaliuk et al., 2021, 2023), educational activities (Stryhul et al., 2019; Semenets-Orlova et al., 2019a,b), and health campaigns will be fruitful and cost-effective in terms of decreasing substance use prevalence.

2.2 Biochemical Factors in Addiction

Knowing the fundamentals of brain chemistry underpinnings of chemical dependency mediates an appreciation of how addiction is a delimited condition and not isolated to individual circumstances, thereby grounding the illness-model view of addiction as being multifactorial. Given that addictive substances interact with the brain's neurotransmitter systems, we see how drug use plays a substantial role in both the onset or persistence of substance use disorders (SUDs) (Giovannelli & Pfister, 2023). For instance, epidemiological evidence on the roles of neurotransmitters, neural pathways, and genetic components underlying addictive behaviors was reviewed by an investigation by Green et al. (2021). These primary research findings provide evidence of what may be triggering addictive behaviors to guide the treatment development and intervention approaches in SUDs. One of the neurotransmitters that have been most documented as a basis of addiction is dopamine (Wei et al., 2020). Dopamine is the foundation of the brain's reward circuitry. When the brain's reward circuitry is activated (e.g., when one eats delicious food or engages in social activities) or using substances with psychoactive properties, dopamine (dopamine-induced pleasure) is released. When drugs are consumed, it often precipitates an increase in dopamine that surpasses the amount that naturally occurs when eating or socializing (Volkow & Blanco, 2023). The high brought by a cocaine or methamphetamine binge is responsible for this dopamine rush. Repeated use of addictive substances such as cocaine, heroin, and methamphetamine cause the brain's reward systems to become defunct because they now depend on the drug to be releasable.

Another essential neurotransmitter, serotonin, participates in the modulation of mood, and adjustments here have been associated with feelings of well-being and happiness. For example, alcohol can raise serotonin levels a bit, offering a shot of mood elevation, but sustained use eventually can cause depletion, contributing to depressive symptoms as well as cravings for more alcohol (Ngui et al., 2022). Then there is norepinephrine, related to the body's stress response and heightening of arousal and alertness but also linked to mood disorders and anxiety, another co-occurring condition that's common with addiction (Fronk et al., 2020).

Chronic exposure to addictive substances also produces structural and functional changes in brain circuitry that, for instance, alter synaptic plasticity, a central process through which memories are formed and learning transpires. Examples include neuroadaptations that induce changes in opioid receptors as a result of chronic opiate use (effects that can result in the individual developing physical dependence or becoming more tolerant and requiring higher doses of this substance to experience the same effect; Strang et al., 2020). A reduction in the brain's tools for experiencing pleasure (i.e., reward circuitry) coupled with sensitization that reduces one's ability to function optimally without a substance reinforces a cycle of drug use that creates an illusion of negative reinforcement where the individual feels an urge for the drug to avoid experiencing the high, low or withdrawal. Another example of biochemical influences includes substance use's downstream consequences on the hypothalamic-pituitary-adrenal

(HPA) axis. This response to stress or traumatic experiences (particularly chronic stress through trauma) produces high levels of cortisol and other stress hormones (Zefferino et al., 2021; Danko & Yudenko, 2024). Hyper-arousal and heightened anxiety associated with stress and trauma promote the sense that the user's brain is temporarily unable to endure these challenging emotional states, which may strengthen the use of drugs as a tool to cope with them. Another endpoint will focus on identifying the genetic basis for addiction. According to Popescu et al. (2021), alternative forms of the same gene can influence the risk for addiction, like the variants for the dopamine D2 receptor gene (DRD2); in particular, they have been shown to affect the vulnerability to alcohol and drug dependence.' Polymorphisms of the dopamine D2 receptor gene (DRD2) have consistently and robustly been associated with increased risk for alcohol and drug dependence (Blum et al., 2023). The identification of genetic markers may help to discover why some people develop chemical dependency while others do not. This would greatly assist in developing personalized treatments.

However, discovering the biochemical mechanisms that support addiction can result in more effective and targeted strategies for rehabilitation, as well. Different medications that can be used to treat opioid dependence – including buprenorphine or naltrexone – create balance, partially restoring systems (Hood et al., 2020). These medications can help reduce cravings and withdrawal symptoms, smoothing the process. Furthermore, many behavioral therapies can help tackle the psychological aspects of addiction. One of the most well-studied behavioral modalities is cognitive-behavior therapy (CBT). This type of therapy can help an individual challenge disordered thought patterns and identify maladaptive behaviors. Overall, when combined with medications, CBT can significantly improve outcomes in treating substance use. In fact, this CBT-plus-medications approach has been shown to be as effective as more intensive talk therapy approaches (i.e., over 12 sessions), which can be cumbersome and expensive to deliver (McHugh et al., 2024).

Nevertheless, the most alluring approach is Gestalt therapy, a more dynamic, holistic model that can also enhance treatment efficacy (Skottun & Krüger, 2021). Similar to yoga, meditation, and mindfulness, Gestalt therapy emphasizes the interconnections between the mind and body, as well as an individual's ability to be present and in charge of their own experiences. Notably, there are hints of a positive relationship between Gestalt therapy and CBT. Just as it is with Gestalt therapy, the underpinnings of CBT interventions incorporate a commitment to increasing self-awareness and facilitating coping strategies. Though distinct in their philosophical makeup, both modalities focus on increasing self-awareness, attending to emotions and sensations, and embracing change for self-growth. These approaches would diverge in the way these modalities suggest that people get there. Gestalt therapy leans more heavily on experiential awareness, encouraging individuals to show up in the present moment with a nonjudgmental focus on sensations, emotions, breathing, and accessing unexpressed parts of the self (Dreitzel, 2021). Conversely, CBT would probably approach these goals with more specific protocols, breaking, and behaviors before facilitating this combination, which holds promise. Integration may allow for a dependency and behavioral choice, a manageable toolkit for incorporating actionable tips in navigating the complex recovery process.

Lastly, when we question whether the therapy works, how might Gestalt therapy complement the cognitive focus of CBT on reshaping substance usage while still capturing the emotional avoidance that drives utilization? Taylor (2021) notes that Gestalt therapy focuses on enabling individuals to become aware of their emotions and feelings and to experience and accept them, literally sitting with the emotions until they pass. For example, someone might feel intense anger but might not be aware that this can be an emotional reaction to unresolved conflict or trauma. Allowing patients to articulate these feelings and explore the associated emotions and triggers can contribute to breaking the cycle of addiction and improving the patient's overall emotional well-being. Cognitive behavior therapy, interim therapy's dominant model thus far, focuses primarily on reorienting one's biochemical and behavioral focus away from substance usage and back to whatever use case initially enabled their utility. But given the often furtive and activating nature of self-administered substance usage, an approach that enables one to articulate the feelings behind such utilization – for illustration, someone feeling the need for communal acceptance and thus turning to drugs – can help the patient achieve a dual focus on both the psychological and biochemical aspects of their addiction. It is about the person in the seat – mapping who they are and who they can become. A behavioral disposition involves regulating the body's biochemical balance and modifying behavior towards what serves rather than against it.

3. Methodology

This study adopts a systematic approach to analyze the current state of research concerning chemical dependency, biochemical factors, and the associated progressive rehabilitation techniques and psychosocial adaptation strategies aimed at enhancing well-being. The methodology encompasses several key components, including literature search criteria, selection and inclusion criteria, data extraction, and analysis.

3.1 Literature Search Strategy

An extensive literature search was carried out across several online databases, including PubMed, Scopus, PsycINFO, Web of Science, and Google Scholar. The search strategy comprised several key steps: Keywords and Search Terms involved using a combination of

relevant terms such as "chemical dependency," "substance use disorder," "biochemical factors," "rehabilitation techniques," "psychosocial adaptation," and "emotional intelligence," with Boolean operators (AND, OR) to systematically refine the search results. Time Frame was set to prioritize research articles published within the last two decades (2004-2024), ensuring that the review captured the most recent advancements and findings in the field.

3.2 Selection and Inclusion Criteria

The selection of articles for inclusion in this review was guided by predefined criteria. Type of Publications: Only peer-reviewed journal articles, systematic reviews, and meta-analyses were considered to ensure the inclusion of high-quality evidence. Relevance: Studies were required to address chemical dependency, biochemical interactions related to addiction, innovative rehabilitation practices, and psychosocial strategies for recovery. Population: Research involving diverse populations, including adolescents, adults, and individuals from various socio-economic backgrounds, was included to provide a comprehensive understanding of the issues. Articles were excluded if they: (i) Focused on non-substance-related dependencies; (ii) Were primarily opinion pieces or commentaries without empirical support; (iii) Addressed outdated methodologies or concepts no longer relevant to contemporary practices.

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3.3 Data Extraction

Once relevant articles were identified, key data were extracted systematically. This process involved gathering the following information from each publication: (i) Author(s) and Year of Publication; (ii) Study Design and Methodology, which included details such as sample size, population characteristics, and types of interventions employed; (iii) Key Findings, focusing on significant results related to biochemical factors, the effectiveness of rehabilitation techniques, and psychosocial adaptation strategies; and (iv) Limitations, which captured any criticisms or limitations noted by the authors concerning their studies.

3.4 Data Analysis

The extracted data were evaluated qualitatively to uncover prevalent themes and patterns within the literature. This analysis focused on several key areas: Trends in Research highlighted significant shifts in the understanding of chemical dependency and its biochemical foundations over time. Innovative Techniques were reviewed comprehensively, examining new rehabilitation strategies and their reported effectiveness across various studies. Psychosocial Adaptation provided insights into the importance of social support systems and the development of emotional intelligence in the recovery process. Additionally, quantitative data from studies featuring numerical analyses were summarized to offer a statistical overview where relevant.

3.5 Synthesis of Findings

The synthesis of findings involved aggregating themes and insights from the reviewed literature into cohesive sections. This process aimed to highlight the interconnectedness of biochemical factors, innovative rehabilitation techniques, and psychosocial strategies in the context of enhancing well-being for individuals facing chemical dependency. Each section was critically analyzed, and conclusions were drawn regarding best practices and areas needing further exploration.

3.6 Ethical Considerations

As this is a review article, there were no direct ethical concerns regarding participant involvement. However, all reviewed studies were selected based on their adherence to ethical research standards, ensuring that they respected the rights and well-being of study participants as outlined by relevant ethical guidelines.

4. Results and Discussion

The utilization of chemical substances, particularly drugs, initiates a self-destructive mechanism within an individual. Even Hippocrates, in his contemplation of addiction, expressed astonishment at the paradox of employing one's own mind in opposition to oneself (Zahir, 2016). In the context of chemical dependency, several groups of risk factors can contribute to an individual's likelihood of developing substance use disorders. These risk factors can be categorized into several domains, including biological, psychological, social, and environmental influences (Table 1).

Addressing these risk factors through comprehensive educational programs, community support systems, and personalized treatment approaches can significantly reduce the likelihood of substance use disorders and foster healthier communities. Moreover, recognizing the categories of individuals vulnerable to chemical dependency (Figure 1) is essential in formulating effective treatment and prevention strategies.

4.1. Individuals with Mental Health Disorders:

People suffering from mental health issues such as anxiety, depression, bipolar disorder, or borderline personality disorder are at a higher risk for developing chemical dependency. They may use alcohol or drugs to alleviate their symptoms or escape emotional pain, creating a cycle that can result in addiction.

4.2. Adolescents and Young Adults:

Younger individuals, particularly adolescents, are particularly vulnerable to the influence of peer pressure and experimentation with drugs and alcohol. Their brains are still developing, which makes them more susceptible to the addictive properties of substances. Early exposure to chemical substances can lead to the early onset of addiction and subsequent long-term consequences.

4.3. Individuals from Dysfunctional Family Backgrounds:

Those who grow up in families characterized by instability, abuse, or neglect are at a heightened risk of chemical dependency. The absence of supportive relationships and positive coping mechanisms can lead these individuals to seek solace in substances as a means of escape or relief from emotional distress.

4.4. Veterans and Individuals Exposed to Combat:

Individuals who have served in military operations may experience significant psychological stress due to the traumatic events they have encountered. Common consequences include post-traumatic stress disorder (PTSD), depression, and anxiety (Yudenko & Stepanenko, 2022). To cope with these overwhelming feelings, many veterans may turn to substances as a way to self-medicate, leading to an increased risk of chemical dependency.

4.5. Individuals Living in Socioeconomically Disadvantaged Conditions:

Poverty-stricken environments often correlate with higher rates of substance abuse. Individuals in these situations may face chronic stress, lack of access to education and health resources, and exposure to crime, all of which can increase vulnerability to chemical dependency.

4.6. Individuals with Historical Trauma:

Populations that have experienced systemic oppression, such as Indigenous communities or marginalized ethnic groups, may exhibit higher rates of substance abuse. The historical trauma faced by these communities contributes to collective psychological distress, leading some individuals to turn to alcohol or drugs as a coping mechanism.

4.7. Individuals in High-Stress Professions:

Certain occupations that involve high levels of stress, such as emergency responders (firefighters, paramedics) and healthcare professionals, can lead to substance use as a means of coping with the demands of the job. The pressure to perform and the emotional toll of dealing with traumatic situations can drive individuals toward chemical dependency.

These issues of chemical dependency and bodily and genomic health are crucial for understanding the genomic landscape of rehabilitation: the psychoactive effects of substances typically vary based on how they are processed, and individuals who use drugs can experience declines in their nutritional intake, immune function, and genomic expression due to the psychological and physiological changes associated with addiction. The relationship between SUD and nutrition is complex; many compensatory factors are interrelated and cause the decreased nutritional intake and absorption that are often the result. Many stimulants, such as cocaine and amphetamines, have an appetite-suppressing effect, which can lead to significant weight loss and nutritional deficiency. Other substances, such as alcohol, can promote increased caloric intake from 'empty' or refined carbohydrates. Substance users might prioritize drugs or alcohol over food, which can lead to a nutritionally inadequate diet. For example, heavy drinkers can suffer from a decreased appetite for nutritious food and an increased appetite for processed foods. Chronic SUD can profoundly impact the gut and its ability to digest and absorb nutrients. Alcohol consumption, for example, can cause inflammation of the gut lining and lead to the depletion of some nutrients (such as zinc, calcium, vitamins A and B) and disturb absorption of others.

Some particular vitamins and minerals are disproportionately affected by substance use, leading to a litany of health issues. Vitamin B12 is a significant cofactor in producing red blood cells and neurological function (Green, 2017). People with SUD might experience trouble absorbing B12 due to poor nutrition, or chronic substance use can lead to gastritis or pancreatitis, preventing absorption altogether. In cases of B12 deficiency, red blood cells containing an increased amount of hemoglobin are produced as the body tries to compensate for the lack of B12 and strove to increase the hemoglobin content of each red blood cell, ultimately resulting in megaloblastic anemia (Fenech, 2012). This condition produces immature, abnormal red blood cells, causing them to be big and amorphous, unable to do their vital job, leading to fatigue, weakness, and neurological malfunctions. Deficiencies in the folate level, also known as vitamin B9, are also implicated in megaloblastic anemia, as it is a vital nutrient for DNA production and repair (Fenech, 2012), similar to B12. Folate aids in the production of red blood cells, too. Vitamin B12, which is mainly derived from dietary sources, is critical to the function of digestive enzymes and is essential for the absorption of folic acid and copper. Folate deficiencies are particularly weighty for people with alcohol-use disorder since they are prone to choose foods that lack valuable nutrients, consequently leading to alcohol-induced deficiency of folate and other B vitamins.

Moreover, substance use may lead to iron deficiency anemia, aggravated by dietary deficiencies, chronic blood loss, or faulty ferritin stores. Fatigue, weakness, and pale look are associated with this kind of anemia and may deter the recovery process. Substance-dependent people may be deficient in vitamin D and calcium, which have a great impact on bone health, therefore promoting osteoporosis, a condition that is of grave consequence for rehabilitation, where physical ferocity and robustness are crucial in the process of rehab.

Poor nutrition impairs immunity, leading to increased susceptibility to infection, which in turn can prolong the time to hospital discharge. Suboptimal amounts of crucial nutrients are tied to impaired mood regulation and cognition. Low levels of B vitamins and omega-3 fatty acids have been linked to heightened anxiety and depression, which are two of the very issues that recovery-minded patients must grapple with (Lange, 2020). Unaddressed nutrient deficiencies can limit rehabilitation efforts,

prolonging the recovery trajectory and increasing the risk of relapse. Favorable nutritional status is associated with better recovery outcomes.

Besides their immediate behavioral impact, addiction systems produce profound genetic changes. Exposure to addictive drugs leads to epigenetic changes (modifications of gene expression) that alter critical biological processes such as stress responsiveness, reward processing, and mood regulation, leading to enduring changes in health.Changes in genetics can be affected by environmental factors and passed down through generations. These changes often persist long after drug use has ceased and significantly affect the individual's long-term wellness and response to (derived from the Greek words for 'on top of' and 'genetics') refers to heritable changes in gene expression that do not involve changes in the underlying DNA sequence. Epigenetic mechanisms can be influenced by environmental exposure, lifestyle factors, and stressors (Danko & Yudenko, 2022). In the context of addiction, exposure to addictive medications and drugs and the lifestyle that develops from active use can cause epigenetic changes. Mechanisms of epigenetic changes include:

DNA Methylation: Involves adding methyl groups to DNA (usually turning off gene expression). Substance use can reverse methylation patterns, leading to persistent changes in genetic expression.

Histone Modification: Histones are proteins that DNA wraps around. Chemical modifications to the code of histones can regulate the genes that are available for transcription. Histone acetylation and methylation can up or down-regulate the expression of proteins involved with addiction and behavior.

Non-coding RNAs: These RNA molecules function to regulate gene expression and can impact the influence of substance use exposure, potentially by adjusting sensitivity to environmental stimuli.

Epigenetic alterations to the body's stress response systems, including the hypothalamic-pituitary-adrenal (HPA) axis, can affect the expression of genes in individuals with an addiction history. People exposed to chronic or prolonged stress who also experience addiction often defy their position in the recovery process with intense stress responses, which alter their maladaptive emotional regulation and render them vulnerable to relapse. Another neural system affected by epigenetics is the reward circuitry, which, for most people, functions mainly through dopamine. When epigenetic changes alter the genes that control dopamine receptors, it can alter an addict's ability to experience pleasure from natural rewards, leaving them chronically unsatisfied with life and, thus, incentivizing substance use as the warm blanket to hold them in a state of bliss. Epigenetic alterations might also affect the expression of neural circuits involved in apparently basic emotional processing through epigenetic changes in brain regions such as the amygdala, a key player in emotional processing. These changes can diminish regulatory capacities through the cerebral cortices and related structures important in self-reflection, guided behavior, life choices, and appraisals. People who have increasingly relied on drugs or alcohol for very long will often find their abilities to manage emotions compromised, leading to increased anxiety, depression, and a return to drugs or alcohol to quell discomfort.

The persistence of epigenetic modifications in individuals recovering from addiction poses significant implications for their long-term health. Even after cessation of substance use, the epigenetic alterations can leave individuals with an increased risk of relapse, as their brain chemistry and emotional responses may still respond to triggers similarly to when they were actively using substances. Such people may be at a heightened risk for developing mental health disorders due to sustained epigenetic changes affecting stress and emotional regulation pathways. This vulnerability can complicate the recovery process and necessitate continued support.

Due to genetic disorders, the consequences can affect the future generations. To illustrate the impact of parental substance use on children, consider the following statistics: if both parents lead a sober lifestyle, the risk of their child developing a propensity for alcohol or drug use is approximately 15-20%. If one parent uses psychoactive substances freely, this risk increases to 35-40%. Moreover, regular moderate drinking, even if limited to holidays, can place future children at risk. When both parents are not opposed to alcohol consumption, the likelihood that their children will follow suit rises to 50% (Wood et al., 2004). Notably, that American researchers have conducted experiments with identical twins raised in different environments. Despite being raised in distinct families and locales, these twins often began smoking at the same age and would frequently choose the same brand of cigarettes (Wright, 2008). This phenomenon highlights the role of biological factors and heredity in influencing behavior. Scientific circles propose that the underlying reasons for such behavior may be found in the blood and its biochemical composition. A key neurotransmitter involved in brain function is acetylcholine, which is responsible for controlling the muscular system, memory, and cognitive processes. Children born with low levels of acetylcholine may experience neuromuscular disorders, poor concentration, and memory problems (Chikkannaiah & Reyes, 2021).

As dopamine plays a pivotal role in generating positive feelings and providing an optimistic outlook on life, it also has a significant influence on cardiovascular health (Förster & Kanske, 2022). Consequently, individuals struggling with alcoholism face heightened risks of heart disease and cancer. A deficiency in dopamine can lead to mental health issues, such as depression and feelings of guilt. Many people may inadvertently turn to substances like wine to cope with feelings of remorse.

Norepinephrine is responsible for motivation, energy levels, and neurohormonal control (Atzori et al., 2016). A deficiency in

norepinephrine can result in fatigue and a lack of vitality, further complicating an individual's capacity to thrive. Serotonin regulates emotional stability and self-control (Boisvert et al., 2018). Individuals prone to addiction often exhibit symptoms that reflect an underlying biochemical imbalance. A deficiency in serotonin may lead to anxiety, fear, and sleep disorders, creating a heightened sensitivity to change and instability. Gamma-aminobutyric acid (GABA) plays a critical role in self-control (Sideraki & Drigas, 2024). Insufficient levels of GABA can lead to increased irritability and the inability to maintain composure. Endogenous opiates function as natural pain relievers, providing emotional and physical stability. When experiencing emotional or physical turmoil, these substances modulate pain perception, allowing individuals to cope better. However, a deficiency in these opiates can lower the pain threshold, leading people susceptible to addiction to experience heightened pain levels. There are documented cases where patients awakened during surgeries due to inadequate anesthesia, which is particularly alarming for those with addiction histories (Earley, 2013).

Encephalins are responsible for regulating the body's stress response (Meno et al., 2011). A deficiency in encephalins can lead to feelings of dissatisfaction and panic, while endorphins contribute to the sensation of well-being. When endorphin levels are low, individuals may perceive the world through a distorted, bleak lens, making it difficult to experience joy or pleasure.

Considering these factors, what implications arise for a child born with a complete set of these biochemical disorders? Such a child might struggle with attention deficits, experience diminished pleasure from everyday activities, and perceive the world in more tragic hues, feeling pain more acutely. Adult children of addicted parents may avoid psychoactive substances but still face a myriad of challenges regarding their self-image, relationships, and overall worldview. The detrimental effects of their parents' harmful addictions can manifest in a range of psychological and emotional difficulties, underscoring the importance of addressing family histories of substance use in treatment and rehabilitation efforts. The intricate biochemical landscape surrounding chemical dependency not only affects individuals directly involved with substances but also has far-reaching consequences for their offspring.

Rehabilitation Techniques

With the aim of providing more excellent tailoring around highly individualized factors affecting its unfolding, 'recovery-oriented systems of care' have largely supplanted 'treatment-as-usual' within the field of addiction rehabilitation. Similarly, there are more effective and less stigmatizing means to fund care. This shift has occurred through an expanded toolbox of sobering-up strategies and a growing emphasis on rehab as playing a constitutive role in long-term recovery – not merely as some Band-Aid solution. For a prolonged period, the dominant rehabilitative approaches to addiction – characterized by the 12-step programs (e.g., Alcoholics Anonymous), which concentrate on personal responsibility and peer sponsorship – were both its instigators and its firewalls. Although widely endorsed, these programs have been criticized for lacking flexibility and being evidence-free across disparate populations (Carroll, 2009). Only in recent years have researchers and practitioners developed a more fine-grained toolbox.

These innovative approaches incorporate psychologically and behaviourally informed psychotherapies that seek to address some of the underlying factors that contribute to addiction. The role of psychotherapy as an integral part of rehabilitation models has helped shape these treatment advances.

CBT has become one of the most effective evidence-based treatment modalities for addiction (Stokes, 2023). CBT reflects the idea that thoughts, feelings, and behaviors are interconnected and together influence addiction. CBT treats anger and hostility. Armed with a firm conviction that the patient is responsible for his or her recovery, CBT addresses addictive thought patterns and helps an individual modify them. As a result, people who received cognitive-behavioral therapy had lower instances of relapse and improved coping skills (Imran, 2023). A therapist might ask a person in recovery to self-monitor feelings and thoughts in a journal, which facilitates the practice of refocusing, or distancing, from negative thoughts and emotions. CBT provides analytical tools that aid in tracking mood, identifying and overcoming cravings, coping with shame and high-risk situations, and practicing and reviewing activities to affirm sober behavior.

Motivational Interviewing (MI) is another novel approach that gains traction in treatment settings. Client-centered counseling is aimed at increasing intrinsic motivation to change by exploring ambivalence and enhancing the person's readiness to change in their direction. MI reduces substance use and enhances treatment retention in rehabilitation (Orciari et al., 2022). The collaborative approach used in MI helps establish rapport between the counselor and client to guide the dialogue toward identifying the motivations and barriers to change. MI could also be substantially helpful in working with highly reluctant or resistant help-seekers or those not ready to commit to standard rehab programs.

Mindfulness-based interventions often serve as rehabilitation approaches focused on 'mindful' present-moment awareness and acceptance, which facilitate recovery by improving elements such as emotional regulation and reducing stress (Peixoto & Gondim, 2020). Activities like mindfulness meditation, yoga, and breathwork can equip individuals with skills to deal with stressful situations and reduce cravings, which is crucial to build resilience against relapse. As for mindfulness practices, individuals report improved emotional awareness, greater self-control, and better coping skills.

Such advancements enrich the recovery process as a whole, both for mental and physical health alike.

Experience-based learning methods – for example, role-play and simulations – have been found to be effective for augmenting treatment and rehabilitation by offering people opportunities to practice new thinking and coping skills to repair relational functioning in a safe environment before using those skills in the natural field. Such active learning improves understanding and retention of coping skills and emotional intelligence (Kastberg et al., 2020).

Role-plays can help participants face their triggers, practice responses, and build resilience in a safe environment (Otani et al., 2024). By playing their role, players acquire confidence while experiencing and exploring their feelings and reactions to high-stakes real-time scenarios, equipping them to take on the challenges of life during recovery.

Psychosocial Adaptation

Psychosocial adaptation as a major asset in recovery from chemical dependency Psychosocial adaptation (the process of adjusting and adapting to one's social environment) is a concept that is drawing wide attention regarding recovery from chemical dependency. To put it in more concrete terms, in the process of 'getting clean' and becoming drug and alcohol-free, drug and alcohol users need to adapt emotionally and socially to their social environment, which has suffered significant change because of the user's life history (e.g., overcoming extreme poverty, leaving difficult family situations, overcoming travesties, etc.). This concept suggests that many challenges likely need to be surmounted for an individual in early or continuing recovery from addiction to avoid relapse or achieve higher levels of spiritual and emotional wellness. Conceptualizing recovery as a process of psychosocial adaptation suggests that recovery must occur within supportive environments. Resilience is a significant asset for people in recovery. This conceptualization of recovery advocates for social and institutional environments that help to prevent relapse and foster resilience in individuals with histories of substance use disorders. Effective rehabilitative strategies, as suggested by this concept, consider the forces that impact the individual and those that affect both the individual and the social/institutional environment, such as when psychological disposition sustains social dysfunction or vice versa. Recovery thus conceived avoids the pitfall of being seen as entirely programmatic and as something that is only a private personal matter. Research by Agarwal et al. (2020) highlights the role of the community in engendering neighborhoods of empathy and care for bolstering resilience and fostering emotional well-being on the path to recovery. Close support systems comprising family, friends, and recovery groups beyond the formal care structure play a crucial role, offering emotional support and identifying with and relating to resilience narratives, fostering a sense of belonging and solidarity in recovery.

Going to peer support groups, especially Alcoholics Anonymous (AA) or Narcotics Anonymous (NA), is common in recovery but highly motivating. Such groups promote a sense of belonging and shared experience where people can give and receive verbal reinforcement about their struggles, successes, and coping. The group context tends to hold people accountable to their commitments and, therefore, motivates continuing efforts towards sustained sobriety.

A crucial aspect of psychosocial adaptation is the development of interventions to increase emotional intelligence (EI), which involves recognizing, understanding, and managing one's own emotions and considering the feelings of others (Zhylin et al., 2023, 2024). People with high EI will be much better positioned to manage their stress, be empathic, and make wiser decisions about how to respond best. Interventions that focus on emotional regulation and empathic capacities might prevent relapse by providing individuals with the ability to regulate their emotions and allowing for emotion-regulatory flexibility without relying on the substances of abuse as coping strategies. Such interventions are developmentally promoted and biologically plausible and should be adequate if included within the rehabilitation strategy. Some examples of these strategies include:

Family Involvement: Fine-tuning family mutuality can foster an environment at home that supports the addict's recovery efforts, including open and understanding communication between the addict and family members. Family therapy sessions can also help develop and rejuvenate these relationships.

Community Engagement: Encouraging community involvement through volunteer work and other social events helps build a sense of purpose and inclusion, contributing to social skills and an appreciation of positive social contributions.

Skill-Building Workshops: Workshops to develop communication, conflict-resolution, and management skills can help individuals hone their capacities. By developing their psychosocial competencies as they progress through recovery, they can better ward off difficulties and engage in healthier relationships.

Integration of Digital Technologies

The broader use of digital technologies for treatment reflects a significant paradigm shift in how rehabilitation programs are developed and delivered. The continued growth of SUDs worldwide calls for innovative approaches to using digital technologies to address the educational, therapeutic, and community support needed by those seeking help. We currently see the use of digital technologies, such as smartphone applications (apps) and online portals, to enhance addiction treatment programs. These technologies provide a means of delivering educational content, therapeutic content, and support to the patient in ways that can be

Table 1. Categories of Risk Factors Contributing to Chemical Dependency

Risk Factor Category	Specific Risk Factors	Description
Biological Risk Factors	Genetic Predisposition	Family history of addiction can increase the likelihood of chemical dependency, with estimates suggesting that genetics may account for 50% of the risk (Deak & Johnson, 2021).
	Neurobiological Factors	Variations in brain chemistry and neurotransmitter systems can affect an individual's susceptibility to addiction (Kaplan et al., 2022). For example, dysregulation of the dopamine system has been linked to increased risk of substance use disorders.
	Mental Health Disorders	Co-occurring mental health issues, such as depression, anxiety, or bipolar disorder, increase vulnerability to substance use as individuals may self-medicate to alleviate symptoms (Shenoi & Yurewicz, 2023).
Psychological Risk Factors	Impulsivity	Individuals with high levels of impulsivity may be more prone to engage in risky behaviors, including substance use (Verdejo-Garcia & Albein-Urios, 2021).
	Low Emotional Intelligence	A lack of skills to recognize and manage emotions may lead individuals to rely on substances for emotional regulation (Weiss et al., 2022).
	Coping Mechanisms	Ineffective coping strategies or reliance on drugs or alcohol as a primary means of coping with stress can increase the risk of addiction (Freeman et al., 2020).
Social Risk Factors	Peer Influence	Association with peers who use substances can significantly elevate the risk of developing chemical dependency, particularly during adolescence (Trucc, 2020).
	Family Dynamics	Dysfunctional family relationships, such as those characterized by abuse, neglect, or lack of support, can contribute to the development of addiction (Matejevic et al., 2014).
	Cultural Norms	Societal attitudes toward substance use can impact individual behaviors. In cultures where substance use is normalized, individuals may be more likely to engage in such behaviors (Room, 2006).
Environmental Risk Factors	Accessibility and Availability	Easy access to addictive substances can increase the likelihood of use and subsequent dependency (Dobbs et al., 2020).
	Trauma and Stressful Life Events	Experiences of trauma (e.g., physical or emotional abuse, violence) and chronic stress can lead individuals to turn to substances as a means of escape or relief (María-Ríos & Morrow, 2020).
	Socioeconomic Status	Individuals from lower socioeconomic backgrounds may face increased risk due to limited access to education, healthcare, and economic opportunities, as well as higher exposure to environmental stressors (Evans & Kim, 2010).
Developmental Risk Factors	Age of First Use	Early initiation of substance use is a significant predictor of later substance use disorders. The younger a person is when they start using substances, the greater the risk of developing addiction (Sung et al., 2004).
	Life Transitions	Key life transitions, such as leaving home, starting college, or entering the workforce, may introduce new stressors and peer influences that heighten the risk of substance use (Staff et al., 2010).

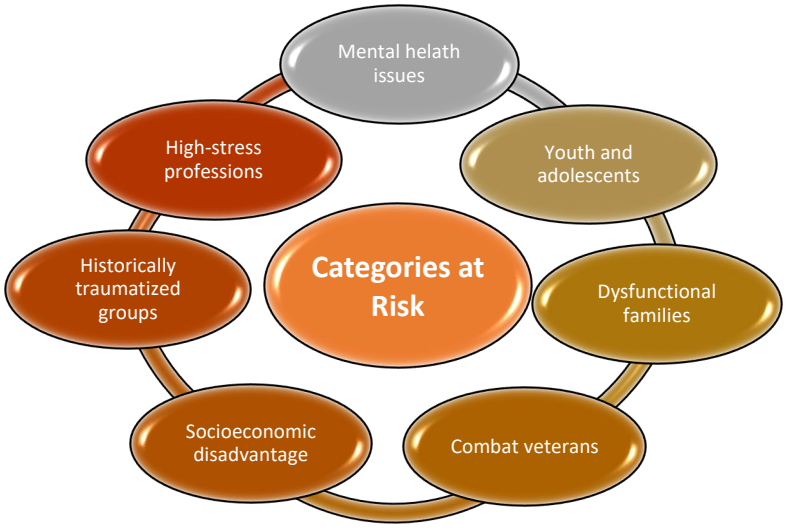

Figure 1. Categories of Individuals at Risk for Chemical Dependency

readily accessible and user-friendly. Mobile health interventions could have an enormous impact on enhancing treatment adherence and favorable outcome (Wang et al., 2020). A number of mobile devices, such as apps designed to support quitting substance use disorders, can help users monitor their mood, offer personalized coping skills, and alert them to stressful situations.

One of the most excellent opportunities that digital technologies can bring to the addiction treatment space is to increase the available care. Individuals with substance use issues might not access care because it is not available nearby, too expensive, or stigmatized (sometimes all of the above!), but digital technologies present a new opportunity to expand access (Cernasev et al., 2021)

And digital solutions can remove many of these barriers, too: There is no need to travel to a treatment resource or support group to access them digitally. Telehealth treatments and support services – where people can talk with a therapist or support staff from home – have become much more common. Research suggests that social support delivered online is helpful and positively impacts how people feel and that teletherapy and online counseling can allow people to function well in their daily lives. While some studies focus on interventions to reduce mental health symptoms among healthy populations, such as helping young people navigate the transition to college or encouraging more positive mood states among workers during the COVID-19 pandemic, most involve people suffering from mental health disorders and exploring strategies to alleviate symptoms and improve quality of life.

Digital technologies in addiction treatment also support greater levels of engagement and interaction with other users. For instance, many current mobile apps now contain community forums in which people can share personal stories, receive guidance and support, and reciprocate advice in return. This peer interaction is meaningful because it often helps overcome feelings of loneliness and encourages feelings of connectedness, which can improve motivation to sustain recovery. Another way in which engagement can be enhanced is by using gamification features in digital apps. Gamification deploys gaming elements (such as designing or competing in challenges, incorporating rewards, keeping scores, etc.) to 'make technology fun' and encourage greater uptake and engagement with digital technologies. For instance, through the use of games, users can explore and play through the development of their addiction, thus fostering deeper insights into their symptoms. The research findings have grown and suggest that these digital interventions work. Cognitive Behavioural Therapy (CBT), Mindfulness-Based Relapse Prevention (MBRP), and other therapeutic interventions can be offered through a digital platform, and such therapies have been shown to have positive effects on individual patients, often when administered online (Andersson & Cuijpers, 2009). These technologies can also be used to harness diverse skill-building exercises, allowing users to complete such skills on their own time and tailor these individual learning experiences to themselves. Offering access to e-learning modules to learn the skills needed for everyday life after treatment, be that psychological insights or practical skills, can contribute to the training to strengthen self-control. In this regard, probably one of the strongest features of digital technologies in addiction treatment might be the opportunity for continuous monitoring: the optimal performance of many applications is based on users regularly self-reporting their use, levels of stress, coping responses, and other variables. The history of this data is beneficial to patients in helping them recover and gives the attending therapist a better understanding of the patient's lived experience and more informative information on which to base a responsive treatment program.

Furthermore, the potential to collect and aggregate data systematically also increases the strength of any treatment program in terms of effectiveness and clinical decision-making. Despite the benefits, there are also many obstacles to a digital mental health agenda in the addiction field, such as digital literacy, access to technology, and privacy and data protection issues. Some people might not be willing to use digital technologies as it makes them feel uncomfortable, and they are scared that their information might get stolen. Similarly, not all digital interventions have been conclusively proven effective, and identifying the most suitable approach for an individual can be challenging. A person's motivation to recover might impact the effectiveness of the intervention.

5. Conclusion

The study of chemical dependency and its biochemical factors emphasizes the crucial need for innovative rehabilitation techniques and psychosocial adaptation strategies that tackle the complex nature of addiction. This article has shown how comprehending the underlying biochemical mechanisms—such as imbalances in neurotransmitters, genetic predispositions, and the effects of long-term substance use on physical health—can guide and improve recovery strategies. The recovery schism encountered in rehabilitation arises from ‘compartmental thinking’ that separates the domains of mind and body, emotion and cognition, nature and nurture. This type of thinking yields a dualistic bias that makes no sense. Suppose recovery, as a lived experience, consists of multiple co-occurring states. In that case, we must pay greater attention to how it can be deeply informed by profound histories and deeply complex physiochemical experiences. The starting point for this requires an integrated approach to rehabilitation, one that recognizes addiction as a brain disease and that intersects and aligns with the social fabrics of daily life rather than one that diverges from them. As psychosocial adaptation increasingly reveals deep emotional histories at the core of addiction, a bridging framework develops that integrates mind and body, cognition and emotion,

and the psychophysical and the social. Addiction, then, must be understood as an emotional and existential problem, for in redesigning the processes of rehabilitation, including centering individualized brain and physiochemical profiling as a pivotal component, we recognize that emotional intelligence holds recovery outcomes.

Moving forward, we should continue to advocate for the implementation of well-integrated, efficacious, biopsychosocial treatment interventions so that we can increase the effectiveness of addiction treatment and recovery among individuals who suffer from substance use disorders. Further research is required to understand the longer-term impacts of these approaches and what works best in combining biochemical and psychosocial strategies within viable recovery programs. With a more nuanced understanding of addiction, we can begin to devise more holistic solutions to sharpen the edge towards healthier citizens and more resilient communities and make a future for the public good.

Author contributions

M.Z. conceptualized the study and drafted the manuscript. V.M. contributed to data analysis and interpretation. O.T. assisted in methodology and provided critical revisions. O.R. and O.Y. supported the review and editing process. All authors reviewed and approved the final manuscript.

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