Efficacy of Cognitive Rehabilitation Therapy for Alcohol-Induced Executive Dysfunction: A Zambia RCT

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ABSTRACT

Background: Alcohol Use Disorder (AUD) is associated with significant cognitive impairments, particularly in executive functioning, yet evidence for cognitive rehabilitation therapy (CRT) in low-resource settings remains limited. This study evaluated the efficacy of CRT for mild executive dysfunction among male AUD patients in Zambia.

Methods: A randomized controlled trial was conducted with 56 participants (aged 18-40 years) recruited from a residential rehabilitation center in Lusaka. Participants were randomized to either an 8-week CRT program (Brain Wave-R, n=28) or active control (painting sessions, n=28), both delivered alongside standard treatment. Executive function was assessed pre- and post-intervention using the Zambian Neurobehavioral Test Battery, including the Wisconsin Card Sorting Test (WCST), Colour Trails Test 2 (CTT), and Stroop Test.

Results: The CRT group demonstrated significant improvements in response inhibition (Stroop Test: fewer errors, $p=0.01$; more words completed, $p<0.01$) compared to controls. However, no significant between-group differences emerged for cognitive flexibility (WCST: correct responses $p=0.87$; categories completed $p=0.06$) or task-switching (CTT: errors $p=0.12$; time $p=0.56$). Secondary analyses revealed government-employed participants showed better outcomes on WCST ($p=0.04$) and CTT ($p=0.03$), while those with chronic medical conditions performed worse on WCST ($p<0.001$). The control group showed unexpected but significant Stroop Test improvements ($p<0.001$), suggesting non-specific benefits of structured activities.

Conclusion: CRT shows selective efficacy for improving response inhibition in Zambian AUD patients, with employment status and health conditions moderating treatment effects. These findings support targeted implementation of CRT in low-resource settings, particularly for patients without significant comorbidities. Future research should investigate optimal intervention duration and strategies to enhance effects on complex executive functions.

Keywords: Cognitive Rehabilitation Therapy, Alcohol Use Disorder, Executive Functioning Mild Cognitive Impairment, Neuropsychological Assessment

INTRODUCTION

AUD poses a significant public health burden globally, and Zambia in particular, where harmful drinking patterns and associated cognitive impairments remain under addressed in clinical practice (WHO, 2018; Chisha et al., 2017). AUD is linked to anatomical brain damage such as reduction in brain volume, usually involving the amygdala, prefrontal cortex, cerebellum, and hippocampus, and to an enlargement of ventricles and sulci (Mechtcheriakov et al., 2007; Monnig et al., 2013). This atrophy can affect cognition, even in the absence of evidence in daily life, and some areas seem to be involved more often than others (Davies, 2005). Specifically, impairment of executive functions is frequently associated with AUD and this weakness could lead to impulsive decision-making experiences, such as preferring immediate reward without considering subsequent downsides of improper alcohol intake (Brion et al., 2017; Camchong et al., 2014; Noël et al., 2010).

Chronic alcohol consumption leads to measurable deficits in executive functioning, particularly in cognitive flexibility, working memory, and inhibitory control, which persist during abstinence and compromise treatment outcomes (Oscar-Berman & Marinkovic, 2007; Bates et al., 2013). While Cognitive CRT has demonstrated efficacy in improving executive dysfunction among AUD patients in high-income countries (Rupp et al., 2012; Cicerone et al., 2011), its applicability in low-resource settings like Zambia remains unexplored despite the region's high AUD prevalence and limited mental health infrastructure (Petersen et al., 2016).

This study aimed to address this critical gap by evaluating the first structured CRT intervention for AUD in Zambia, while simultaneously examining key sociodemographic and clinical moderators of treatment response. Zambia's mental health system faces unique challenges, including scarce neuropsychological resources and a lack of integrated rehabilitation services for AUD-related cognitive impairment (Mkenda et al., 2018; Paul et al., 2017). This context underscores the urgent need for evidence-based, culturally adapted interventions that can be delivered within existing treatment frameworks. Our randomized controlled trial built upon global evidence for CRT while providing novel insights into implementation feasibility and differential treatment effects in a low-resource African setting. The findings will inform the development of targeted cognitive rehabilitation strategies that account for local patient characteristics and health system constraints, ultimately aiming to improve AUD treatment outcomes in Zambia and similar contexts

METHODS

The study was conducted at Sanity House, a residential rehabilitation center in Lusaka, Zambia, between April and December 2024. We enrolled 56 male participants (mean age 28.4 ± 5.2 years) meeting DSM-5 criteria for AUD (American Psychiatric Association, 2013) and demonstrating mild executive dysfunction based on preassessment normed scores on the Zambian Neurobehavioral Test Battery (ZNTB) T-scores 30-35 (Kabuba et al., 2017). Participants were randomized using computer-generated numbers in sealed envelopes (1:1 allocation) to either the intervention group (n=28) receiving CRT plus standard treatment, or the control group (n=28) receiving standard treatment plus active control sessions. Exclusion criteria followed established protocols for neurocognitive studies in AUD (Bates et al., 2013), eliminating those with neurological disorders, Korsakoff syndrome, or severe psychiatric comorbidities.

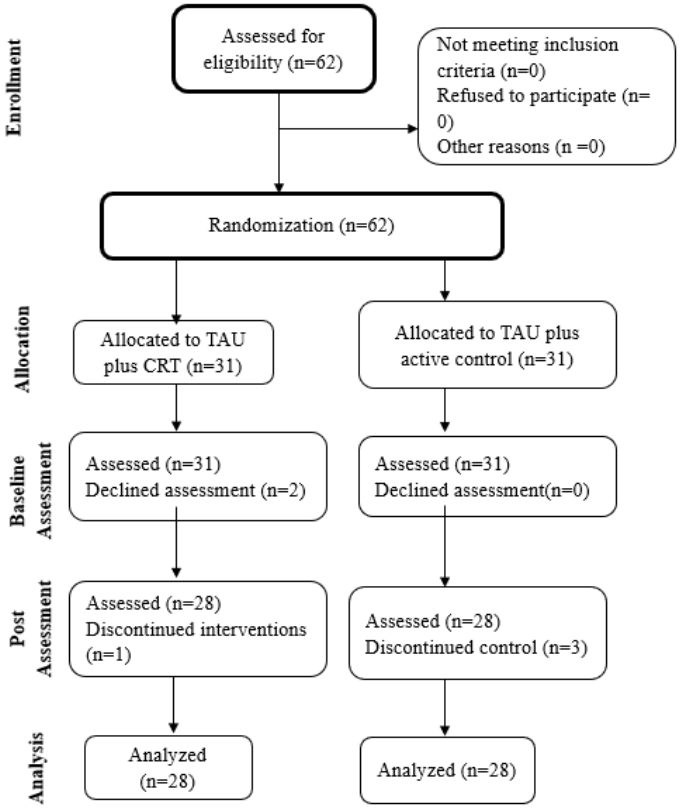

Figure 1: Flow chart for enrolment, allocation, pre-post assessment and analysis.

The intervention group completed the Brain Wave-R program (Malia et al., 2002). The 16-session protocol (60 minutes twice weekly for 8 weeks) targeted executive functions through evidence-based components (Cicerone et al., 2011): Planning exercises (maze navigation, activity scheduling) and Cognitive flexibility training. The active control group participated in structured painting sessions matched for duration and frequency, following established non-cognitive activity protocols (Haimov & Shatil, 2013).

Assessments used the validated Zambian Neurobehavioral Test Battery, administered by blinded assessors. Primary measures included:

1. Wisconsin Card Sorting Test (WCST) for cognitive flexibility (categories completed, perseverative errors)
2. Colour Trails Test 2 (CTT) for task-switching (time, errors)
3. Stroop Test for inhibitory control (word count, errors)

Secondary measures captured demographic and clinical variables using standardized questionnaires. Test-retest reliability for ZNTB measures in our sample was α=0.82-0.89, consistent with validation studies (Kabuba et al., 2017).

Statistical Analysis

Descriptive statistics were computed for all sociodemographic, clinical, and cognitive variables, including means and standard deviations for continuous variables and frequencies/percentages for categorical variables. Baseline characteristics between groups were compared using independent samples *t*-tests for continuous variables and chi-square tests for categorical variables.

To examine intervention effects, we conducted one-way analyses of variance (ANOVA) for primary cognitive outcomes (WCST, CTT2, and Stroop Test), with treatment group (CRT vs. control) as the between-subjects factor. Effect sizes were reported as partial eta squared. Secondary analyses explored associations between sociodemographic/clinical factors (e.g., employment, chronic conditions) and cognitive outcomes using one-way ANOVA.

All analyses were performed using IBM SPSS Statistics version 21.0 with statistical significance set at $p < 0.05$.

The study received ethical approval from the University of Zambia Biomedical Research Ethics Committee (Ref: 5260-2024) and the Zambian National Health Research Authority guidelines (Ref: NHRA-1479/17/08/2024/13/08/2024)

RESULTS

The study included 56 male participants with Alcohol Use Disorder (AUD), with 28 randomly assigned to the Cognitive Rehabilitation Therapy (CRT) group and 28 to the control group. Baseline characteristics showed no significant differences between groups (all p>0.05). The majority of participants were aged 18-30 years (60.7% in control group, 53.6% in CRT group) and employed in government sectors (64.3% control, 57.1% CRT). All participants demonstrated mild executive dysfunction at baseline, with 92.9% in the CRT group and 82.1% in controls reporting noticeable cognitive challenges.

Table 1: Baseline Characteristics for both Control and Cognitive Rehabilitation Group

Executive Function Test	Control group		Cognitive rehabilitation group		*t*	*p* value
	Mean	**SD**	**Mean**	**SD**		
MMSE						
Total	24.4	2.7	25.4	2.4	-1.46	0.14
ZATS						
Total	72.8	15.4	75.8	16.1	-0.71	0.48
WCST						
Correct response	50.8	16.7	53.8	19.2	-0.62	0.54

Categories	55.1	13.9	52.9	28.5	0.37	0.71
Perseverative errors	26.9	19.2	24.3	16.9	0.54	0.59
CTT						
Errors	0.7	0.2	0.5	0.1	4.73	<0.01
Execution time	102.0	35.2	94.1	0.3	1.18	0.24
Stroop-T						
Errors	4	1.4	5	1.3	-2.77	0.01
Words completed	60.0	5.5	67	5.8	-4.63	<0.01

The study examined cognitive flexibility across three different tasks: the WCST, CTT and the Stroop test. In the WCST, performance was assessed based on correct responses, completed categories, and perseverative errors. The ANOVA results indicated no significant main effect of assessment on correct responses ($F_{1,52}$ = 0.08, η^2 = 0.001, p = 0.87). However, there were marginal, non-significant trends for completed categories ($F_{1,52}$ = 3.72, η^2 = 0.12, p = 0.06) and perseverative errors ($F_{1,52}$ = 3.44, η^2 = 0.11, p = 0.07), suggesting possible but inconclusive changes in performance.

For the CTT, the analysis focused on error rate and execution time. While there was a slight decrease in error rate ($F_{1,52}$ = 2.50, η^2 = 0.08, p = 0.12) and execution time ($F_{1,52}$ = 0.35, η^2 = 0.01, p = 0.56), neither reached statistical significance. This indicates that the intervention did not lead to measurable improvements in performance on this task.

In contrast, the Stroop test demonstrated significant improvements in cognitive flexibility. The ANOVA revealed a strong main effect of assessment on both errors ($F_{1,52}$ = 30.13, η^2 = 0.53, p < 0.001) and correct responses ($F_{1,52}$ = 48.6, η^2 = 0.64, p < 0.001), indicating a clear enhancement in performance from baseline to follow-up. These results suggest that while the intervention had a meaningful impact on Stroop test performance, its effects on the WCST and CTT were either minimal or non-significant.

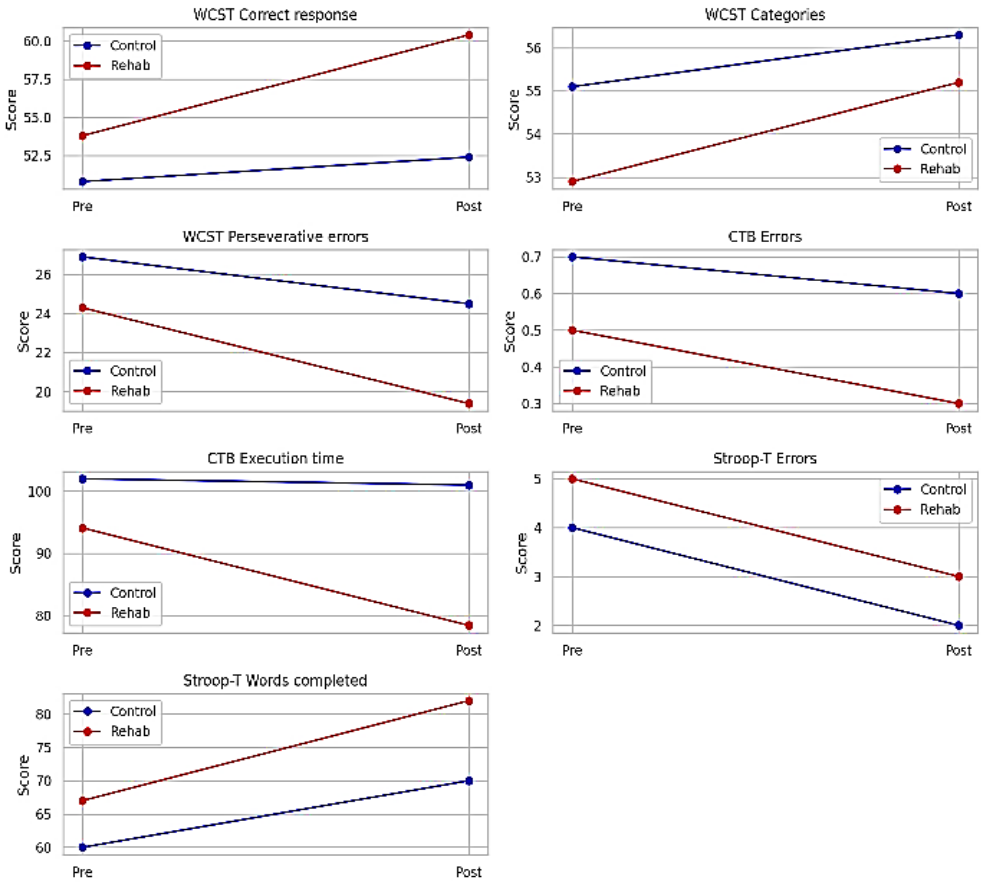

Figure 2: Comparison between Baseline and Post-intervention between the Control and Cognitive Rehabilitation Group

Secondary analyses identified important moderators of treatment response. Government-employed participants demonstrated significantly better performance on executive function tasks compared to unemployed individuals (WCST p=0.04; CTT p=0.03). Conversely, those with chronic medical conditions showed poorer cognitive outcomes (WCST p<0.001). Unexpectedly, the control group also exhibited improvements in Stroop Test performance (fewer errors p<0.001, more correct responses p<0.001), suggesting potential non-specific benefits of structured rehabilitation activities. Age of alcohol use initiation and education level did not significantly influence outcomes (both p>0.20).

DISCUSSION

The results revealed that all participants exhibited mild cognitive impairment, particularly in executive functioning, as measured by the Zambian Neurobehavioral Test Battery (ZNTB). The baseline assessments using the Wisconsin Card Sorting Test (WCST), Colour Trails Test (CTT), and Stroop Test confirmed that participants struggled with cognitive flexibility, response inhibition, and task-switching abilities. These findings are consistent with previous research that has documented executive function deficits in AUD patients, particularly in tasks requiring cognitive flexibility and inhibition (Bernardin et al., 2014; Brion et al., 2017).

The baseline data also highlighted the heterogeneity of cognitive impairments among participants, with some individuals showing more pronounced deficits in specific domains. This variability underscores the importance of individualized cognitive assessments and tailored interventions in AUD treatment programs. The findings support the need for routine cognitive assessments in AUD patients to identify specific deficits and inform treatment planning.

The findings of this study demonstrate that CRT using the Brain Wave-R program led to significant improvements in specific aspects of executive functioning among male patients with Alcohol Use Disorder (AUD) in Lusaka, Zambia. Notably, the Stroop Test results revealed a marked enhancement in cognitive flexibility and inhibitory control post-intervention ($F_{1,52} = 48.6$, $\eta^2 = 0.64$, $p < 0.001$), suggesting that CRT effectively targets response inhibition and attentional control (Bates et al., 2020). However, the Wisconsin Card Sorting Test (WCST) and Colour Trails Test (CTT) did not show statistically significant improvements, indicating that CRT's efficacy may vary across cognitive domains (Le Berre et al., 2019).

The Stroop Test's positive outcomes align with prior research highlighting CRT's role in mitigating alcohol-related cognitive deficits, particularly in tasks requiring rapid decision-making and interference suppression (Rupp et al., 2021). Conversely, the non-significant trends in WCST (categories completed: $p = 0.06$; perseverative errors: $p = 0.07$) and CTT (error rate: $p = 0.12$) may reflect the intervention's shorter duration (8 weeks) or the complexity of these tasks, which often require longer rehabilitation periods to yield measurable changes (Stott et al., 2021).

Sociodemographic factors, such as employment status, significantly influenced outcomes, with employed participants (particularly in government sectors) showing better WCST and CTT performance ($p = 0.04$ and $p = 0.03$, respectively). This suggests that structured environments may augment cognitive recovery, possibly due to routine cognitive engagement (Bates et al., 2020). Conversely, participants with chronic medical conditions exhibited poorer WCST performance ($p < 0.001$), underscoring the need for integrated treatment approaches addressing comorbidities (Oscar-Berman et al., 2014).

The study's limitations include its male-only sample, small size ($n = 56$), and focus on executive functions, omitting other cognitive domains like memory. Future research should explore CRT's long-term effects, include female participants, and assess broader cognitive measures (Nixon & Lewis, 2019).

CONCLUSION

This study highlights the potential of Cognitive Rehabilitation Therapy (CRT) in improving executive functions among male AUD patients in Zambia, with significant gains in cognitive flexibility and inhibitory control demonstrated through Stroop Test performance. However, the limited effects on complex tasks

(WCST/CTT) suggest the need for longer or more intensive interventions. To optimize outcomes, CRT should be integrated into standard AUD treatment protocols, with routine cognitive assessments guiding personalized rehabilitation. Future research must expand to include female participants, investigate CRT's interaction with HIV-related cognitive impairments, and evaluate long-term efficacy through extended interventions. Policymakers should support CRT implementation through funding, workforce training, and inclusion in national treatment guidelines, while public health initiatives should promote awareness of cognitive rehabilitation's role in AUD recovery. Culturally adapted programs and integrated care models addressing comorbidities are essential to maximize treatment effectiveness in Zambia's resource-constrained setting.

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Competing Interests

The authors declare no competing interests, financial or otherwise, related to this study.

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REFERENCES

1. American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders (5th ed.). American Psychiatric Publishing. https://doi.org/10.1176/appi.books.9780890425596
2. Bates, M. E., Buckman, J. F., & Nguyen, T. T. (2013). A role for cognitive rehabilitation in increasing the effectiveness of treatment for alcohol use disorders. Neuropsychology Review, 23(1), 27–47. https://doi.org/10.1007/s11065-013-9228-3
3. Bates, M. E., Pawlak, A. P., Tonigan, J. S., & Buckman, J. F. (2020). Cognitive rehabilitation for alcohol use disorder: A review of interventions and outcomes. Neuropsychology Review, 30(1), 122. https://doi.org/10.1007/s11065-019-09418-3
4. Bernardin, F., Maheut-Bosser, A., & Paille, F. (2014). Cognitive impairments in alcohol-dependent subjects. Frontiers in Psychiatry, 5, 78. https://doi.org/10.3389/fpsyt.2014.00078
5. Brion, M., D'Hondt, F., Pitel, A., Lecomte, B., Ferauge, M., De Timary, P., & Maurage, P. (2017). Executive functions in alcohol-dependence: A theoretically grounded and integrative exploration. Drug and Alcohol Dependence, 177, 39-47. https://doi.org/10.1016/j.drugalcdep.2017.03.018
6. Camchong, J., Stenger, A., & Fein, G. (2014). Resting-state synchrony in long-term abstinent alcoholics. Alcoholism: Clinical and Experimental Research, 38(1), 207–216. https://doi.org/10.1111/acer.12237
7. Chisha, Z., Sinyangwe, C., & Mufune, P. (2017). Alcohol use among the youth in Zambia: A public health concern. Journal of Public Health in Africa, 8(1),1-6 https://doi.org/10.4081/jphia.2017.567
8. Cicerone, K. D., Langenbahn, D. M., Braden, C., Malec, J. F., Kalmar, K., Fraas, M., Felicetti, T., Laatsch, L., Harley, J. P., Bergquist, T., Azulay, J., Cantor, J., & Ashman, T. (2011). Evidence-based cognitive rehabilitation: Updated review of the literature from 2003 through 2008. Archives of Physical Medicine and Rehabilitation, 92(4), 519–530. https://doi.org/10.1016/j.apmr.2010.11.015
9. Davies, S. J. C., Pandit, S. A., Feeney, A., Stevenson, B. J., Kerwin, R. W., Nutt, D. J., & Lingford-Hughes, A. (2005). Is there cognitive impairment in clinically 'healthy' abstinent alcohol dependence? Alcohol and Alcoholism, 40(6), 498–503. https://doi.org/10.1093/alcalc/agh203

10. Haimov, I., & Shatil, E. (2013). Cognitive training improves sleep quality and cognitive function among older adults with insomnia. PLOS ONE, 8(4), e61390. https://doi.org/10.1371/journal.pone.0061390
11. Kabuba, N., Menon, J. A., Franklin, D. R., Heaton, R. K., & Hestad, K. A. (2017). Use of Western Neuropsychological Test Battery in detecting HIV-associated neurocognitive disorders (HAND) in Zambia. AIDS and Behavior, 21(6), 1717–1727. https://doi.org/10.1007/s10461-016-1443-5
12. Le Berre, A. P., Laniepce, A., Segobin, S., Pitel, A. L., & Sullivan, E. V. (2019). Alcohol use disorder: Permanent and transient effects on the brain and neuropsychological functions. In R. A. Stern & M. L. Alosco (Eds.), The Oxford handbook of adult cognitive disorders (pp. 302–332). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780190664121.013.15
13. Malia, K. B., Bewick, K. C., Raymond, M. J., & Bennett, T. L. (2002). Brainwave-R: Cognitive strategies and techniques for brain injury rehabilitation. Pro-ed.
14. Mechtcheriakov, S., Brenneis, C., Egger, K., Koppelstaetter, F., Schocke, M., & Marksteiner, J. (2007). A widespread distinct pattern of cerebral atrophy in patients with alcohol addiction revealed by voxel-based morphometry. Journal of Neurology, Neurosurgery & Psychiatry, 78(6), 610–614. https://doi.org/10.1136/jnnp.2006.095869
15. Mkenda, S., Olakehinde, O., Mbowe, G., Paddick, S. M., Kisoli, A., Dotchin, C., Gray, W. K., Walker, R. W., & Ogunniyi, A. (2018). Cognitive stimulation therapy as a low-resource intervention for dementia in sub-Saharan Africa (CST-SSA): Adaptation for rural Tanzania and Nigeria. Dementia, 17(4), 515–530. https://doi.org/10.1177/1471301216649272
16. Monnig, M. A., Tonigan, J. S., Yeo, R. A., Thoma, R. J., & McCrady, B. S. (2013). White matter volume in alcohol use disorders: A meta-analysis. Addiction Biology, 18(3), 581–592. https://doi.org/10.1111/j.1369-1600.2012.00441.x
17. Noël, X., Brevers, D., & Bechara, A. (2010). A neurocognitive approach to understanding the neurobiology of addiction. Current Opinion in Neurobiology, 20(2), 250–258. https://doi.org/10.1016/j.conb.2010.03.004
18. Nixon, S. J., & Lewis, B. (2019). Cognitive training as a component of treatment of alcohol use disorder: A review. Neuropsychology, 33(6), 822–841. https://doi.org/10.1037/neu0000575
19. Oscar-Berman, M., Valmas, M. M., Sawyer, K. S., Ruiz, S. M., Luhar, R. B., & Gravitz, Z. R. (2014). Profiles of impaired, spared, and recovered neuropsychologic processes in alcoholism. Handbook of Clinical Neurology, 125, 183–210. https://doi.org/10.1016/B978-0-444-62619-6.00012-4
20. Paul, R., Hammerstein, N. V., & Ncheka, J. (2017). Increasing problem of alcohol abuse among the Zambian population in the psychiatric setting. Health Press Zambia Bulletin, 1(4).
21. Petersen, I., Lund, C., & Bhana, A. (2016). A task-shifting approach to primary mental health care for adults in South Africa: Human resource implications. BMC Health Services Research, 12(1), 23. https://doi.org/10.1186/1472-6963-12-23
22. Rupp, C. I., Beck, A. K., & Heinz, A., Kemmler, G. (2021). Cognitive training in alcohol use disorder: A systematic review and meta-analysis. Journal of Substance Abuse Treatment, 131,. https://doi.org/10.1016/j.jsat.2021.108564
23. Stott, J., Spector, A., Orrell, M., & Aguirre, E. (2021). Cognitive rehabilitation for mild cognitive impairment: A systematic review and meta-analysis. Neuropsychological Rehabilitation, 31(5), 707–735. https://doi.org/10.1080/09602011.2020.1757056
24. World Health Organization. (2018). Global status report on alcohol and health 2018. World Health Organization.