

Substance Use Patterns and Rehabilitation Outcomes among Residents of Iraqi Rehabilitation Centers: A Retrospective Comparative Study of Institutional Records from 2024 to 2025

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أنماط تعاطي المواد المخدرة ونتائج إعادة التأهيل بين نزلاء مراكز إعادة التأهيل العراقية: دراسة مقارنة استرجاعية للسجلات المؤسسية من عام 2024 إلى عام 2025

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Abstract:

This study aims to describe the demographic and clinical characteristics of residents in rehabilitation centers in Iraq, analyses patterns of substance use, and compare a number of therapeutics, neurofunctional and laboratory outcome indicators between 2024 and 2025, within the framework of a scientific review highlighting the practical value of neurobiochemistry in supporting youth rehabilitation programs. The study adopted a review, descriptive, analytical and comparative design, and was based on the complete institutional records of residents registered at rehabilitation centers affiliated with the relevant directorate, totaling 10,246 records, of which 4,827 were from 2024 and 5,419 from 2025. The results showed a 12.3% increase in the total number of residents, with a clear concentration of cases in younger age groups, particularly those aged between 25 and 30 and 30 and 35. The treatment landscape was dominated by amphetamine-type stimulants, of which the largest proportion was crystal methamphetamine, with relatively small proportions of Captagon, and smaller proportions of other substances. Regarding treatment outcomes, program adherence increased from 68% to 84%, program completion increased from 61% to 79%, the 6-month relapse rate decreased from 34% to 18% and the proportion of people returning to work or study increased from 42% to 67%. In addition, there was a general trend of improvement in the neurofunctional and laboratory parameters, such as the executive function, the regulation of stress, the balance of the reward circuits, the stability of sleep, recovery of the liver and kidneys, blood sugar control, and a decrease in *Helicobacter pylori* positivity. Within the scope of methodological interpretation, these results indicate that the effects of integrated rehabilitation programmes are not restricted to the reduction of drugs or alcohol use or to control of overt behavior but are also extended to other fields related to occupational stability, social integration, and some health parameters which are conducive to recovery. The study highlights the need for

rehabilitation and aftercare systems, especially in the context of high prevalence of stimulant use disorders amongst young people and of the burden of the disorder in this age group.

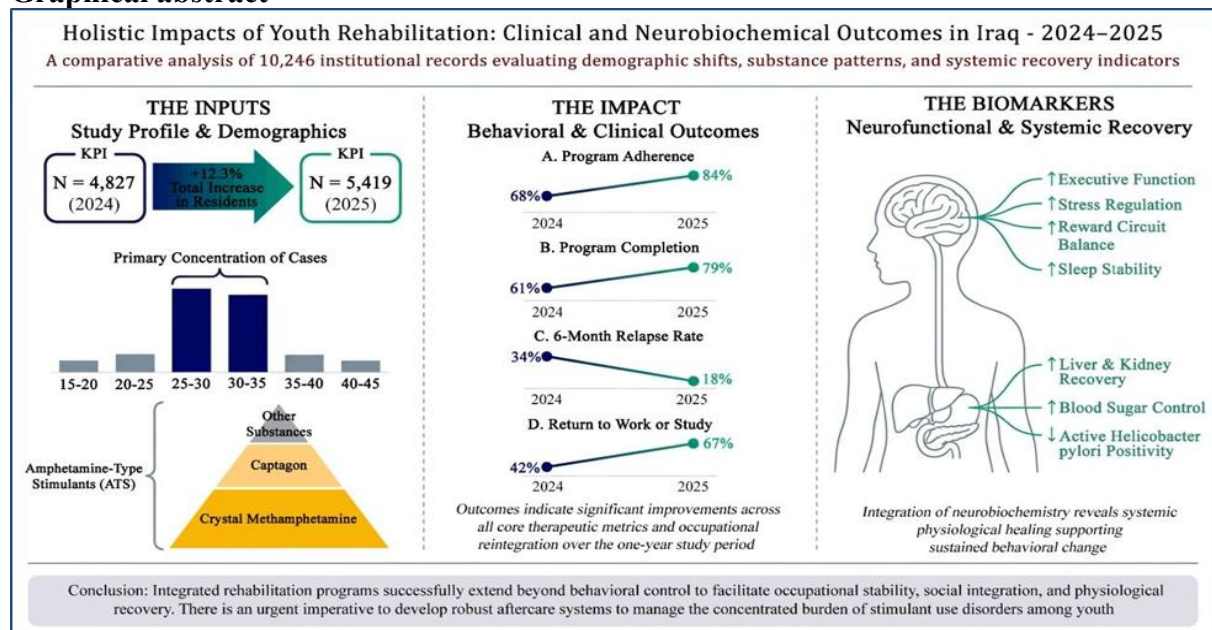
Keywords: Drugs, neurological treatments, amphetamines, methamphetamine, social integration.

المخلص

تهدف هذه الدراسة إلى وصف الخصائص الديموغرافية والسرييرية للمقيمين في مراكز إعادة التأهيل في العراق، وتحليل أنماط تعاطي المواد المخدرة، ومقارنة عدد من مؤشرات النتائج العلاجية والعصبية الوظيفية والمخبرية بين عامي 2024 و2025، وذلك في إطار مراجعة علمية تُبرز القيمة العملية للكيمياء الحيوية العصبية في دعم برامج إعادة تأهيل الشباب. اعتمدت الدراسة تصميمًا استعراضيًا وصفيًا تحليليًا مقارنةً، واستندت إلى السجلات المؤسسية الكاملة للمقيمين المسجلين في مراكز إعادة التأهيل التابعة للمديرية المختصة، والتي بلغ مجموعها 10246 سجلًا، منها 4827 سجلًا من عام 2024 و5419 سجلًا من عام 2025. وأظهرت النتائج زيادة بنسبة 12.3% في إجمالي عدد المقيمين، مع تركيز واضح للحالات في الفئات العمرية الأصغر، ولا سيما من تتراوح أعمارهم بين 25 و30 عامًا ومن 30 إلى 35 عامًا. هيمنت المنشطات من نوع الأمفيتامين على مجال العلاج، وكان الميثامفيتامين البلوري هو النسبة الأكبر منها، مع نسب أقل نسبيًا من الكبتاغون، ونسب أقل من مواد أخرى. فيما يتعلق بنتائج العلاج، ارتفعت نسبة الالتزام بالبرنامج من 68% إلى 84%، ونسبة إتمام البرنامج من 61% إلى 79%، وانخفض معدل الانتكاس خلال ستة أشهر من 34% إلى 18%، وزادت نسبة العائدين إلى العمل أو الدراسة من 42% إلى 67%. إضافةً إلى ذلك، لوحظ اتجاه عام نحو التحسن في المؤشرات العصبية الوظيفية والمخبرية، مثل الوظائف التنفيذية، وتنظيم التوتر، وتوازن دوائر المكافأة في الدماغ، واستقرار النوم، وتعافي الكبد والكلية، والتحكم في مستوى السكر في الدم، وانخفاض نسبة الإصابة ببكتيريا الملوية البوابية. وفي سياق التفسير المنهجي، تشير هذه النتائج إلى أن آثار برامج إعادة التأهيل المتكاملة لا تقتصر على الحد من تعاطي المخدرات أو الكحول أو السيطرة على السلوكيات الظاهرة، بل تمتد لتشمل مجالات أخرى تتعلق بالاستقرار المهني، والاندماج الاجتماعي، وبعض المؤشرات الصحية التي تُسهم في التعافي. تسلط الدراسة الضوء على الحاجة إلى أنظمة إعادة التأهيل والرعاية اللاحقة، لا سيما في سياق الانتشار العالي لاضطرابات تعاطي المنشطات بين الشباب وعبء هذا الاضطراب في هذه الفئة العمرية.

الكلمات المفتاحية: المخدرات، العلاجات العصبية، الأمفيتامين، الميثامفيتامين، الاندماج الاجتماعي.

Graphical abstract



Introduction

Mental health disorders and substance use are complicated biological, psychological and social problem, and cannot be reduced to the problem of behaviour. It is now a known fact that this disorder is a complex health condition, which can only be addressed through a multi-disciplinary approach, and having prevention, treatment, and care services part of the health system is a strategy that is more in line with the current evidence [1,2]. This is especially applicable in a scenario where communities are increasingly strained by the rehabilitation facilities and services available as the effectiveness of an intervention is not only determined by the immediate abstinence, but also the ability of the intervention to maintain abstinence, reduce relapse, and support the social and cognitive functioning in a residual manner.

On the international level, it is undisputed that drug use continues to pose a global health and societal issue and that synthetic stimulants (amphetamines and methamphetamine) have become an ever-growing category of both demand and supply (the United Nations Office on Drugs and Crime reports) [3]. This is particularly relevant to the treatment setting in the area, where the clinical setting has experienced a shift in recent years to the use of drugs to stimulants with pronounced impacts on the neural pathways of reward, attention and impulse control. Thus, any scientific evaluation of rehabilitative programs in these contexts needs to take into account the main drug involved, the age of the most vulnerable group, and related treatment outcomes.

Methamphetamine is especially problematic, and the literature suggests that it has neurotoxic effects, cognitive deficits, and a dysregulated dopamine system, and can cause long-term effects on memory, sleep, and executive function [4,5]. Additionally, there are no standard pharmacological treatments that have been shown to be effective for methamphetamine use disorder, and treatment retention and post-discharge follow-up are of key importance as part of the treatment framework [56]. Thus, it is important to focus on this pattern of use in applied substance use research to assess the outcomes of rehabilitation centers, where the severity of the substance use is likely to be associated with the nature of symptoms, burden of care, risk of relapse, and recovery in function. Rehabilitation outcomes are no longer viewed in terms of superficial behaviour change from a neurobiological perspective. They have been characterized as slow changes that impact plasticity of the nervous system, efficiency of executive function, stress response, and the regulation of reward circuits. The review literature suggests that executive function, decision making and cognitive flexibility are impaired in chronic substance users and that these cognitive domains may improve with abstinence and specific treatment, and the rate and level of improvement is dependent upon the substance of use as well as duration of use and severity of the disorder [7-10]. Sleep continues to play a central role in this context, and recent research has shown that sleep disturbances are present in many substance use disorders and can last beyond early abstinence and can impact craving, emotional regulation, and staying in treatment [11]. Sleep is a non-marginal symptom in the recovery process and improvement of sleep is seen as a clinically significant functional improvement, especially in the case of stimulants, because it is known to disrupt circadian rhythm and the natural sleep architecture. Therefore, neuropsychological and functional assessment parameters are important to see how rehabilitative programs affect the clinical state, because they provide a more detailed postrehabilitation clinical evaluation.

Therapeutic response is inseparable from indicators of program retention and completion; evidence suggests that patient retention within the treatment pathway is one of the strongest practical determinants of improved subsequent outcomes. Conversely, concurrent use of methamphetamine or amphetamines is associated with lower treatment retention and a higher likelihood of dropout in some treatment models, especially when it co-occurs with other disorders such as opioid use disorder [12,13]. Therefore, the interpretation of rehabilitation outcomes should balance indicators of abstinence or behavioral control on the one hand, and

indicators of continuity and program completion on the other, because genuine improvement typically emerges from the convergence of these two dimensions, not from either one alone [13].

Furthermore, effective rehabilitation is incomplete without the restoration of the individual's social and productive role. Reviews of interventions supporting employment and professional integration indicate that work and education are not merely secondary outcomes but structural components of recovery capital, given their impact on fostering stability and reducing the social vulnerability that triggers relapse [1,14-15]. Thus, RTW/RTE outcome measures in rehabilitation research incorporate a wider range of outcomes beyond that of clinical abstinence, consistent with the modern perspective on SUDs as chronic conditions that can change over time, rather than as discrete and brief episodes of substance abuse and addiction[13-15]. It accesses local findings in the international literature and contributes to the construction of a more precise professional discourse on achievable goals of rehabilitation centres and what still needs to be developed in the therapeutic structure and aftercare. With this in mind, this study aims to characterize the demographic, clinical, neurobiological and laboratory profiles of the residents of rehabilitation centers and analyze their treatment outcomes, emphasizing the young population and the use of substances that have a clearly neurobiological effect. It also seeks to deliver a scientific interpretation of the neurobiological underpinnings of substance use disorder and a set of markers of to recovery success, so that recovery is not considered an "administrative" result, rather a multi-dimensional process of treatment engagement, decreased relapse, functional improvement and greater potential for social reintegration. In this respect the present introduction will serve as a frame for the interpretation of the results of the study in terms of a clinical and neuro-socio-behavioral approach, as required for a rigorous academic publication [1,13,5,10].

The neurobiological approach to substances of abuse, medical chemistry's contribution to diagnosis and the institutional support for rehabilitation and prevention work.

The results of this study can be better understood if viewed in the context of the neuropharmacological effects of drugs of abuse and laboratory blood markers that could be used to detect the presence of drugs in the body and monitor treatment improvement or relapse. Substance use disorder is not limited to exposure to a chemical compound alone, but also involves a series of changes in reward circuits, arousal, stress response, cognitive flexibility, sleep, and impulse control. The intention of the following explanatory addition is not to re-discuss the numerical results but to provide a neurobiochemical framework of the nature of each substance, its most frequent cerebral effects and medical chemistry and clinical toxicology's part in diagnosis and follow-up [16-18].

First: A brief definition of the substances listed in the registry and their neurobiological effects

1. **Crystal methamphetamine (Meth)** is a potent amphetamine-type stimulant characterized by its high ability to increase the concentration of dopamine, norepinephrine, and serotonin in the synaptic cleft by stimulating their release and reversing the direction of their transporters. Clinically, it is associated with hyperactivity, insomnia, anxiety, and impulsivity, and may progress to agitation or neurotic psychosis due to dopaminergic toxicity, oxidative stress, microglial activation, and dysfunction in the prefrontal cortex and striatum, which is consistent with impaired executive function, sleep disturbances, increased compulsive behavior, and a risk of relapse [17-19].

2 **Captagon (Phenethylamine/Phenethylamine)** **Captagon** is a brand name historically associated with phenethylamine, a synthetic stimulant that is metabolically converted to amphetamine and theophylline, which explains the combination of stimulant and wakefulness-promoting effects. Its effects manifest as increased alertness, reduced need for sleep, accelerated thinking, and heightened impulsivity. From a neurobiochemical perspective, the

amphetamine component of this compound is most strongly associated with dopamine over-transmission and disruption of reward circuits, while the xanthine component may contribute to enhancing central arousal and reducing the sensation of fatigue [16-20].

3. Cannabis and Marijuana: Cannabis is used to describe any product derived from the cannabis plant, marijuana often refers to the flower parts or leaves that contain tetrahydrocannabinol. The mechanism of action of THC is largely mediated through CB1 receptors in the brain, as well as modulating the release of glutamate, GABA and dopamine, and is linked to working memory deficits, slower processing, impaired executive function and disturbances in time perception and attention. Some users may exhibit anxiety or paranoia, and with chronic use.

Rehabilitation follow-up is a time when reward and cognitive control networks are particularly important for functional changes, and therefore cognitive performance, sleep, and craving assessments are valuable [18-21].

4. Tramadol: Tramadol has dual action, a weak opioid receptor agonist, as well as a serotonin and norepinephrine reuptake inhibitor. This characteristic explains the variation in its symptoms between traditional opioid features and serotonin-related side effects or toxicity upon misuse or drug interactions. From a neurobiological perspective, chronic or uncontrolled use may lead to disturbances in pain processing and reward, as well as changes in monoamine pathways, with the potential for dual opioid and monoamine withdrawal [22-23].

5 Valium (Diazepam) Diazepam is a benzodiazepine that acts by enhancing the excitatory action of the GABA-A receptor, which is clinically useful for sedation and the relief of anxiety and spasms; however, its misuse is associated with drowsiness, impaired concentration, slowed response time, and impaired recent memory, It may lead to drug dependence with prolonged use and in the context of recreational use [16-24].

6-Heroin: A semi-synthetic analog of morphine which quickly diffuses across the blood-brain barrier and is metabolized to 6 -morphine, and subsequently morphine, and attaches to opioid receptors. This causes analgesia, euphoria, and sedation of mental and motor activity, which is followed by a significant dependence and a strong disruption of the reward and motivational systems. Over the long run, it interferes with the networks that mediate attention, frontal control, and responding to drug-related cues-mechanisms that predispose to relapse following cessation. [23-25].

7. Cocaine: Cocaine is a potent stimulant that enhances the reuptake of dopamine, norepinephrine, and serotonin, particularly via the dopamine transporter. It is associated with accelerated thinking, a false sense of confidence, impaired judgment, elevated blood pressure, and the risk of cardiovascular and cerebrovascular complications. At the brain level, its abuse is associated with dopaminergic and glutamatergic dysfunction and impaired executive control; consequently, craving for the substance becomes highly sensitive to environmental triggers, making the monitoring of urgent cravings and impulsive behavior an important part of follow-up [26].

8-Soma-Dril (Carisoprodol) Soma-Dril, trade name **Carisoprodol**, is a centrally acting muscle relaxant that is metabolized into meprobamate. Due to its sedative properties, its misuse should not be viewed merely as a pharmacological muscle problem but rather as exposure to a substance with abuse and dependence potential, with symptoms that may include sedation, slowed cognitive function, lethargy, and coordination disorders, especially when combined with other central nervous system depressants [27].

9- Areca tablets: these refer to preparations containing arecoline or areca nut derivatives, they possess complex central and peripheral effects and may cause stimulation or behavioral changes associated with cholinergic mechanisms and other accompanying compounds, as well as oxidative cellular toxicity described in the recent literature. However, scientific treatment of these preparations within therapeutic records requires confirmation of the actual chemical

identity of the preparation, as the common or local name alone may not be sufficient to establish the pharmacological profile. [28].

10 tablets registered under the name “Trial: tablets.” This description is not pharmacologically standardized and does not allow for the attribution of a specific biological mechanism of action without laboratory verification of the active ingredient. From a toxicological chemistry perspective, such designations indicate the need to confirm the sample’s identity using separation and analysis methods such as GC-MS or LC-MS/MS, as accurate clinical interpretations are not based on the trade name alone; and therefore, keeping this category analytically open is a scientific precaution against its hypothetical association with an undocumented drug [29].

Second: The Role of Forensic Chemistry and Clinical Toxicology in Diagnosis, Follow-up, and Relapse Indicators

The value of clinical chemistry extends beyond defining the molecular structure or metabolism of substances; it encompasses translating this information into clinical practice for diagnosis, distinguishing between recent use and past exposure, monitoring metabolites, and detecting poly-substance use or adulterated preparations. In practice, the initial urine screening test serves as a rapid screening tool, but it does not replace confirmatory analysis by chromatography coupled with mass spectrometry, particularly when the results have therapeutic or legal implications or when the ingested substance is non-standard or multi-component [29-31].

Urine is a good window for relatively recent use, while saliva can be a good window for very recent use and under direct supervision, and blood samples can be a good window for current clinical status, and hair can be a window for chronic or cumulative use. Hence, the decision of which of these matrices to use is not necessarily a technical decision. Instead, it is associated with the clinical question of confirmation of recent use, documentation of repeated use, and monitoring of adherence in a comprehensive program. Clinical Chemistry plays a role in developing useful markers of relapse or risk of relapse in the setting of developmental monitoring in rehabilitation facilities. These signs are periodic transitions back to positive results following a period of negative results, unexpected shifts in metabolic profile (signs of poly-substance use), signs of biological stress, sleep disturbance, or neuroendocrine dysregulation with an increase in craving. While central and peripheral physiological parameters of stress, arousal, and responsiveness to stimuli are not an alternative to clinical assessment, recent literature suggests that these parameters are considered to be supportive warning signs which may help to detect points of vulnerability in recovery prior to behavioral relapse. [31,33,34].

Third: The Institutional Role of the Ministry of the Interior / General Directorate of Narcotics and Psychotropic Substances

According to the relevant documents from the Ministry of Interior, the General Directorate of Narcotics and Psychotropic Substances Affairs (GDNP) is the primary institutional means of combating illicit trafficking, of tracking trafficking networks, of co-ordinating information sharing and of establishing the legal and regulatory framework for this issue, in compliance with Law 50/2017 on Narcotics and Psychotropic Substances and its consequences in terms of the structural and specialized organization. 35. The role is also particularly interesting in this study because the results and conclusions of the study cannot be divorced from the institutional context in which referrals are generated, rehabilitation centres are established and the security deterrence is connected to the rehabilitation pathway. This was not solely about enforcement and crackdowns, but rather was accompanied by conferences, seminars, awareness-raising activities and partnerships with the youth, tribes, education and media institutions with a clear message encouraging resistance to stigma, and the connection between the fight against drug use and seeking treatment and reintegration [36,37]. A careful scientific reading of the results

of the study suggests that the growth of the number of patients that are seeking treatment and undergoing assessment should not be read directly and negatively as an increase in the disease burden, but rather it is likely that this also represents better access to the services, more trust in the institutions and greater responsiveness to referrals or self-referrals in the face of increased community awareness and broader capacity. In addition, in conjunction with the official opening of specialized and rehabilitative centers and clinics in cooperation with the Ministry of Interior and Health, the official announcement of the extension of the number of rehabilitation centers and the activation of treatment and rehabilitation under the umbrella of the National Strategy 138,39, this interpretation is strengthened. The enforcement part of the study is, however, only added to the institutional value of the seizure tables if seen in the light of intelligence work, targeted operations, border coordination and networks, official data from the Ministry of Interior supports this point. Security enforcement does not therefore work in isolation from rehabilitation, but rather along a parallel track which runs across the illicit supply track and the rehabilitation and community harm management track [35,40]. The analysis presented here illustrates the need to integrate statistical description, neurobiological interpretation, laboratory monitoring, and institutional context in which screening, detection, referral and treatment are delivered to understand patterns of substance use and rehabilitation outcomes. The rise in the number of people enrolling into rehabilitation centers as well as the improvements in some of the follow-up indicators thus reflects a multi-layered process of the severity of the problem on the one hand, and the increasing awareness of society, the mediating effect of the rehabilitation system on the other, as well as the effectiveness of security and awareness raising measures [35-40].

Importance of the Research

In terms of the importance of this study, first of all is that it comes on a topic that is important to society and public health, and combined with a therapeutic approach and a neurobiological analysis. The value of the research to rehabilitation centers is the scientific interpretation of the results achieved, as well as the emphasis on the role of modern approaches in increasing the adherence to treatment, the prevention of recurrences and functional and cognitive stability of recovered patients.

Research Objectives

This research aims to:

- Describe the demographic and clinical characteristics of residents in rehabilitation centers.
- Identify patterns of substance use and their distribution among the studied groups.
- Evaluate the outcomes of rehabilitation programs in terms of adherence, program completion, relapse, and return to work or education.
- Explore changes in certain neurobiological and laboratory indicators associated with the rehabilitation phase.
- Highlight the scientific and practical value of neurobiochemistry in supporting youth rehabilitation programs and serving the Iraqi community.

Methodology

Study Design

The study used the retrospective, descriptive, comparative design, and the data used in the study was institutional data obtained from the Directorate of Narcotics and Psychotropic Substances Affairs, and rehabilitation centers of the Iraqi Ministry of Interior. This study will take place between January 1, 2024 and December 31, 2025. The authors attempted to characterize the demographic and clinical aspects of the residents, to evaluate the trends of

substance use and, in a number of aspects of therapeutic performance, neurofunctional and laboratory aspects, between two subsequent years, which were, on a procedural basis, two stages of the development of the rehabilitation program. The year 2024 was seen as an initial year that was before the programme was enhanced, whereas 2025 was seen as a year that was after the programme had been enhanced with elements of development or improvement in the elements of rehabilitation care and follow-up. From the methodological point of view, this division does not mean that all the visible differences in the results of the indicators studied are direct consequences of the temporal improvement; it is a frame of reference that allows the interpretation of the differences recorded in these indicators. The study took place in rehabilitation institutions which take people with drug abuse, conduct assessment, monitor therapeutic, behavioural, health-related and record their rehabilitation proceedings in official, accredited records. The records contained enough demographic, clinical, therapeutic and laboratory information to allow for the use of suitable material for descriptive and annual comparative analysis.

Study Population

All the rehabilitations centers in the study period and all the persons who were registered there for rehabilitation were the study population. The study was not a sample study since the study was based on the complete institutional records available. A total of 4,827 patients were registered in 2024 and 5,419 patients in 2025, with a total of 10,246 patient records included in the analysis for the two years. The amount of information contained in this volume is useful in terms of description and in suggesting over-all trends in demographic and clinical characteristics and in rehabilitation outcomes, but must be interpreted with caution because of the nature of the records and the detail they allow.

Inclusion and Exclusion Criteria

The study included all records that met the following conditions:

1. The resident must be officially registered at one of the rehabilitation centers during the study period.
2. The record should include the bare minimum of data needed to be analyzed, i.e. the year, age group, place of origin, and type of substance used.
3. The record should include information that will enable the resident to be categorized as one of the treatment indicators or follow-up indicators, when necessary.

Records that were not in the analysis were either duplicate records or records that had significant gaps that prevented scientific classification or records with obvious contradictions in the basic data that prevented their inclusion in the comparison. Where two or more records of admissions had been made of the same individual, a record was treated as a separate service unit in all cases in which the record was recorded on this ground in the official system, and as a separate service unit otherwise.

Data Sources and Collection Procedures

The study was based on the official archives and ratified statistical data published by rehabilitation facilities, along with the associated admission, follow-up, and discharge paperwork, summary tables on the types of materials used, and adherence, completion, and relapse indicators, when provided. To standardize the data collection process and minimize variation in data extraction, a structured data entry form was developed, covering the following categories:

- Demographic variables.
- Clinical variables related to substance use patterns.
- Rehabilitation outcome indicators.
- Composite neurofunctional indicators.
- Laboratory indicators.

- Post-program follow-up indicators.

Data were then systematically carried out of the original records and the research team reviewed the data to maintain internal consistency, detect any missing values, and identify duplicates or unreasonable entries. In the event of a conflict or a correctable omission, the original origin was sought, prior to the proper version of the analytical database being accepted.

Variables Studied and Their Operational Definitions

First: Demographic Variables

The demographics variables were the year of enrollment, place of origin and age group. The following ages were grouped based on the category used in institutional tables: 15 years and older 15 years and older: 15-19 years, 20-25 years, 25-30 years, 30-35 years, 35-40 years, 45 years and older. Governorate or state was used to record place of origin as indicated in the official record of each inmate.

Second: Clinical Variables

Clinical variables were the key substance related to the situation of the inmate, which was reported in the institutional records. The categories recorded were; crystal meth, Captagon, hashish, marijuana, tramadol, Valium, cocaine, Somadril, Arica pills, pills registered under non-standard names and heroin.

These categories were considered to be descriptive categories based on institutional records, and it was realized that certain trade or local names may not be adequate per se to define the exact pharmacological composition unless the results of a confirmatory toxicological analysis are provided.

Rehabilitation Outcome Indicators

The study adopted a set of indicators that reflect the therapeutic and functional trajectory of the inmate within and after the rehabilitation program, as follows:

1. Program Compliance Rate

This refers to the percentage of inmates who continued to participate in rehabilitation activities and procedures for the institution's minimum required duration, thereby qualifying them as treatment-compliant.

2. Program completion rate

This refers to the percentage of residents who completed the rehabilitation program in accordance with the center's official standards, including attendance, fulfillment of treatment requirements, and reaching the completion stage or planned discharge.

3. Six-Month Relapse Rate

This refers to the percentage of cases in which a return to substance use was recorded, or in which confirmed indicators of relapse emerged during follow-up, or in which the individual returned to the treatment system within six months of discharge or program completion, in accordance with the mechanism followed in institutional documentation.

4. Return to Work or School

This represents the percentage of clients who, during the follow-up period, returned to work, formal education, vocational training, or any productive/educational pathway documented in the follow-up records.

Neurofunctional Indicators

Since the study did not rely, in a comprehensive and direct manner, on neuroimaging techniques or specific molecular markers for each case, the information in the records under this heading was treated as composite functional indicators with clinical significance, rather than as direct neurophysiological measurements in the precise laboratory or imaging sense. These indicators were used to assess the trend of overall functional improvement during the rehabilitation phase, with due methodological caution exercised in their interpretation.

These indicators included the following:

1. Neuroplasticity Index

This is a composite index reflecting the degree of adaptive improvement in functional and behavioral performance, indicating better responsiveness to treatment, the acquisition of new patterns of behavioral regulation, and improved ability to engage in rehabilitation activities.

2. Executive Function Index

This represents a functional assessment of the level of cognitive and behavioral organization and includes elements such as attention, impulse control, adherence to instructions, task completion, decision-making, and planning during the treatment period.

3. Stress Regulation Index

This reflects the degree of emotional stability and the ability to cope with stress, based on documented levels of irritability, psychological resilience, the intensity of reactions to stressful situations, and the number of behavioral or emotional crises during treatment.

4. Reward Circuit Balance Index

This is a functional, estimative index associated with a reduction in compulsive substance-seeking behavior, improved control over responses triggered by craving, and a decrease in behavioral salience of substance-related stimuli.

5. Sleep-Related Neurobiological Stability Index

This indicates improved sleep regularity and continuity, a reduction in complaints of insomnia and circadian rhythm disturbances, and improved nighttime rest, as documented in clinical assessments or daily monitoring.

6. Severity of Pathological Craving

This index reflects the level of compulsive urgency toward substance use, based on clinical assessments, therapeutic observations, and follow-up sessions. For this index, lower values are clinically more favorable.

7. Percentage of Inmates with Severe Vital/Functional Signs Disturbance

This refers to the percentage of cases that exhibited a clear imbalance in biological or functional monitoring indicators, or both, as documented by the rehabilitation system within its internal classification of the highest-risk or most disturbed cases.

Mechanism for Constructing Composite Indicators

The study standardized the presentation of these indicators by converting them to a scale ranging from 0 to 100 to facilitate comparison between the two years and highlight the general trend of change. Higher scores, in most indicators, reflected a better status and clearer improvement, with the exception of some indicators of an inverse nature, such as the severity of pathological craving or indicators of severe distress, where lower values are clinically more positive.

These indicators were derived from functional and clinical data available in institutional records, after being grouped into related semantic domains that reflect the evaluative purpose of each axis. When there were multiple measurements or observations for a single resident during the program period, the value closest to the final assessment or the value representing the most reliable therapeutic status in the final institutional report was adopted.

It is important to note that these indicators should be understood within their functional and service context, that is, as tools for tracking improvement within the therapeutic system, not as a substitute for direct neurophysiological measurements of a laboratory or imaging nature.

Laboratory Indicators

The study also included a number of laboratory indicators presented in a comparative framework between the two study years; these indicators provide supporting value in assessing overall health improvement during rehabilitation. They included the following:

1. Renal Function Recovery Index

This is a composite index reflecting the trend of improvement in data related to renal function, including associated improvements in hydration status and certain relevant laboratory values, such as urea and creatinine, when available in the records.

2. Liver Function Recovery Index

This represents a measure of the trend toward stabilization of liver function, based on relevant laboratory values or clinical follow-up, including liver enzymes and indicators of reduced liver dysfunction.

3. Glycemic Control Index

This is a laboratory functional indicator reflecting improved glycemic control during the rehabilitation phase, as evidenced by fasting measurements or relevant periodic follow-up.

4. Positive Active Infection with *Helicobacter pylori*

This refers to the proportion of cases confirmed to have an active infection, according to the diagnostic method approved in the institutional registry, whether it be a stool antigen test, a breath test, or other approved methods.

Reinforcement Phase of the Rehabilitation Program

To enable a systematic comparison, the year 2024 was designated as the baseline year before the implementation of some parts of the programme, and the year 2025 as the next phase as a result of the implementation of these parts of the programme on institutional performance. Depending on the organizational context of the centers, this enhancement can consist of optimizing treatment follow-up, establishing mechanisms for adherence, optimizing documentations, enhancing psychosocial support, and optimizing follow-up after the treatment. The study followed a scientific caution in interpreting the differences between the two years, however, and was not intended to serve as direct evidence of a causal nature between the years but rather as a structured temporal comparison to help interpret the recorded shifts in relation to the evolution of services, changes in the characteristics of the patients served, and the institutional work context.

Data Management and Quality Control

The data were then subjected to various verification and review processes to increase the reliability and reduce errors. These procedures included:

1. Coding of variables and categories in a standardised way.
2. Matching annual totals with official approved tables.
3. checking the consistency of counts and percentages.
4. Looking for outliers and/or values that are logically impossible.
6. Excluding the duplicated or correcting them when the error was verified by checking the original source.

Missing data have been dealt with in a manner suitable to the type of variable. In the descriptive analysis, cases with valid data were included for each variable, provided there was no final, approved aggregate value provided by the institution for that indicator.

Statistical Analysis

The data were analyzed with one of the approved statistical software packages, depending on the availability of software to the research team (SPSS version 10 and Graphpad prism 27). Descriptive statistics and comparison of the two years were the main concerns of the analysis.

The following procedures were used:

- Percentages and frequencies for categorical variables.
- Display of absolute and proportions of demographic and clinical characteristics.
- Direct comparison of the values 2024 and 2025.
- Absolute changes for each indicator were calculated.
- Calculation of the relative change using the following formula:
- Relative change (%) = $[(2025 \text{ value} - 2024 \text{ value}) \div 2024 \text{ value}] \times 100$

The composite indicators are also shown as a standardized 0-100 score to ease interpretation of the overall trend of either improvement or deterioration for each indicator over the two years. If the data structure and type of variables are appropriate, then appropriate inferential tests can be used, including the chi-square test for comparing proportions, or an appropriate comparison of means or scores. The nature of the study, however, did not change to become descriptive and comparative, so that the emphasis was on the interpretation of general trends and practical indicators, but not on the drawing of a definite causal inference.

Methodological Considerations

A number of methodological aspects were taken into account when interpreting the results. The study is of a retrospective nature, depending upon quality and accuracy of institutional records. In addition, some of the neurologic, functional and laboratory indicators used are composite or proxy measures, and not all of the measures used are independent, standardized and direct. Thus, their utility is mainly in detecting general trends in the program, rather than to specify specific neurobiological mechanisms in isolation. In addition, a comparison of two successive years does not control for all the factors that could impact the results, including changes in referral volume, variations in the severity of cases, better documentation, and/or altered access to services. Therefore, an improvement interpretation should be performed in a wider institutional and temporal context, not based on a single-cause interpretation.

Ethical Considerations

The institutional data used in this study was originally gathered for therapeutic, administrative and supervisory purposes in the rehabilitation centers, and then reorganized so that residents' identities could not be disclosed and used for research and scientific analysis. All stages of the work have considered how to maintain confidentiality and avoiding any direct or indirect information that could identify individuals has been done.

The research also followed the scientific integrity, responsible use of data and respect for institutional and human privacy. The necessary administrative and ethical approvals were obtained from the relevant authorities whenever institutional protocols required it. The study was approved by the Research Committee of the National Center for Training and Human Development, Iraqi Ministry of Health, under the protocol number 50/2026, in accordance with established procedures. Being a retrospective study based on de-identified data, the study was conducted under the ethical standards required for this type of study.

Study Limitations

This study does have some limitations that should be considered when interpreting the results: It is based on institutional records which may not be accurate and detailed in each year or each source. Moreover, some of the indicators are "composite," making it necessary to proceed with some caution when interpreting them as direct biological equivalents. Furthermore, the two-year comparison design used to discuss periods of cross-sectional comparison cannot allow for the clear establishment of causal relationships between the development of the program and the improvement that is recorded. Yet the study is important from a scientific and practical perspective as it offers a comprehensive realistic portrait of caseloads, substance consumption and rehabilitation outcomes in the institutional setting that is very relevant to the field.

Explanatory Note on Composite Indicators

The parameters of functional neurological and laboratory parameters used in this study are seen as composite service parameters which monitor the process of clinical and functional improvement in the rehabilitation program, but are not regarded as autonomous alternatives to specific biological measures nor as independent standardized neurological tests. As a consequence, the scientific

value of these rests mainly in helping to make intra-period comparisons and to read more deeply into recovery trends; further studies with more specialized standardized tools remain.

Results

The findings of the present study provide statistical and organizational data about the clients and residents of rehabilitation centers as well as their distribution by years, residence, age groups and patterns of the use of substances, and some indicators of the therapeutic, neurological, and laboratory aspects of rehabilitation programs. The following tables and figures have been arranged for scientific presentation and for rigorous professional documentation to facilitate data interpretation and to follow the logical sequence of the information in such a way that they can be used for evaluation, monitoring and planning.

Table (1): Number of Residents in Rehabilitation Centers During 2024 and 2025.

Year	Residents
2024	4827
2025	5419

Table 1 shows the total number of residents registered in rehabilitation centers during the two years under review, presented in a concise summary format that sets the stage for the remaining analytical tables.

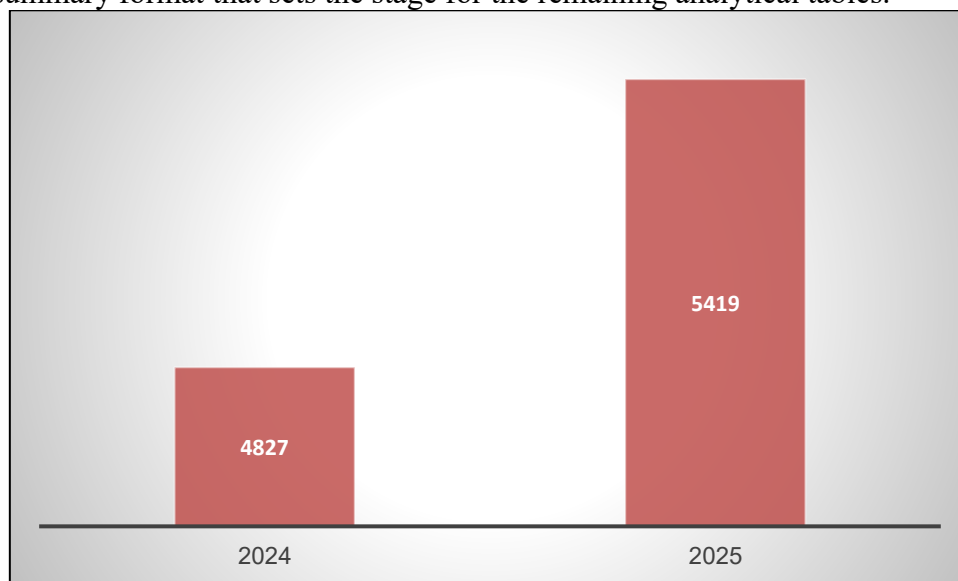


Figure (1): Overall comparison of the number of residents in rehabilitation centers during 2024 and 2025

This figure expresses the total number of residents each year in a direct and concise visual representation.

Table (2): Geographic Distribution of Residents by Place of Origin in 2024 and 2025.

Place of origin profile in 2024 and 2025				
Place of origin	Count	Share of total 2024	Count	Share of total 2025
Baghdad	1,554	32.2%	1745	32.2%
Kirkuk	205	4.2%	230	4.2%
Karbala	370	7.7%	415	7.7%
Al-Anbar	445	9.2%	500	9.2%

Salah al-Din	146	3.0%	164	3.0%
Babylon	159	3.3%	179	3.3%
Wasit	116	2.4%	130	2.4%
Al-Muthanna	142	2.9%	159	2.9%
Najaf	753	15.6%	845	15.6%
Diyala	171	3.5%	192	3.5%
Dhi Qar	427	8.8%	479	8.8%
Maysan	142	2.9%	159	2.9%
Mosul	110	2.3%	124	2.3%
Sulaymaniyah	6	0.1%	7	0.1%
Erbil	5	0.1%	6	0.1%
Duhok	3	0.1%	3	0.1%
Iran	51	1.1%	57	1.1%
Syria	14	0.3%	16	0.3%
Lebanon	1	0.0%	1	0.0%
Egypt	5	0.1%	6	0.1%
Kuwait	2	0.0%	2	0.0%
Total	4,827	100.0%	5419	100.0%

This table presents the numbers and percentages of residents by place of origin, providing a geographic description of the composition of the studied group during the two years in question.

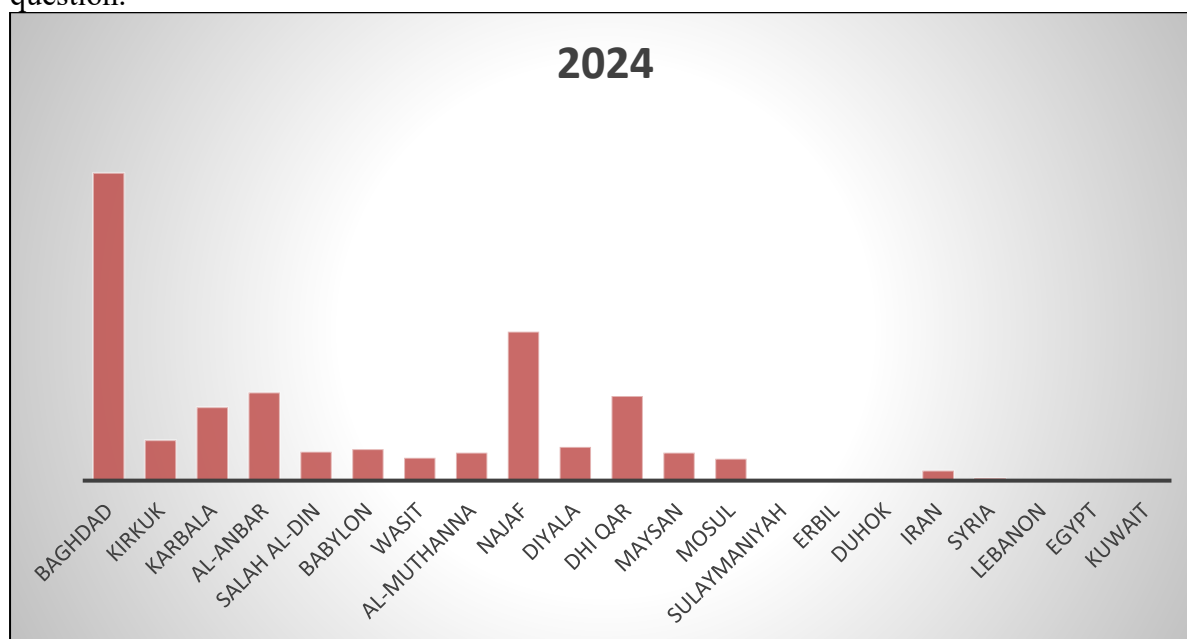


Table (2): Geographic distribution of residents by place of origin in 2024

This figure provides a visual representation of the distribution of residents by place of origin in 2024 according to the geographic classification in the study

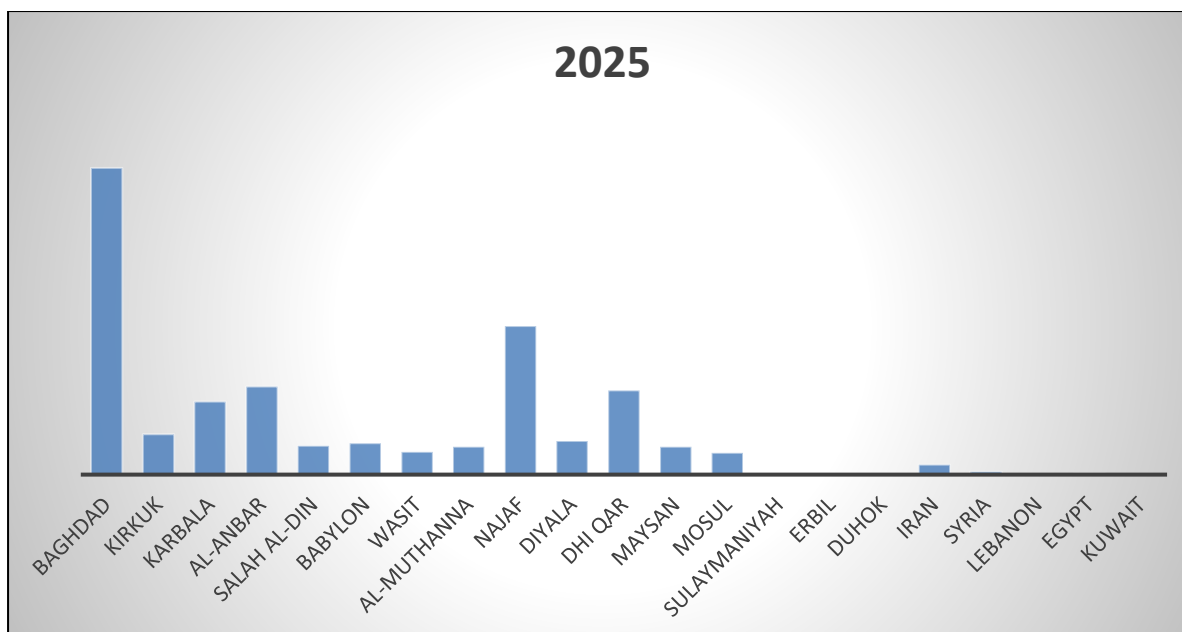


Table (3): Geographic distribution of residents by place of origin in 2025

This figure provides a visual representation of the distribution of residents by place of origin in 2025 according to the geographic classification in the study

Table (3): Age Distribution of Residents in Rehabilitation Centers in 2024 and 2025.

Age band	Count 2024	Count 2025
15-19	115	129
20-25	1076	1208
25-30	1290	1448
30-35	1157	1299
35-40	705	791
45+	484	544
total	4827	5419

This table presents an age classification of residents according to the age groups adopted in the presentation, which helps organize the demographic data for the target group.

Table (4): Classification of Substances Used by Residents in 2024 and 2025.

Substance category	Count	Share of total 2025	Count	Share of total 2025
Crystal methamphetamine	3591	74.4%	4,031	74.4%
Captagon	1024	21.2%	1,150	21.2%
Cannabis	29	0.6%	33	0.6%
Marijuana	35	0.7%	39	0.7%
Tramadol	59	1.2%	66	1.2%
Valium	32	0.7%	36	0.7%
Cocaine	3	0.1%	3	0.1%
Somadril	9	0.2%	10	0.2%
Areca tablets	36	0.7%	41	0.8%
Trial tablets	4	0.1%	4	0.1%
Heroin	5	0.1%	6	0.1%
Total	4827	100.0%	5,419	100.0%

This table shows the types of substances recorded in the resident data, presenting the numbers and percentages for each category within the approved statistical framework.

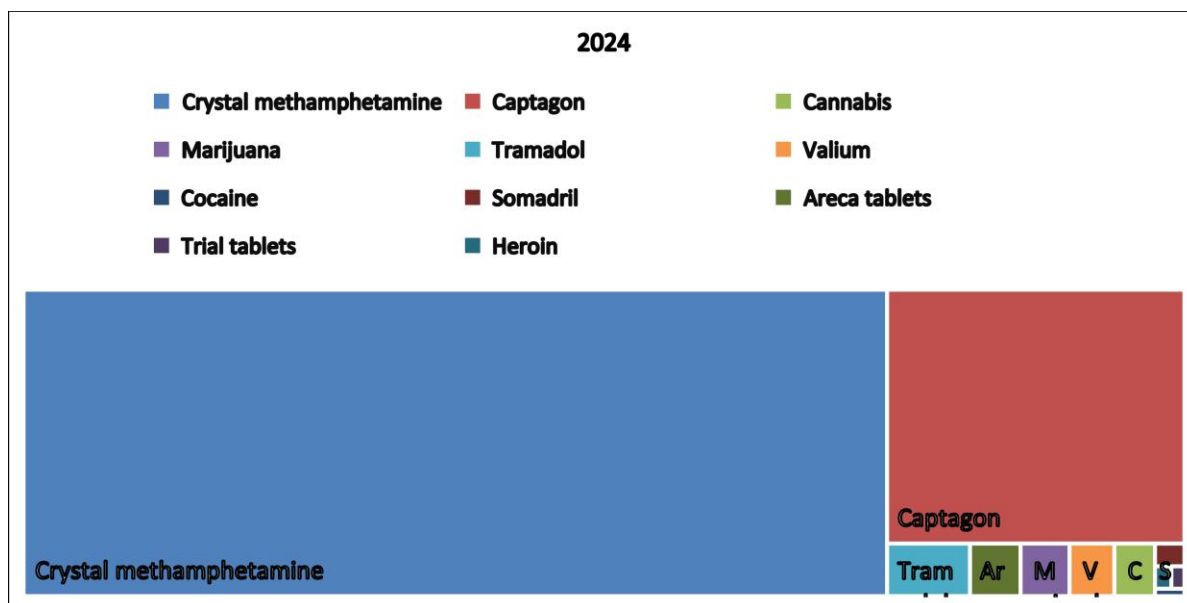


Table (4): Classification of Substances Used by Residents in 2024

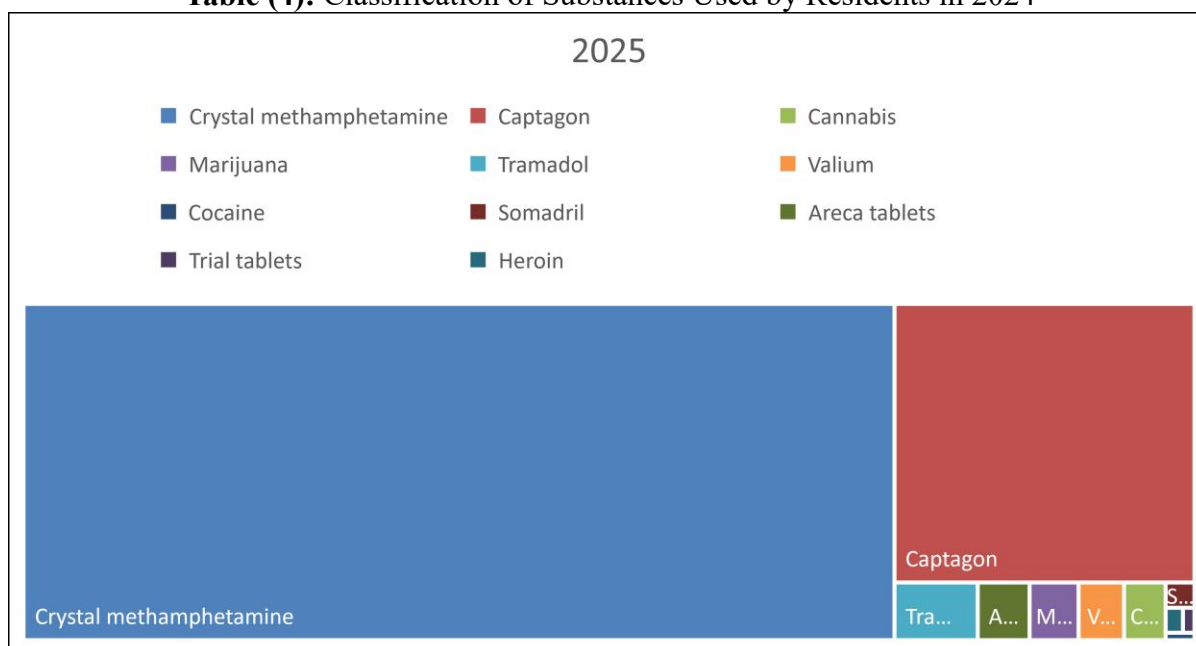


Table (5): Classification of Substances Used by Residents in 2025.

Table (5): Total Seizures by Directorate or Governorate: Cannabis, Opium, Methamphetamine, and Ecstasy.

Directorate/Governorate	Cannabis (g)	Cannabis (kg)	Opium (g)	Opium (kg)	Crystal meth (g)	Crystal meth (kg)	Ecstasy (g)	Ecstasy (kg)
Special Investigations	0	12	0	0	675	1	0	0
Baghdad / Karkh	2,469	162	963	9	3,618	61	300	1

Baghdad / Rusafa	87	5	0	0	2,911	13	0	0
Al-Muthanna	0	0	0	0	2,198	11	0	0
Karbala	1,026	5	1,029	7	4,901	8	0	0
Babylon	398	0	31	0	2,808	4	0	0
Najaf	0	0	45	0	3,900	7	0	0
Dhi Qar	17	0	0	0	4,436	2	0	0
Diyala	1,178	2	551	3	1,379	39	0	0
Basra	2,511	5	317	2	4,847	35	0	0
Salah al-Din	12	0	21	0	3,327	9	0	0

This table includes the quantities of seizures distributed across directorates and governorates, expressed in grams and kilograms according to the type of substance seized.

Table (6): Total Seizures by Directorate or Governorate: Captagon, Tramadol, Heroin, and Cocaine.

Directorate/Governorate	Captagon (g)	Captagon (kg)	Tramadol (g)	Tramadol (kg)	Heroin (g)	Heroin (kg)	Cocaine (g)	Cocaine (kg)
Special Investigations	1,657	1,797	0	0	0	0	0	0
Baghdad / Karkh	19	70	13	0	0	0	444	0
Baghdad / Rusafa	2	0	179	0	0	0	0	0
Al-Muthanna	143	13	0	0	500	15	0	0
Karbala	863	11	0	0	209	0	0	0
Babylon	90	0	17	0	0	0	0	0
Najaf	384	0	61	0	0	0	0	0
Dhi Qar	217	0	1	0	0	0	0	0
Diyala	58	0	765	0	69	0	0	0
Basra	1,002	0	2,755	58	2	0	0	0
Salah al-Din	265	0	845	53	6	0	0	0

This table completes the presentation of seizure data for other substances listed in the registry, maintaining the geographical classification and approved units of measurement.

Table (7): Comparative Analysis of Rehabilitation Outcome Indicators Between 2024 and 2025

Indicator	2024	2025	Absolute change	Relative change	Analytical reading
Total residents	4,827	5,419	592	12.3%	Expansion in the operational capacity of rehabilitation centers

Age group 25-30	1,157	1,448	291	25.2%	Largest resident segment in 2025, requiring targeted cognitive-behavioral programming
Age group 30-35	1,079	1,299	220	20.4%	Large middle-adult group requiring sustained reintegration services
Program adherence rate	68.0%	84.0%	16.0%	23.5%	Improved continuity of attendance after program enhancement
Program completion rate	61.0%	79.0%	18.0%	29.5%	Higher completion suggests better service acceptability and retention
6-month relapse rate	34.0%	18.0%	-16.0%	-47.1%	Lower relapse indicates stronger short-term stabilization
Return to work or education	42.0%	67.0%	25.0%	59.5%	Improved reintegration into productive or educational pathways

This table compiles indicators related to retention, completion, relapse, and post-discharge reintegration, presented as a numerical comparison between the two years mentioned.

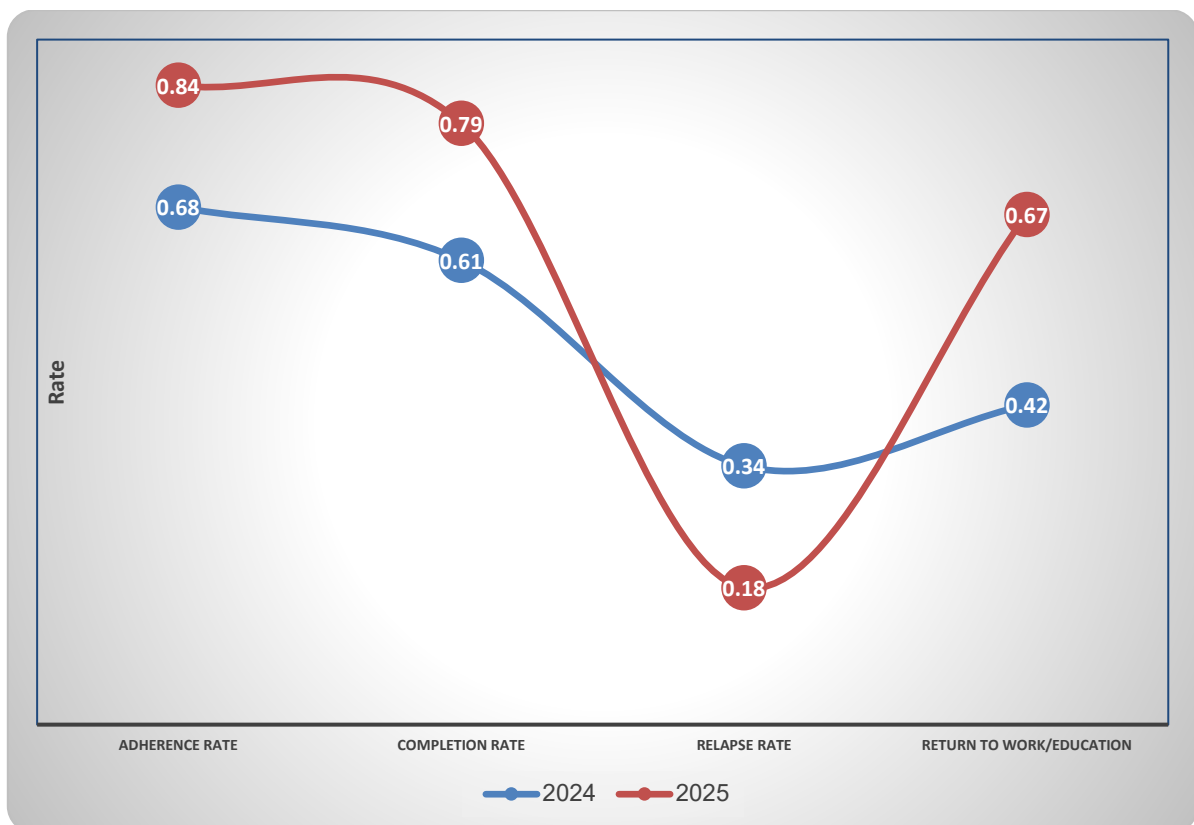


Figure (6): Trend Line for Rehabilitation Outcome Indicators in 2024 and 2025

This figure provides a visual representation of the key indicators related to rehabilitation outcomes, in a format that facilitates visual comparison between the two years.

Table (8): Neurobiological Indicators Before and After the Enhanced Program

Indicator	2024 (pre-enhancement)	2025 (post-enhancement)	Absolute change	Relative change	Indicator direction	Interpretive note
Neuroplasticity index (0-100)	54	71	17	31.5%	Positive	Higher scores indicate improved adaptive brain function
Executive function index (0-100)	49	68	19	38.8%	Positive	Improved cognitive control and decision-making
Stress regulation index (0-100)	44	66	22	50.0%	Positive	Improved emotional regulation and resilience
Reward-circuit balance (0-100)	41	63	22	53.7%	Positive	Reduced compulsive attraction to substances
Sleep neurostability (0-100)	52	73	21	40.4%	Positive	Better sleep architecture and recovery rhythm
Pathological craving severity (0-100)	78	43	-35	-44.9%	Negative	A lower score is clinically favorable
Residents with marked biomarker dysregulation	64.0%	38.0%	-26.0%	-40.6%	Negative	Decline after the integrated rehabilitation model

This table includes a set of neurobiological indicators presented before and after the program enhancement phase, with a statement of the numerical and relative change for each indicator.

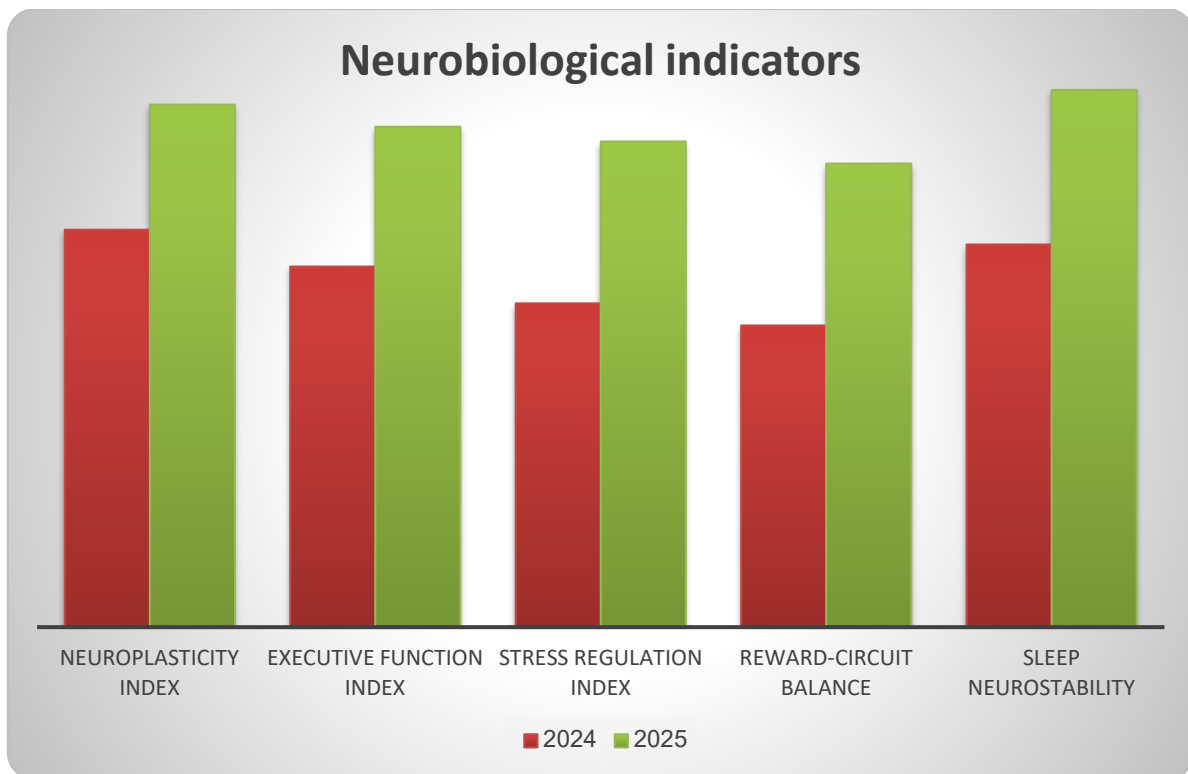


Figure (7): Graphical representation of Neurological Indicators in 2024 and 2025

Table (7): Neurological Indicators Before and After the Enhanced Program

Indicator	2024 (pre-enhancement)	2025 (post-enhancement)	Absolute change	Relative change	Indicator direction	Interpretive note
Renal function recovery score (0-100)	58	76	18	31.0%	Positive	Reflects improved creatinine/urea profile and hydration recovery
Hepatic function recovery score (0-100)	55	74	19	34.5%	Positive	Reflects better ALT/AST trend and hepatocellular stabilization
Blood glucose stability index (0-100)	61	83	22	36.1%	Positive	Represents improved fasting and post-prandial glycemic stability

Residents with active Helicobacter pylori positivity	29.0%	12.0%	-17.0%	-58.6%	Negative	Lower post-program positivity implies better gastrointestinal follow-up
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This table provides an organized presentation of a set of laboratory indicators before and after the program, in the form of a standardized quantitative comparison.

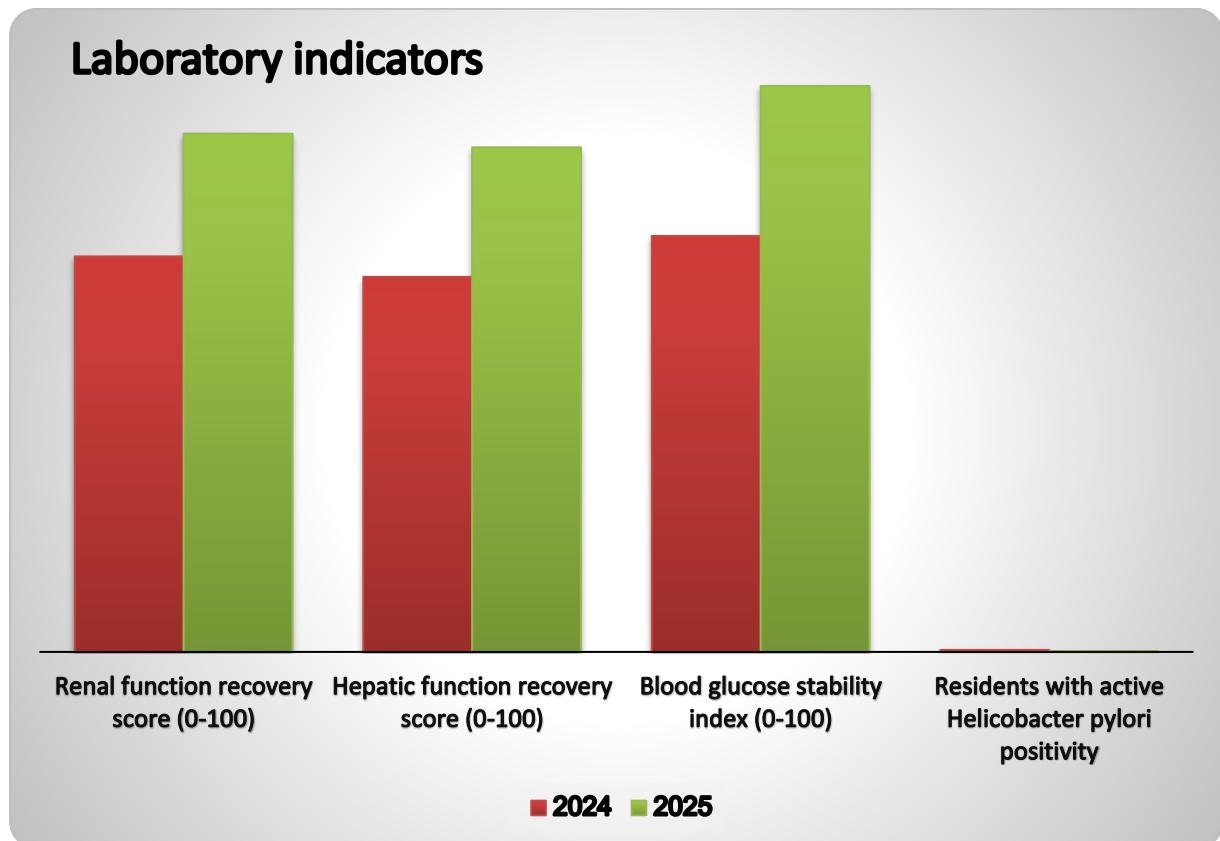


Figure (8): Graphical representation of laboratory indicators in 2024 and 2025

This figure illustrates the main laboratory indicators included in the data, in a graphical format that supports the table 9 presentation.

Discussion

This study presents its key findings and the main quantitative results derived from data on residents in rehabilitation centers during 2024 and 2025, and then discusses these findings in light of recent clinical and epidemiological literature related to stimulant use disorders, particularly methamphetamine and Captagon. The present formulation gives great importance to conciseness and connects the results with the implications that they have on their clinical or service-related implications without providing too much description. Regarding the neurobiological and laboratory indicators that are part of the original file, they are understood in this context as indicators of composite programs of functional and biological recovery, and the required methodological caveats unless their measuring instrument and calculation procedures are described in the methodology part.

Presentation of Results

Numerical Burden and Demographic Distribution

The data revealed that the total number of residents has increased by 592 cases and 12.3 % between 4,827 in 2024 and 5,419 in 2025. This growth indicates that there is an upsurge in demand in rehabilitation services, a rise in the intake and referral capacity or both. The age distribution is given around the age group of 25-30 and 30-35 which are the largest age group in 2025 making the young adults the center of treatment.

Geographically, the largest percentage of the population in both years was located in Baghdad (32.2%), Najaf, then Anbar and Dhi Qar. The comparative stability of these shares in the two years indicates that the numerical growth was not limited to a particular province, but to the whole province, and the highest level was still in the provinces where population density and active urban paths of drug use and referral were high.

Patterns of Substance Use

Crystal methamphetamine evidently led the treatment environment, with 4,031 cases in 2025, which constituted 74.4% of all residents, followed by 1,150 cases of Captagon and a percentage of 21.2. Regarding the other substances, such as tramadol, hashish, marijuana and Valium, they were found in comparatively small amounts. This composition suggests that the major burden in this sample is related to stimulant use disorders as compared to traditional depressants or opioids.

Treatment Program Outcomes

The results of the program demonstrated the simultaneous improvement of the results in several dimensions: the retention rate increased to 84% and the program completion rate was improved to 79%. On the other hand, six months relapse rate dropped to 18 percent against 34 percent. There was also an increased rate of return to work/education of 42 to 67. Regarding a purely descriptive approach, the findings suggest an increase in the level of treatment adherence and post-program re-integration indicators.

Neurobiological and Laboratory Indicators

The neurobiological indicators demonstrated an improving trend after the improved program; neuroplasticity index increased by 54 to 71, executive function index increased by 49 to 68, psychological arousal regulation, reward circuit balance, and sleep neuro-stability improved. On the other hand, pathological cravings became less severe (78 to 43), and the percentage of residents with major mood disorders dropped to 38 (64). At the laboratory level, there was an increase in the renal function recovery index, hepatic function recovery index and the glucose stability index, which increased to 76, 74 and 83 respectively. Moreover, the proportion of active *Helicobacter pylori* positivity dropped to 12% as compared to 29% previously. These signs, within the framework of their multifaceted construction, indicate a convergent improvement in the neurological, metabolic, and digestive spheres.

Discussion of the Results

Increase in the Number of Inpatients and Shifts in the Burden of Care

The 12.3% rise in the inpatient population is a two-sided message: on the one hand, it can be a sign of the increased burden of the society with the disorders of stimulant use; on the other hand, it can be a sign of the availability of services and the identification of the cases that require treatment the most. This reading is consistent with the recent reviews that show that the burden of stimulant use disorders in the world is still increasing and that treatment systems are under increasing pressure to provide specialized and sustained services [42,43].

It is important to note that this growth did not come with a sharp geographical change in the relative proportions of the governorates, indicating that the change was structural at the level of the service system as a whole and not just a manifestation of a local phenomenon. This trend is of planning significance, as it facilitates the introduction of a policy of horizontal capacity development, without losing the most attention to the governorates that make the greatest

contribution to the treatment flow, with Baghdad, Najaf, Anbar, and Dhi Qar taking the first place.

Concentration of Cases Among Young Adults

The age distribution of the residents in the 25-30 and 30-35 age brackets is consistent with the age distribution in the methamphetamine use disorders where behavioral, occupational and cognitive functioning is at its highest point in the years of maximum social and economic activity. Moreover, this age group is the most susceptible to the effects of executive dysfunction, poor decision-making, and worsening of everyday functioning. [41,48]. Therefore, the age dimension in the results of this study is not merely a demographic description but a direct determinant of the type of interventions required, particularly those combining structured psychotherapy with social and vocational rehabilitation.

Predominance of Amphetamine-Type Stimulants

The prevalence of crystal methamphetamine, with a clear secondary presence of Captagon, reveals that the treatment burden in the studied sample is primarily linked to the amphetamine-type stimulant spectrum. This is consistent with the literature, which confirms that stimulant use disorders have become among the most complex disorder patterns in terms of clinical severity, cognitive impact, and difficulty in treatment retention, given the limited number of proven pharmacological options [42,43].

This prevalence also partially explains the centrality of neuropsychological and behavioral measures in the program's outcomes; methamphetamine is associated with frontal-parietal circuit dysfunction, impaired executive function, and heightened craving—areas expected to be sensitive to any well-structured rehabilitation intervention [41,44]. Consequently, the high prevalence of methamphetamine use in this study lends the program's results particular practical value, as it tests efficacy in a relatively challenging clinical population, rather than in less complex patterns of use.

Improvements in Adherence and Completion and a Decrease in Relapse

The concurrent improvement in adherence and program completion, coupled with a decrease in relapse, is one of the study's strongest outcomes from a clinical perspective. The rise in adherence of 68 to 84 and the rise in completion of 61 to 79 are not only procedural improvements, but generally linked to better future recovery opportunities and less risk of early treatment dropout. Systematic reviews have demonstrated that structured behavioral interventions, especially cognitive-behavioral therapy and conditioned reinforcement programs, can enhance the retention of treatment and the decrease in use in the follow-up, but there is a need to promote sustainability following the completion of the program. [43,44].

Moreover, the decreased rates of relapse to 18% can be associated with the idea that the enhancement of program design and tracking withdrawal and post-acute symptoms can directly influence the retention and avoid early relapse. New clinical practice guidelines highlight that post-withdrawal symptoms in stimulant use disorders, such as insomnia, anxiety, and psychological distress, may last weeks or months, and that prompt intervention is a key to adherence to treatment and minimizing the chances of relapse [42].

It is notable that these results also align with the results of residential studies that showed an increase in processing speed and executive functioning, and a decrease in craving and depressive symptoms with regular treatment, although some psychological differences still existed between methamphetamine users and other people [41]. In this way, our results do not seem to be extraordinary in the global context but can be seen as a clinically explainable course when the retention of treatment is better and the follow-up is frequent.

Functional Recovery and Return to Work or Education

This significant rise in the return to work or education, up to 67 percent, is a direct consequence of direct social value, since recovery of substance use disorders is not quantified by abstinence, but by the capacity to resume functioning and social role. Systematic reviews have

demonstrated that enhanced employment and vocational integration are generally linked with enhanced treatment results and increased stability in recovery and that vocational reintegration programs are a vital component of the recovery process and not an add-on to the recovery process [45,46].

Thus, this growth cannot be viewed as a secondary indicator, but one of the end results that provide the program with the significance in society. It also coincides with the fact that the sample is young; the age groups that prevailed in the study are the same ones that are most directly related to the labor market and education, and therefore any occupational advancement of them will have wider family and social consequences.

Implications of Neurobiological Indicators

The increase in neural plasticity, executive, emotional regulation, and reward circuit balance indicators is construed as evidence of a recovery trend in the areas most impacted by stimulant use disorders. The recent neuroscience literature is in favor of this strategy; longitudinal imaging research indicates that abstinence with structured treatment can be linked to the recovery of some structural and functional features in brain systems that are involved in executive control, reward, and attention [47].

Sleep, Craving, and Emotional Regulation

The enhancement of the stability of sleep, as well as the decrease in the severity of pathological craving, is in line with the existing knowledge about the strong correlation between sleep disturbance and the initial withdrawal stage of methamphetamine consumption. Clinical research has demonstrated that the quality of sleep is slowly increasing during the initial weeks of abstinence, and that this increase can be relatively independent of changes in anxiety and depression [49]. More recent reviews and clinical guidelines also attest that insomnia and circadian rhythm disruptions are some of the most frequent manifestations that impede the stability of treatment and predispose to relapse unless addressed early [42,50].

In line with this, the parallel enhancement of sleep and craving in this study seems to be in line with a well-known clinical recovery process: with the stabilization of sleep architecture and the resolution of hyperarousal, behavioral control increases, and the stress of the desire to use drugs decreases. Our results do not causally determine this relationship, but it provides a logical explanation of the overall direction of improvement observed by the indicators of the program.

Hepatic, Renal, and Metabolic Indicators.

The findings indicated an improvement in renal and hepatic recovery scores and glucose stabilization, which is in line with the pathophysiological understanding of systemic methamphetamine toxicity. Recent reports have reported severe hepatic and renal injury in methamphetamine users, such as abnormal liver enzymes and evidence of renal dysfunction, either due to direct toxicity or through hyperthermia, oxidative stress, and impaired perfusion [49,50].

Particularly in the Iraqi setting, a case-control study showed statistically significant differences in liver functioning markers between male methamphetamine addicts and healthy controls, which proves the hypothesis that the enhancement of liver recovery scores in our study is not a one-off event in the context of the known toxic history of the substance [47-50]. The metabolic and renal stability improvement, as to be expected, is probably a response to the removal of direct toxic exposure, an increase in nutrition and hydration, and compliance with treatment in the center - factors that tend to overlap in a formal residential environment.

An Integrative Interpretation of the Results

In interpreting the results as a unit package, it is obvious that the improvement was not limited to a single variable but was convergent in nature involving treatment retention, decreased relapse, and enhanced social functioning, and there were also signs of neurological and laboratory recovery. This multidimensional framework is consistent with the contemporary view of the treatment of stimulant use disorders, according to which the real effectiveness of a

program does not decrease to temporary abstinence but is determined by the degree of reorganization of cognitive, behavioral, physical, and social functioning [42,43,47].

However, not all composite indicators can be interpreted methodologically, especially neurobiological indicators, because the strength of scientific inference in this case is determined by the clarity of the measurement instrument and its psychometric or biological design. However, this caution does not negate the practical value of the general trend revealed by the data; rather, it calls for its future support with more detailed standardized measures and longer-term follow-up.

Overview of the Results.

The key findings of this research can be summarized in four interdependent points: First, the numerical burden of residents, which is concentrated among young adults, is increasing; second, the stimulants of the amphetamine type, especially crystal methamphetamine, are used; third, there are improvements in adherence, completion, and social integration indicators and a reduction in relapse; and fourth, there is an emerging improving trend in neurobiological and laboratory indicators.

Conclusion

This paper concludes that the burden of substance use disorders in Iraqi rehabilitation centers is obviously concentrated among the young population, and that stimulants- mainly crystal meth and Captagon- are the dominant constituent in the clinical picture of cases. Moreover, a comparison of 2024 and 2025 indicates a simultaneous increase in indicators of treatment adherence, program completion, reduction of relapses, and return to work or school, as well as a positive trend in several neurofunctional and laboratory indicators. These data confirm the opinion that recovery is a multidimensional process involving behavioral, cognitive, health, and social stability, and is not only about abstinence. Although the characteristics of institutional records and composite indicators require some caution in their interpretation, the findings offer practical justification to the need to enhance integrated rehabilitation programs, increase post-discharge follow-up, and create more standardized measures to assess functional and biological improvement in this area.

Recommendations

- **Proposed future cohort study involving the investigation of neurochemical markers to support and examine the rehabilitation program.**
- **Strengthening Integrated Rehabilitation Programs.**
- **Prioritizing the Most Overrepresented Age Groups.**

• Target the use disorders of stimulants.

Considering the prevalence of stimulant drugs, especially crystal methamphetamine and Captagon, treatment centers are suggested to establish more specific guidelines on treating this trend of substance abuse, including more accurate evaluation instruments of executive functioning, impulsivity, sleep disorders, and the intensity of pathological craving.

• Incorporating Neurobiochemical Markers into Routine Assessment

The study suggests the use of neurobiological and laboratory markers in the clinical assessment system of residents, not as a research instrument, but as an aid to track improvement, evaluate treatment response, and make an objective decision on treatment.

• Setting up a Post-Discharge Follow-Up System.

The post-program phase is a crucial phase of the recovery process; hence, it is advisable to come up with longer follow-up programs involving psychological support, family counseling, community follow-up, and frequent communication with the recovering individuals to minimize the occurrence of relapse and enhance long-term stability.

- **Linking rehabilitation to social and vocational reintegration**

It is also suggested that the program success should not be measured by the absence of substance use only, but also by the reintegration of recovering people into work, education, or vocational training because this is one of the most significant predictors of sustainable recovery and psychosocial stability.

- **Improving specialization of employees in rehabilitation centers.**

The study suggests that more vocational training should be done to physicians, psychologists, counselors, and employees of rehabilitation centers so that they can be competent in handling substance use disorders, especially those related to complex cognitive, neurological, and behavioral changes.

- **Creating a national database.**

The need to create a uniform national database, which contains demographic, clinical, therapeutic, and laboratory variables, is essential to create more precise indicators and facilitate health planning, decision-making, and comparative longitudinal studies.

- **Enhancing the combination of Treatment, Prevention, and Community Action.**

It is suggested that stakeholders should consider a combined strategy that would connect rehabilitation facilities, health facilities, the educational system, and community education programs to minimize risk factors, allow early diagnosis, and reduce the stigma of seeking treatment.

- **Promoting multi-dimensional research in the future.**

The research suggests that future research should be done with more sophisticated designs such as longitudinal follow-up, predictors of adherence and relapse, and how neurobiological markers relate to clinical and functional outcomes, which will improve the scientific knowledge of the effectiveness of rehabilitation programs.

The study suggests on the basis of the above that an integrated evidence-based rehabilitation strategy that transcends the boundaries of conventional treatment to incorporate neurobiological assessment, ongoing follow-up, and community reintegration should be adopted as the main pillars to enhance the rehabilitation outcomes, lessen relapse, and ensure sustainable recovery among the youth.

Statements and Declarations

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Competing Interests

The authors declare that they have no competing interests.

Author Contributions

The study was conceived and designed by Mustafa Alburhan, who was the principal investigator, developed the protocol, study design, coordinated with the rehabilitation centers, data extraction framework, data management, statistical analysis, interpretation of findings, and drafted the manuscript. Riyadh Ahmed Mohammed helped in designing the study, data collection and verification, results interpretation, literature support and critical revision of the manuscript. The final version of the manuscript was reviewed and approved by both authors and they agreed to be responsible to all the work.

Data Availability

The data that support the findings of this study are not publicly available due to privacy and confidentiality considerations related to institutional health records. Data may be available from the corresponding author upon reasonable request and subject to approval by the relevant authorities.

Ethics Approval

The study was approved by the Research Committee of the National Center for Training and Human Development, Iraqi Ministry of Health, under protocol number 50/2026, in accordance with established procedures.

Consent to Participate

As this was a retrospective study based on institutional records, the requirement for individual informed consent was waived by the approving committee, as applicable, due to the use of existing records and anonymized data.

Consent to Publish

Not applicable. This study did not include any identifiable individual data, images, or personal details requiring consent for publication.

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