

Cerebral Blood Flow Velocity Parameters Among Chronic Alcohol Dependent Patients Following Detoxification: A Cross-Sectional Study.

¹Sanjaya Kumar Pany, ²Rati Ranjan Sethy, ³Aniket Dash, ⁴S A Idrees,

¹Associate Professor, Department of Psychiatry, Hi Tech Medical College, Bhubaneswar, Odisha, India

²Associate Professor, Department of Psychiatry, Government Medical College & Hospital, Phulbani, Odisha, India

³Assistant Professor, Department of Psychiatry, Pabitra Mohan Pradhan Medical College & Hospital, Talcher, Odisha, India

⁴Associate Professor, Department of Psychiatry, Hi Tech Medical College and Hospital, Bhubaneswar, Odisha, India

Page | 1

ABSTRACT

Background:

Chronic alcohol dependence is associated with neurovascular alterations that may impair cerebral blood flow and autoregulation. Although detoxification is a key component of treatment, cerebral hemodynamic abnormalities may persist after withdrawal. Evidence regarding cerebral blood flow velocity following detoxification remains limited, particularly in the Indian population.

Objectives:

To evaluate cerebral blood flow velocity parameters among chronic alcohol-dependent patients following detoxification using Transcranial Doppler ultrasonography and determine their association with clinical and demographic variables.

Methods:

A hospital-based cross-sectional analytical study was conducted among 60 male patients with alcohol dependence syndrome who had completed detoxification at the Central Institute of Psychiatry, Kanke, Ranchi. Participants were recruited using consecutive sampling. Clinical assessment included sociodemographic characteristics, alcohol use profile, and Severity of Alcohol Dependence Questionnaire (SADQ) scores. Cerebral hemodynamic parameters were measured using Transcranial Doppler ultrasonography. Data were analyzed using descriptive statistics, independent *t*-test, one-way ANOVA, Pearson correlation, and multiple linear regression.

Results:

The mean age of participants was 36.8 ± 7.4 years, and the mean duration of alcohol use was 14.2 ± 6.1 years. Severe alcohol dependence was associated with significantly lower middle cerebral artery mean velocities and higher pulsatility indices ($p < 0.05$). Duration of alcohol use showed a significant negative correlation with right middle cerebral artery mean velocity ($r = -0.42, p = 0.010$) and independently predicted reduced cerebral blood flow velocity.

Conclusion:

Chronic alcohol dependence is associated with persistent cerebral hemodynamic alterations despite detoxification. Longer duration and greater severity of alcohol exposure are associated with impaired cerebral circulation.

Recommendation:

Longitudinal multicenter studies with larger sample sizes are recommended to evaluate long-term neurovascular recovery following sustained abstinence.

Keywords: Alcohol dependence syndrome; cerebral blood flow velocity; transcranial Doppler ultrasonography; detoxification; cerebral hemodynamics.

Submitted: April 10, 2026 **Accepted:** May 20, 2026 **Published:** June 30, 2026

Corresponding author: S A Idrees

Email: idreeskem@gmail.com

Associate Professor, Department of Psychiatry, Hi Tech Medical College and Hospital, Bhubaneswar, Odisha, India

INTRODUCTION

Alcohol dependence remains a major contributor to neurological morbidity worldwide and is associated with significant structural and functional brain abnormalities. Chronic alcohol exposure induces neurotoxicity through oxidative stress, excitotoxicity, altered neurotransmitter regulation, and endothelial dysfunction, leading to disturbances in cerebral circulation (1,2).

Multiple neuroimaging studies have demonstrated reduced cerebral metabolism and impaired regional blood flow among chronic alcohol users, particularly involving frontal and subcortical regions (3,4). Chronic exposure to ethanol produces vascular remodeling and altered autoregulatory responses that contribute to persistent perfusion abnormalities (5).

Cerebral blood flow velocity serves as an indirect indicator of neurovascular integrity. Alterations in flow velocity may reflect impaired vascular compliance, increased cerebrovascular resistance, and reduced perfusion capacity (6).

Transcranial Doppler ultrasonography provides a reliable, non-invasive method for measuring cerebral blood flow velocity within major intracranial vessels and has increasingly been used in neuropsychiatric research (7,8).

Previous investigations demonstrated lower middle cerebral artery velocities among chronic alcohol users and suggested incomplete recovery even following abstinence (9,10). Additional studies have reported relationships between alcohol severity and abnormalities in vascular resistance indices (11).

Despite increasing evidence regarding alcohol-related neurovascular changes, data from Indian populations remain limited. Furthermore, studies examining cerebral hemodynamic changes following detoxification remain scarce (12–14).

Therefore, the present study aimed to evaluate cerebral blood flow velocity changes among chronic alcohol dependent patients after detoxification.

MATERIALS AND METHODS

Study Design

A hospital-based cross-sectional analytical study was conducted to evaluate cerebral blood flow velocity parameters among chronic alcohol-dependent patients following detoxification using Transcranial Doppler (TCD) ultrasonography.

Study Setting

The study was conducted in the Department of Psychiatry in collaboration with the Department of Radiology at the Central Institute of Psychiatry (CIP), Kanke, Ranchi, India, over a period of January 2022 to December 2024. All clinical evaluations and TCD examinations were performed within the institute using standardized protocols.

Participants

The study included male patients aged 18–60 years who were diagnosed with Alcohol Dependence Syndrome according to standard diagnostic criteria and had successfully completed the detoxification protocol. Eligible participants were clinically stable, free from active alcohol withdrawal symptoms, and able to provide written informed consent.

Patients were excluded if they had a history of cerebrovascular disease, severe head injury, major psychiatric disorders other than alcohol dependence, severe systemic illnesses affecting cerebral circulation, current polysubstance dependence (except nicotine), structural intracranial abnormalities, or an inadequate temporal acoustic window that prevented TCD assessment.

Participants were recruited consecutively until the required sample size was achieved. As this was a cross-sectional study, no follow-up of participants was undertaken after completion of the assessment.

Bias

Several measures were implemented to minimize potential sources of bias. Consecutive sampling was used to reduce selection bias by enrolling all eligible participants during the study period. Standardized diagnostic criteria and the validated Severity of Alcohol Dependence Questionnaire (SADQ) were used for clinical assessment. Cerebral hemodynamic measurements were performed using a standardized TCD protocol by trained personnel under resting conditions after completion of detoxification to minimize measurement variability.

Study Size

A total of 60 participants were included in the study. The sample size was determined based on the availability of eligible patients who met the inclusion criteria during the study period and were recruited using consecutive sampling.

Data Collection

After obtaining written informed consent, each participant underwent a detailed clinical evaluation, including demographic characteristics, alcohol consumption history, age at initiation of alcohol use, duration of alcohol consumption, and assessment of dependence severity using the Severity of Alcohol Dependence Questionnaire (SADQ).

Following completion of detoxification, cerebral hemodynamic assessment was performed using Transcranial Doppler ultrasonography. Mean blood flow velocity (MV), pulsatility index (PI), and resistance index (RI) were measured in the bilateral middle cerebral arteries (MCA) and anterior cerebral arteries (ACA) while participants were in the supine resting position.

Outcome Measures

The primary outcome was cerebral blood flow velocity among detoxified alcohol-dependent patients. Secondary outcomes included the association between dependence severity and cerebral hemodynamic parameters, the relationship between duration of alcohol use and cerebral blood flow indices, and correlations between demographic characteristics and cerebral hemodynamic measurements.

Statistical Methods

Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics version 26.0. Continuous variables were expressed as mean $\pm$ standard deviation, while categorical variables were presented as frequencies and percentages. Independent Student's *t*-test and one-way analysis of variance (ANOVA) were used for group comparisons. Pearson's correlation coefficient was used to evaluate associations between continuous variables, and

multiple linear regression analysis was performed to identify independent predictors of cerebral blood flow velocity. A two-tailed *p*-value <0.05 was considered statistically significant.

Ethical Considerations

Ethical approval for the study was obtained from the Institutional Ethics Committee of the Central Institute of Psychiatry, Kanke, Ranchi. Written informed consent was obtained from all participants before enrolment. Participant confidentiality and anonymity were maintained throughout the study, and the research was conducted in accordance with the ethical principles of the Declaration of Helsinki.

RESULTS

Participant Flow

During the study period, 74 patients with alcohol dependence syndrome who completed inpatient detoxification were assessed for eligibility. Eight patients were excluded because of inadequate temporal acoustic windows for Transcranial Doppler examination, three patients had significant neurological or systemic illnesses affecting cerebral circulation, and three patients declined participation. Finally, 60 participants fulfilled the eligibility criteria, provided written informed consent, and were included in the analysis. All enrolled participants completed the assessment and were analyzed.

1. Sociodemographic and Clinical Characteristics of Study Population

The majority of participants belonged to the age group of 31–40 years (41.7%). Most subjects were married (68.3%), belonged to the lower-middle socioeconomic class (53.3%), and were from urban settings (61.7%).

Table 1: Sociodemographic and Clinical Characteristics of Participants (N=60)

Variables	Frequency (%) / Mean $\pm$ SD
Age (years)	36.8 $\pm$ 7.4
Age at onset drinking (years)	20.1 $\pm$ 4.2
Duration of alcohol use (years)	14.2 $\pm$ 6.1
SADQ score	31.4 $\pm$ 5.8
Married	41 (68.3%)
Unmarried	19 (31.7%)
Urban residence	37 (61.7%)
Rural residence	23 (38.3%)
Moderate dependence	24 (40.0%)
Severe dependence	36 (60.0%)

Table 1 demonstrates that most participants had long-standing alcohol exposure with moderate-to-severe dependence.

2. Cerebral Hemodynamic Parameters Following Detoxification

Transcranial Doppler assessment demonstrated relatively lower blood flow velocities within anterior circulation vessels. Mean MCA velocities remained comparatively preserved, whereas ACA velocities were lower.

Table 2: Cerebral Blood Flow Velocity Parameters Following Detoxification

Parameter	Mean $\pm$ SD
Right MCA Mean Velocity (cm/s)	53.6 $\pm$ 6.4
Left MCA Mean Velocity (cm/s)	54.1 $\pm$ 5.8
Right ACA Mean Velocity (cm/s)	34.8 $\pm$ 4.0
Left ACA Mean Velocity (cm/s)	34.4 $\pm$ 4.1
Right MCA Pulsatility Index	1.02 $\pm$ 0.14
Left MCA Pulsatility Index	1.01 $\pm$ 0.12
Right MCA Resistance Index	0.61 $\pm$ 0.09
Left MCA Resistance Index	0.60 $\pm$ 0.08

Table 2 summarizes cerebral hemodynamic findings among detoxified alcohol dependent individuals.

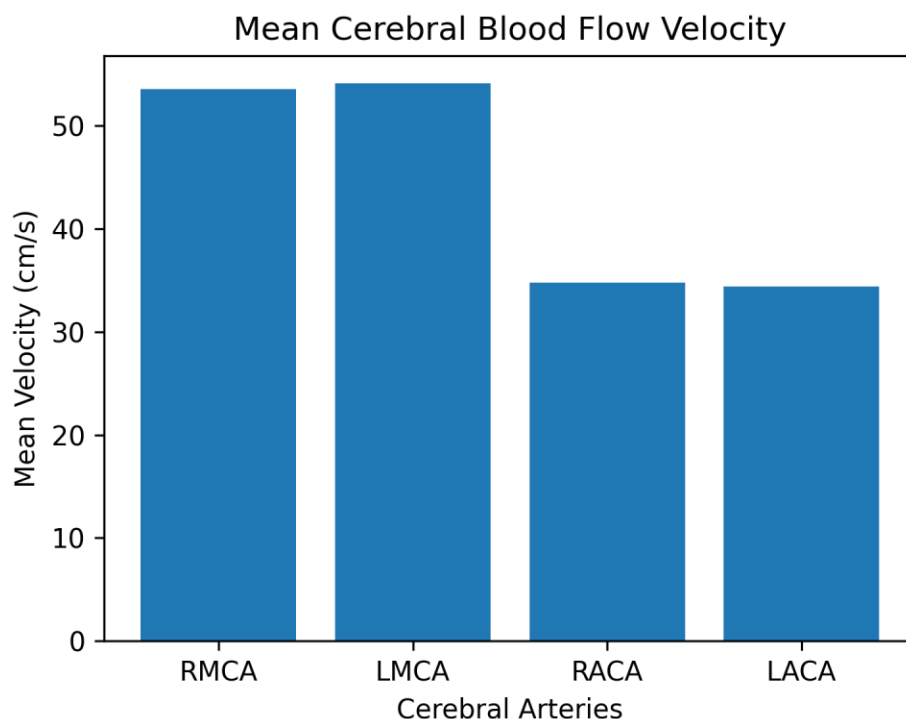


Figure 1: Distribution of Mean Cerebral Blood Flow Velocity

Figure 1 illustrates relatively reduced mean blood flow velocities within ACA territories compared with MCA territories.

3. Association Between Severity of Alcohol Dependence and Blood Flow Velocity

Comparison between moderate and severe alcohol dependence groups demonstrated significantly lower MCA velocity among severe alcohol dependence patients.

Table 3: Association Between Severity of Alcohol Dependence and Cerebral Hemodynamics

Variable	Moderate Dependence (n=24)	Severe Dependence (n=36)	p value
RMCA Mean Velocity	56.4 ±5.2	51.9 ±6.5	0.018
LMCA Mean Velocity	56.0 ±5.1	52.8 ±5.8	0.031
RMCA PI	0.95 ±0.11	1.09 ±0.15	0.020
RMCA RI	0.58 ±0.07	0.64 ±0.08	0.024

Table 3 demonstrates significant reductions in mean velocity and increased vascular resistance among severe alcohol dependence groups.

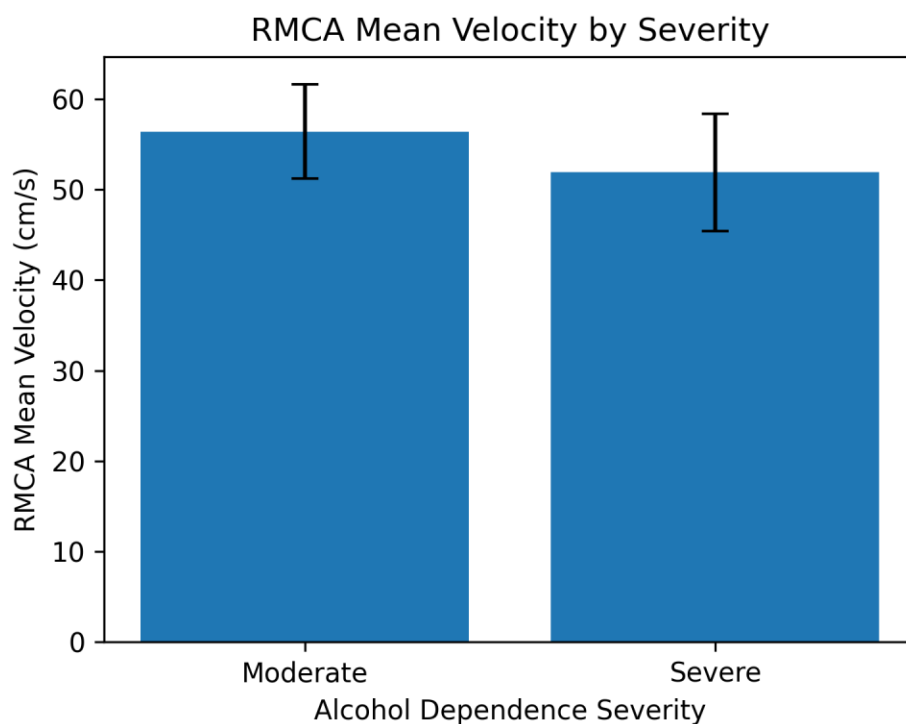


Figure 2: Comparison of RMCA Mean Velocity According to Severity Moderate dependence

Figure 2 demonstrates lower RMCA velocity among severe alcohol dependence patients.

4. Correlation Between Duration of Alcohol Use and Hemodynamic Parameters

Pearson correlation analysis demonstrated a significant inverse relationship between duration of alcohol use and blood flow velocity.

Table 4: Correlation Between Clinical Variables and Cerebral Hemodynamics

Variable	Correlation Coefficient (r)	p value
Duration vs RMCA MV	-0.42	0.010
Duration vs LMCA MV	-0.35	0.021
SADQ vs PI	0.38	0.019
Age vs RI	0.29	0.041

Page | 6

Table 4 demonstrates a significant negative correlation between duration of alcohol exposure and blood flow velocity.

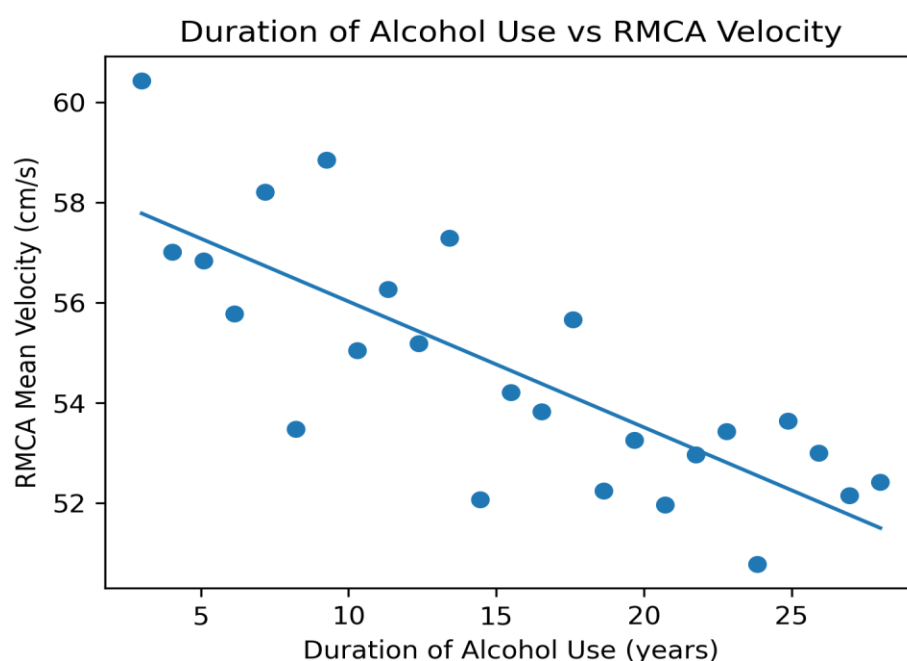


Figure 3: Correlation Between Duration of Alcohol Use and RMCA Velocity

RMCA Velocity

Figure 3 demonstrates an inverse relationship between duration of alcohol exposure and right middle cerebral artery velocity.

5. Comparison of Cerebral Hemodynamics According to Duration of Alcohol Use

Participants were divided according to alcohol exposure duration (<10 years and ≥10 years).

Table 5: Hemodynamic Comparison According to Duration of Alcohol Use

Parameter	<10 Years (n=22)	≥10 Years (n=38)	p value
RMCA Mean Velocity	56.7 ±5.4	51.8 ±6.0	0.012
LMCA Mean Velocity	55.8 ±5.1	52.9 ±5.7	0.028
RMCA PI	0.96 ±0.10	1.07 ±0.14	0.019
RMCA RI	0.57 ±0.07	0.63 ±0.09	0.022

Table 5 demonstrates significantly altered hemodynamic parameters among long-duration alcohol users.

6. Multivariate Analysis

Multiple linear regression demonstrated that duration of alcohol use independently predicted RMCA velocity after adjustment for age and severity score.

Table 6: Multiple Linear Regression Analysis for RMCA Velocity

Variable	Beta Coefficient	95% CI	p value
Duration of alcohol use	-0.38	-0.71 to -0.12	0.009
Age	-0.14	-0.28 to 0.04	0.118
SADQ score	-0.22	-0.42 to -0.03	0.041

Table 6 suggests that longer alcohol exposure independently predicts reduced cerebral blood flow velocity.

DISCUSSION

Key Results

The present study aimed to evaluate cerebral blood flow velocity parameters among chronic alcohol-dependent patients following detoxification and to determine their association with demographic and clinical characteristics. A total of **60 male participants** with a mean age of **36.8 ± 7.4 years** and a mean alcohol consumption duration of **14.2 ± 6.1 years** were included. Most participants had severe alcohol dependence (60.0%). The findings demonstrated reduced cerebral blood flow velocities following detoxification, particularly among individuals with severe alcohol dependence. Significant inverse correlations were observed between the duration of alcohol use and middle cerebral artery (MCA) mean velocity (Table 4), while multivariable regression analysis identified duration of alcohol use as an independent predictor of reduced cerebral blood flow velocity (Table 6). Participants with longer alcohol exposure also exhibited significantly higher pulsatility and resistance indices (Table 5), indicating persistent cerebrovascular alterations despite detoxification.

Interpretation of Findings

The findings of this study support the primary objective of evaluating cerebral hemodynamic changes following detoxification among patients with alcohol dependence syndrome. As shown in **Table 2**, cerebral blood flow velocities remained reduced after completion of detoxification, suggesting that neurovascular impairment may persist beyond the acute withdrawal period. Similar observations have been reported by previous neuroimaging and Transcranial Doppler studies, which demonstrated incomplete recovery of cerebral perfusion during early abstinence (15,16).

The comparison between moderate and severe alcohol dependence groups (**Table 3**) demonstrated significantly

lower MCA mean velocities and higher pulsatility and resistance indices among patients with severe dependence. These findings indicate that greater alcohol dependence severity is associated with increased cerebrovascular resistance and impaired vascular compliance. Chronic alcohol exposure has been shown to induce endothelial dysfunction, oxidative stress, neuroinflammation, and impaired cerebrovascular autoregulation, all of which contribute to persistent abnormalities in cerebral circulation (17–20).

Consistent with the second study objective, the present study demonstrated a significant inverse correlation between duration of alcohol consumption and cerebral blood flow velocity (**Table 4** and **Figure 3**). Furthermore, participants with alcohol use lasting ten years or longer had significantly lower MCA velocities and higher vascular resistance indices than those with shorter exposure (**Table 5**). These findings suggest that prolonged alcohol exposure produces cumulative neurovascular injury that may continue even after successful detoxification.

Multivariable regression analysis (**Table 6**) further demonstrated that duration of alcohol use independently predicted reduced cerebral blood flow velocity after adjustment for age and dependence severity. This finding highlights the importance of cumulative alcohol exposure as a major determinant of persistent cerebral hemodynamic impairment.

The present study also demonstrates the usefulness of Transcranial Doppler ultrasonography as a simple, non-invasive, and cost-effective technique for assessing cerebral blood flow among patients recovering from alcohol dependence. The technique may have clinical value in monitoring neurovascular recovery during long-term rehabilitation.

Generalizability

Although this study was conducted at a single tertiary psychiatric center and included only male participants, the findings provide valuable evidence regarding cerebral hemodynamic alterations among detoxified patients with

alcohol dependence syndrome. The results may be applicable to similar hospital-based populations receiving specialized addiction treatment. However, caution should be exercised when generalizing the findings to females, community-based populations, or individuals with different clinical characteristics. Larger multicenter studies involving more diverse populations are required to improve the external validity of these findings.

CONCLUSION

Chronic alcohol dependence is associated with persistent alterations in cerebral hemodynamic parameters despite completion of detoxification. Greater severity and longer duration of alcohol exposure were associated with lower cerebral blood flow velocities and increased cerebrovascular resistance. Transcranial Doppler ultrasonography appears to be a useful non-invasive tool for evaluating cerebral circulation among individuals recovering from alcohol dependence. Longitudinal studies are required to determine the extent of neurovascular recovery during sustained abstinence.

LIMITATIONS

This study has several limitations. First, its cross-sectional design precludes establishing causal relationships between alcohol dependence and cerebral hemodynamic changes. Second, the study was conducted at a single tertiary care

center with a relatively small sample size, which may limit the precision and external validity of the findings. Third, only male participants were included, limiting the applicability of the results to female patients. Fourth, the absence of a healthy control group prevented direct comparison with normal cerebral blood flow parameters. Finally, cerebral hemodynamic measurements were obtained only after detoxification, and longitudinal follow-up was not performed to evaluate recovery over time.

RECOMMENDATIONS

Future multicenter prospective studies with larger and more diverse populations should evaluate cerebral hemodynamic changes during long-term abstinence. Inclusion of healthy control groups and serial Transcranial Doppler assessments would improve understanding of neurovascular recovery and may help establish Transcranial Doppler ultrasonography as a routine monitoring tool in patients undergoing treatment for alcohol dependence.

Acknowledgement

The authors sincerely thank all the participants who voluntarily participated in this study. The authors also acknowledge the support provided by the Department of Psychiatry and the Department of Radiology, Central Institute of Psychiatry, Kanke, Ranchi, for facilitating this research.

List of abbreviations

Abbreviation	Full Form
ACA	Anterior Cerebral Artery
ADS	Alcohol Dependence Syndrome
CIP	Central Institute of Psychiatry
IEC	Institutional Ethics Committee
MCA	Middle Cerebral Artery
MV	Mean Blood Flow Velocity
PI	Pulsatility Index
RI	Resistance Index
SADQ	Severity of Alcohol Dependence Questionnaire
SD	Standard Deviation
SPSS	Statistical Package for the Social Sciences
TCD	Transcranial Doppler Ultrasonography

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this study.

Source of funding

This research received no external funding. The study was conducted using institutional resources only.

Author biography

Dr. Sanjaya Kumar Pany is an Associate Professor in the Department of Psychiatry, Hi-Tech Medical College, Bhubaneswar, Odisha, India. His research interests include addiction psychiatry, neuropsychiatry, and psychiatric epidemiology.

Dr. Rati Ranjan Sethy is an Associate Professor in the Department of Psychiatry, Government Medical College and Hospital, Phulbani, Odisha, India. His areas of interest include substance use disorders, community psychiatry, and mental health services research.

Dr. Aniket Dash is an Assistant Professor in the Department of Psychiatry, Pabitra Mohan Pradhan Medical College and Hospital, Talcher, Odisha, India. His research focuses on addiction medicine, clinical psychiatry, and neuropsychiatric disorders.

Dr. S. A. Idrees is an Associate Professor in the Department of Psychiatry, Hi-Tech Medical College and Hospital, Bhubaneswar, Odisha, India. His research interests include addiction psychiatry, neuroimaging, and clinical neuroscience.

References

1. Oscar-Berman M, Marinkovic K. Alcohol: effects on neurobehavioral functions and the brain. *Alcohol Res Health*. 2007;31(1):16-26. <https://doi.org/10.1007/s11065-007-9038-6>
2. Harper C. The neuropathology of alcohol-related brain damage. *Alcohol Alcohol*. 2009;44(2):136-40. <https://doi.org/10.1093/alcalc/agn102>
3. Volkow ND, Wang GJ, Franceschi D, Fowler JS, Thanos PP, Maynard L, et al. Low doses of alcohol substantially decrease glucose metabolism in the human brain. *Neuroimage*. 2006;29(1):295-301. <https://doi.org/10.1016/j.neuroimage.2005.07.004>
4. Pfefferbaum A, Rosenbloom MJ, Deshmukh A, Sullivan EV. Sex differences in the effects of alcohol on brain structure. *Am J Psychiatry*. 2001;158(2):188-97. <https://doi.org/10.1176/appi.ajp.158.2.188>
5. Crews FT, Nixon K. Mechanisms of neurodegeneration and regeneration in alcoholism. *Alcohol Alcohol*. 2009;44(2):115-27. <https://doi.org/10.1093/alcalc/agn079>
6. Aaslid R, Markwalder TM, Nornes H. Noninvasive transcranial Doppler ultrasound recording of flow velocity in basal cerebral arteries. *Stroke*. 1982;13(6):769-74. <https://doi.org/10.3171/jns.1982.57.6.0769>
7. Markus HS. Transcranial Doppler ultrasound. *BMJ*. 2000;321(7270):1123-7.
8. Alexandrov AV. Cerebrovascular ultrasound in stroke prevention and treatment. *Cerebrovasc Dis*. 2004;17(Suppl 3):56-67. <https://doi.org/10.1002/9780470752883.ch2>
9. Gdovinova Z, Juhas S, Tkacova R, et al. Cerebral hemodynamic changes in chronic alcoholism. *Eur Neurol*. 2001;45(3):147-51.
10. Pietila K, Nukari T, Jalava M, et al. Cerebral blood flow velocity during alcohol withdrawal measured by transcranial Doppler sonography. *Stroke*. 1997;28(2):459-63.
11. Blaha M, Zvolsky P, Kozumplik O, et al. Cerebral hemodynamic changes assessed by transcranial Doppler sonography in alcohol dependence. *Neuro Endocrinol Lett*. 2003;24(3-4):199-203.
12. Rosenbloom MJ, Sullivan EV, Pfefferbaum A. Using magnetic resonance imaging and diffusion tensor imaging to assess brain damage in alcoholics. *Alcohol Res Health*. 2003;27(2):146-52.
13. Gazdzinski S, Durazzo TC, Meyerhoff DJ. Temporal dynamics and determinants of whole brain tissue volume changes during recovery from alcohol dependence. *Drug Alcohol Depend*. 2005;78(3):263-73. <https://doi.org/10.1016/j.drugalcdep.2004.11.004>
14. Durazzo TC, Meyerhoff DJ. Neurobiological and neurocognitive effects of chronic cigarette smoking and alcoholism. *Front Biosci*. 2007;12:4079-100. <https://doi.org/10.2741/2373>
15. Catafau AM, Etcheberrigaray A, Pérez de los Cobos J, Estorch M, Guardia J, Flotats A, et al. Regional cerebral blood flow changes in chronic alcoholic patients during short-term abstinence. *Neuropsychopharmacology*. 1999;20(5):438-46.
16. Gdovinova Z, Juhas S, Tkacova R, et al. Cerebral blood flow velocity changes during abstinence in alcohol dependent subjects. *Alcohol Alcohol*. 2006;41(5):514-8.
17. Moselhy HF, Georgiou G, Kahn A. Frontal lobe changes in alcoholism: a review of the literature. *Alcohol Alcohol*. 2001;36(5):357-68. <https://doi.org/10.1093/alcalc/36.5.357>
18. Meyerhoff DJ, Durazzo TC, Ende G. Chronic alcohol consumption, cerebral perfusion and metabolic abnormalities. *Alcohol Clin Exp Res*. 2004;28(6):928-35.



Student's Journal of Health Research Africa

e-ISSN: 2709-9997, p-ISSN: 3006-1059

Vol.7 No. 2 (2026): June 2026 Issue

<https://doi.org/10.51168/62y9f469>

Original Article

19. Zahr NM, Kaufman KL, Harper CG. Clinical and pathological features of alcohol-related brain damage. *Nat Rev Neurol*. 2011;7(5):284–94. <https://doi.org/10.1038/nrneurol.2011.42>
20. Monnig MA, Tonigan JS, Yeo RA, Thoma RJ, McCrady BS. White matter volume and impulsivity in alcohol dependence. *Addict Biol*. 2013;18(1):130–8. <https://doi.org/10.1111/j.1369-1600.2012.00441.x>
21. Fein G, Di Sclafani V, Finn P, Scheiner DL. Psychiatric comorbidity and brain dysfunction in long-term abstinent alcoholics. *Alcohol Clin Exp Res*. 2002;26(4):550–7.
22. Nixon SJ, Lewis B. Cognitive recovery in abstinent alcohol-dependent individuals. *Alcohol Res*. 2014;35(2):177–85.
23. Stendel R, Pietila TA, Al Hassan AA, et al. Transcranial Doppler monitoring and cerebral hemodynamic assessment in neuropsychiatric disorders. *J Clin Neurosci*. 2006;13(2):183–8.
24. Sullivan EV, Harris RA, Pfefferbaum A. Alcohol's effects on brain and behavior. *Alcohol Res Health*. 2010;33(1–2):127–43.
25. Koob GF, Volkow ND. Neurobiology of addiction: a neurocircuitry analysis. *Lancet Psychiatry*. 2016;3(8):760–73. [https://doi.org/10.1016/S2215-0366\(16\)00104-8](https://doi.org/10.1016/S2215-0366(16)00104-8)

PUBLISHER DETAILS

Student's Journal of Health Research (SJHR)

(ISSN 2709-9997) Online

(ISSN 3006-1059) Print

Category: Non-Governmental & Non-profit Organization

Email: studentsjournal2020@gmail.com

WhatsApp: +256 775 434 261

**Location: Scholar's Summit Nakigalala, P. O. Box 701432,
Entebbe Uganda, East Africa**

