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Original Article

Psychiatry/Mental Health Section

A Cross-sectional Study to Assess the Association between the Cognitive Function with Severity of Dependence and Motivation to Quit in Patients with Substance Use Disorder

SHIVANI DUA[1], RAMCHANDRA DAS[2], SUDIPTA KUMAR DAS[3]

ABSTRACT

Introduction: Long-term substance abuse can impact an individual's cognition and higher mental abilities, which can, in turn, affect their judgment-making capacity and lead to a higher chance of relapse. This is because the individual's motivation to quit is linked to their cognitive functioning.

Aim: To assess the association between cognitive function, the severity of dependence, and the motivation to quit in patients with Substance Use Disorder (SUD).

Materials and Methods: This was a cross-sectional observational study conducted in a tertiary care hospital in Eastern India between October 2018 and September 2020. The study includes total 83 patients diagnosed with substance dependence according to the International Classification of Diseases-10 guidelines by the treating psychiatrist, and admitted to the inpatient unit of the Department of Psychiatry Socio-demographic details such as age, gender, background, marital status, primary substance, and duration of use were obtained using a semi-structured questionnaire. Cognitive functions were assessed using the Montreal Cognitive Assessment Scale (MoCA) and the Frontal Assessment Battery (FAB). The severity of dependence was assessed using the Leeds Dependence Questionnaire. Motivation to quit substances was assessed using the Stages of Change Readiness and Treatment Eagerness Scale. Statistical Package for the Social Sciences(SPSS) v23 was used for data analysis.

Results: All subjects included in the study were male. Approximately 56 (67.5%) were admitted for alcohol dependence, followed by opioid dependence. The majority of the study sample had moderate severity of dependence, with 52 (62.7%) participants showing good motivation. A total of 53 (63.9%) participants had global cognitive deficits, and frontal lobe dysfunction was seen in 41 (49.4%) of the study sample. Both cognitive functioning and frontal lobe functioning were significantly associated with motivation to quit. The severity of dependence on the substance was not significantly associated with either cognitive function or frontal lobe functioning.

Conclusion: Out of the total sample, almost two-thirds had cognitive deficits, and half had frontal lobe dysfunction. The correlation between poor motivation and cognitive impairment, as well as frontal lobe dysfunction, was found to be statistically significant, indicating that poor motivation to quit substances in patients may be affected by cognitive process dysfunction or frontal lobe damage.

Keywords: Cognitive impairment, Frontal lobe dysfunction, Mental ability

INTRODUCTION

People of all ages can be affected by Substance Use Disorders (SUDs), which can lead to a wide range of negative consequences. An estimated 14.6% of Indians used alcohol in the past year, with 2.7% reporting dependence on it, according to the National Drug Use Survey [1]. Opioid and cannabis use each account for 2.8% and 2.1% of the population, respectively. Tobacco use disorder was reported at 13.1% of the population, while other drug use disorders were recorded at 0.6% of the population by the National Mental Health Survey [2].

Poor cognitive functioning is connected with drug dependency and long-term illicit drug use [3]. The Montreal Cognitive Assessment (MoCA) has been utilized in several investigations to demonstrate this. Deficits in cognition across multiple studies ranged from approximately 30% to 80% [4]. According to a study conducted in Puducherry in 2017, four-fifths of patients with alcohol dependence had global cognitive impairments after the detoxification period [5]. One-sixth reported problems with their executive functions. Although cognitive function as measured by MoCA was not found to be statistically significant, frontal executive dysfunction was associated with almost six times the likelihood that the patient would be less motivated to quit drinking [6].

It is typical for individuals to relapse after addiction treatment. This relapse can be attributed to the individual's motivation to quit, which is linked to their cognitive functioning. Thus, patients with higher cognitive functioning should be more motivated to quit [7]. The majority of studies conducted compare substances with cognitive function by testing the functioning of the prefrontal and frontal cortex. However, these studies primarily assess orientation, abstract ability, memory, and attention, and not motivation, which is also an aspect of cognition. Our study is among the few that assess motivation to quit alongside the severity of dependence on substances. This has further research implications that could lead to better treatment outcomes and relapse prevention strategies.

The aim of this study was to assess cognitive function in relation to the severity of dependence and motivation to quit in patients with SUD.

MATERIALS AND METHODS

This was a cross-sectional observational study conducted at a tertiary care hospital in Eastern India between October 2018 and September 2020. Ethical clearance was granted by the Institutional Ethical Committee of the hospital (KIMS/KIIT/IEC/123/2018). The study includes total 83 patients.

Inclusion criteria: Patients aged over 18 years, diagnosed with substance dependence according to the International Classification of Diseases-10 (ICD-10) guidelines by the treating psychiatrist and admitted to the inpatient unit of the Department of Psychiatry, were

consecutively recruited for the study [8]. Patients with other medical or surgical illnesses were included, provided they did not experience any withdrawal symptoms.

Exclusion criteria: Patients diagnosed with dementia or other amnestic disorders, psychosis, or mood disorders, those experiencing withdrawal symptoms {Clinical Institute Withdrawal Assessment of Alcohol Scale, Revised (CIWA-Ar) <10, Clinical Opiate Withdrawal Scale (COWS) <5}, and those who did not give their consent or complete the assessment process were excluded from the study population. Patients admitted to the department for treatment for substance use but who were either transferred to other departments for treatment or discharged from the hospital before assessment for the study could take place were also excluded.

Sample size calculation: Hypothesizing that the percentage of cognitive deficits in patients with SUD is 31% [9], with a margin of error (α)=0.05, confidence interval (1-α)=0.95, and absolute precision at 0.1, the sample size was calculated as follows:

$$n=\frac{Z^2p\,(1-p)}{d^2}$$

Where:

n=required sample size

Z=Z-score corresponding to the desired confidence level (for 95%, approximately 1.96)

p=estimated proportion (here, 0.31)

d=absolute precision or margin of error (here, 0.1)

$$n=\frac{(1.96)2\times0.31\times(1-0.31)}{(0.1)^2}$$

=82.3

The minimum sample size required was determined to be 83. Assessments were conducted after the withdrawal period had ended, which was evaluated using CIWA-Ar for COWS for opioids. For other substances, withdrawal was assessed clinically by two psychiatrists independently. Informed consent was obtained from all participants before their inclusion in the study.

Study Procedure

A semi-structured questionnaire containing socio-demographic details and patterns of substance use was developed by the authors and used for the study. The socio-demographic variables assessed included age, sex, background, socio-economic status, marital status, type of family, religion, education, occupation, and monthly income. Once the patients were out of withdrawal based on clinical assessment and charting with withdrawal scales, the MoCA Scale [10] was applied to assess cognitive function. MoCA scores range from 0 to 30, with a score of 26 or higher considered normal. The Frontal Assessment Battery (FAB) was employed to check for frontal lobe dysfunction [11]. The FAB score ranges from 0 to 18, with a cut-off score of 12.

Motivation to quit among subjects was assessed using the Stages of Change Readiness & Treatment Eagerness Scale (SOCRATES) - 8A & 8D. The instrument yields three factorially-derived scale scores: Recognition (Re), Ambivalence (Am), and Taking Steps (Ts). Based on the 'Taking Steps' subscale, patients were categorized as having poor motivation if they scored very low (score of 8-25), low (score of 30), or medium (score of 33), and as having good motivation if they scored high (score of 36) or very high (score of 39-40), with the scores ranging from 8 to 40 [12]. The severity of dependence was assessed using the Leeds Dependence Questionnaire (LDQ), which contains 10 items scored from 0 to 3. Cut-offs are: <10=low dependence; 10-22=medium dependence; ≥22=high dependence, with total scores ranging from 0 to 30 [13].

STATISTICAL ANALYSIS

Data analysis was conducted using SPSS v23 (IBM Corp.). Group comparisons for continuously distributed data were made using the independent sample t-test when comparing two groups. If data were found to be non-normally distributed, appropriate non-parametric tests like the Wilcoxon test were used. Chi-squared tests were employed for group comparisons of categorical data. In cases where the expected frequency in the contingency tables was <5 for more than 25% of the cells, Fisher's exact test was used instead. Linear correlation between two continuous variables was explored using Pearson's correlation (for normally distributed data) and Spearman's correlation (for non-normally distributed data). Statistical significance was set at p-value <0.05.

RESULTS

A total of 83 patients were included in the study. The clinical and socio-demographic profile of the subjects is summarized in [Table/Fig-1]. The mean age (in years) was 38.35±10.64. All 83 participants in the sample were male. A majority of the sample was admitted for alcohol dependence (67.5%), followed by opioid dependence (24.1%). The mean duration of substance use (in years) was 8.64±4.98.

Characteristic	Frequency (%)
Age	
≤20 Years	4 (4.8)
21-30 Years	17 (20.5)
31-40 Years	30 (36.1)
41-50 Years	20 (24.1)
51-60 Years	12 (14.5)
Gender (Male)	83 (100)
Background	
Urban	59 (71.1)
Rural	24 (28.9)
Marital Status	
Married	56 (67.5)
Unmarried	24 (28.9)
Separated	3 (3.6)
Primary substance	
Alcohol	56 (67.5)
Opioids	20 (24.1)
Cannabis	6 (7.2)
Zolpidem	1 (1.2)
	Mean±SD || Median (IQR) || Min-Max
Duration of substance use (years)	8.64±4.98 || 7.00 (5.00-15.00) || 1.00-20.00

[Table/Fig-1]: Sociodemographic characteristics.

A majority of the study sample had moderate severity of dependence (62.7%). Approximately 47.0% of the participants exhibited good motivation to quit, while the remaining 53.0% had poor motivation. The SOCRATES and Leeds Questionnaire scores are presented in [Table/Fig-2].

Parameter	Frequency N(%)
Recognition	
Very low	8 (9.6%)
Low	59 (71.1%)
Medium	12 (14.5%)
High	4 (4.8%)
Ambivalence	
Very low	2 (2.4%)
Low	46 (55.4%)
Medium	22 (26.5%)
High	13 (15.7%)

Taking steps	
Very low	3 (3.6%)
Low	18 (21.7%)
Medium	23 (27.7%)
High	32 (38.6%)
Very high	7 (8.4%)
LDQ Scores	
Severity	
Low	9 (10.8%)
Moderate	52 (62.7%)
Severe	22 (26.5%)

[Table/Fig-2]: Scoring for SOCRATES and leeds dependent questionnaire.

The MoCA scores obtained were not normally distributed (Shapiro-Wilk Test: p-value <0.001). The mean MoCA score was 22.11±4.52. Out of the total sample, 63.9% scored below the cut-off score for MoCA, indicating cognitive impairment. The FAB scores were also not normally distributed (Shapiro-Wilk Test: p-value=0.004). The mean FAB score was 12.63±2.89, with frontal lobe dysfunction observed in 49.4% of the study sample. For every one-unit increase in MoCA, the FAB increased by 0.52 units.

To explore the association between cognitive function and motivation, the Chi-square test was used. Among the patients with cognitive dysfunction (scoring below the cut-off score on MoCA), 28.3% had good motivation, whereas the remainder had poor motivation. Approximately 80.0% of participants who scored higher than 26 on MoCA demonstrated good motivation to quit. There was a significant difference between the various groups in terms of the distribution of motivation (χ^2=20.555, p-value <0.001) [Table/Fig-3].

Motivation	MoCA			Chi-squared Test	
	<26	≥26	Total	χ^2	p-value
Good	15 (28.3%)	24 (80.0%)	39 (47.0%)	20.555	<0.001
Poor	38 (71.7%)	6 (20.0%)	44 (53.0%)		
Total	53 (100.0%)	30 (100.0%)	83 (100.0%)		

[Table/Fig-3]: Association of MoCA with motivation to quit.

Similarly, to investigate the association between frontal lobe dysfunction and motivation, the Chi-square test was utilized. Approximately three-quarters (73.2%) of the participants exhibiting frontal lobe dysfunction had poor motivation. Among patients who scored above the cut-off for frontal lobe dysfunction, the majority (66.7%) had good motivation. A significant difference was found between the various groups concerning the distribution of motivation (χ^2=13.218, p-value <0.001) [Table/Fig-4].

Motivation	FAB category			Chi-squared test	
	≤12	>12	Total	χ^2	p-value
Good	11 (26.8%)	28 (66.7%)	39 (47.0%)	13.218	<0.001
Poor	30 (73.2%)	14 (33.3%)	44 (53.0%)		
Total	41 (100.0%)	42 (100.0%)	83 (100.0%)		

[Table/Fig-4]: Association of FAB with motivation to quit.

The majority of the sample (62.7%) reported a moderate level of severity of substance dependence on the Leeds Dependence Questionnaire, while 10.8% of participants had a low level of severity, and 26.5% were severely dependent on substances. We also assessed whether there was any association between the severity of substance dependence, cognitive functioning, and frontal lobe dysfunction. No significant difference was observed between the various groups in terms of MoCA distribution (χ^2=5.215, p-value=0.068) [Table/Fig-5]. Fisher's exact test was applied to explore the association between severity and frontal lobe dysfunction, revealing no significant results difference between the various groups in terms of the distribution of participants having frontal lobe dysfunction and the severity of dependence (χ^2=0.358, p-value=0.836) [Table/Fig-6].

Severity	MoCA			Chi-squared test	
	<26	≥26	Total	χ^2	p-value
Low	4 (7.5%)	5 (16.7%)	9 (10.8%)	5.215	0.068
Moderate	38 (71.7%)	14 (46.7%)	52 (62.7%)		
Severe	11 (20.8%)	11 (36.7%)	22 (26.5%)		
Total	53 (100.0%)	30 (100.0%)	83 (100.0%)		

[Table/Fig-5]: Association of cognition with severity.

Severity	FAB Category			Fisher's-exact Test	
	≤12	>12	Total	χ^2	p-value
Low	4 (9.8%)	5 (11.9%)	9 (10.8%)	0.358	0.836
Moderate	25 (61.0%)	27 (64.3%)	52 (62.7%)		
Severe	12 (29.3%)	10 (23.8%)	22 (26.5%)		
Total	41 (100.0%)	42 (100.0%)	83 (100.0%)		

[Table/Fig-6]: Association of frontal lobe dysfunction with severity.

DISCUSSION

There is a lack of literature comparing variables like motivation to quit substances and cognitive functioning in cases of Substance Use Disorders (SUDs). Most studies reviewed focused individually on comparing cognitive functioning with the substances consumed.

Our findings revealed that a significant portion of the sample (36.1%) fell within the age group of 31 to 40 years, followed by the age group of 41 to 50 years (24.1%), which aligns with a study conducted by Avasthi A et al., where the majority of the sample consisted of males in their early thirties [14]. The rate of substance abuse was higher among men compared to women. This discrepancy may arise not only from the low prevalence of the disorder in females but also from the fact that women may avoid seeking help from de-addiction services due to social stigma [15].

Cortical atrophy, hypometabolism, decreased cerebral blood flow, and altered neurotransmitter activity have been linked to ethanol intake [16]. Long-term outcomes are also influenced by premorbid functioning, neuromedical problems, and mental health conditions. Alcohol-induced deficiencies are hypothesized to selectively impair abilities required for controlled and effortful processing of new information, as well as selective and divided attention, while generally sparing intelligence, overlearned knowledge, and automatic processes [3,17].

In our study, MoCA scores ranged from 9 to 29, with the majority of the sample (63.9%) scoring below the cut-off score, indicating cognitive impairment. The range of cognitive dysfunction reported in individuals with substance addiction has varied across studies, ranging from 31% to 84.2% [3,7,18,19]. This wide range of cognitive dysfunction may be attributed to differences in the methodologies employed in the various studies. This suggests a need to formulate and develop standardized tests for cognitive dysfunction tailored to different population samples.

A better cognitive outcome and higher scores on the MoCA are observed in patients with a shorter duration of substance intake. Using a cut-off score of 33 on the 'Taking Steps' subscale to categorize patients into those with good motivation and poor motivation, the MoCA score was statistically significant in relation to motivation ($p \leq 0.001$). We observed that participants with cognitive impairment were less motivated to quit the substance compared to patients without cognitive impairment on the MoCA. The median MoCA score was also higher in the group with good motivation. Viswam A et al., compared the MoCA scores of patients with good and poor motivation in their study and found that patients with poor motivation scored lower on the MoCA compared to those with good

motivation; however, this difference was not statistically significant (p-value=0.128) [5]. These cognitive deficits may limit the patient's ability to benefit from psychoeducation and cognitive behavioral approaches, potentially making treatment less effective. They may also contribute to a person's risk of relapse [20].

Long-term drug users experience a loss of grey matter in their prefrontal cortex. A lack of dopamine-2 receptors leads to unopposed actions of dopamine-1 receptors, creating hyperconnections in the basal ganglia and cortical loops, which have been proposed as the source of cognitive symptoms associated with addiction. Fifty-nine percent of the participants in our study had a frontal lobe dysfunction score below the cut-off of 12, which is considered abnormal. Researchers have found that drug-free individuals outperform substance addicts in studies linking frontal lobe damage to persistent substance abuse. More research is needed to determine whether the malfunction is primarily caused by drug usage. There was a statistically significant association between FAB scores and motivation to quit substances (p-value=0.001). The median FAB score was lower among those with little motivation compared to those with high motivation. Nearly six times as many patients with frontal lobe impairment were found to be less motivated to stop using substances [17,21,22].

Addiction can be understood as a disease in which the normal circuits that reward and promote positive behaviors are altered due to prolonged drug use. These changes in the brain also increase the likelihood of drug-seeking behavior by enhancing Dopamine-2 Receptor (D2R)-mediated signals. These findings suggest that D1 and D2 dopamine receptor mechanisms could be targeted to develop anti-craving medications for treating drug addiction [21,23,24].

We compared the severity of dependence to the cognitive functioning of the study sample. The association between these two variables was found to be insignificant (p-value=0.06). Similarly, when the FAB scores were compared to the severity of dependence, no statistical significance was found (p-value=0.8). While the severity of dependence may play a role in cognitive functioning [25], it is also influenced by several other factors, such as the type of substance, the presence of withdrawal symptoms, the duration of use, and the amount of substance consumed. More research is needed to determine the relationship between the severity of dependence and its link to cognitive or frontal dysfunction.

Limitation(s)

The study had a few limitations. As it was a cross-sectional study, we were unable to determine whether the patients' cognitive function had improved or deteriorated over time. Since the study was conducted in a hospital setting, the results may not be generalizable to the broader population and may not provide accurate estimates regarding cognitive functioning or dependence severity. A higher level of precision would have been preferable, even though the sample size was calculated using established formulas. Additionally, since no women sought de-addiction treatment, we could not assess the substance dependence patterns and their effects on women. As a result, we were also unable to determine if pre-morbid cognitive functioning influenced the patients' current cognitive abilities or the effects of any current medications.

CONCLUSION(S)

Poor motivation to quit substances in patients may stem from cognitive process dysfunction or frontal lobe damage. Individuals predisposed to developing substance dependence often exhibit pre-morbid deficits in specific domains of cognitive dysfunction, particularly in executive functions. Although addiction medicine is advancing, cognitive evaluation and retraining in patients with Substance Use Disorders (SUDs) are not widely utilized. To improve treatment outcomes and reduce the disease burden associated with SUDs, the implementation of pharmacological and non-pharmacological cognitive remediation techniques should be investigated.

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PARTICULARS OF CONTRIBUTORS:
1. Assistant Professor, Department of Psychiatry, LNCT Medical College, Indore, Madhya Pradesh, India.
2. Professor, Department of Psychiatry, Kalinga Institute of Medical Sciences, Bhubaneswar, Odisha, India.
3. Professor, Department of Psychiatry, Kalinga Institute of Medical Sciences, Bhubaneswar, Odisha, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Sudipta Kumar Das,
Professor, Department of Psychiatry, Kalinga Institute of Medical Sciences,
Patia, Bhubaneswar, Odisha, India.
E-mail: linksudipta@gmail.com

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