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Tunisian Adolescents at CHR for Psychosis: A Pilot Study of Cognitive Remediation in a LMIC

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ABSTRACT

Background: Clinical high risk (CHR) youth are known to exhibit cognitive deficits at similar levels to their more severally ill counter parts. Cognitive training (CT) programs offer a promising method for early intervention and the prevention of further cognitive decline in this vulnerable population. However, there are few structured CT intervention programs addressing the needs of CHR youth in LMICs of the Middle East.

Methods: We conducted a study in the Child and Adolescent Psychiatry Department of Razi University Hospital. Patients were assessed by trained raters with the "Comprehensive Assessment of At-Risk Mental States" to confirm their CHR status. Cognitive Training (CT) was combined with the Neuropsychological Educational Approach to Remediation (CT-NEAR) as part of a social rehabilitation program. We enrolled 25 CHR patients and examined several domains of cognitive functioning and evaluated daily functioning prior to starting the intervention and after completion.

Results: There were 20 patients who completed the study. The CT-NEAR group ($n = 10$) completed an average number 28.33 sessions over 12 weeks, which were matched for therapist time with the TAU group ($n = 10$). We found statistically significant improvements in CT-NEAR versus TAU in several cognitive domains; such as cognitive flexibility, memory-short and long-term, and verbal fluency. Also, CT-NEAR versus TAU patients improved in global functioning.

Conclusions: Our findings indicate that cognitive remediation versus TAU for Tunisian CHR youth is feasible and effective especially in improving cognitive functioning when delivered in a social rehabilitation context (Bridging Group) and extends to global level of functioning.

1 | Introduction

Extensive research has demonstrated that CHR youth experience cognitive deficits that are key risk factors for further development of serious mental illness such as schizophrenia (Fusar-Poli et al. 2012; Montemagni et al. 2020; Tor et al. 2020; Catalan, Salazar de Pablo, Aymerich, et al. 2021; Andreou et al. 2023). This is especially true for low- and middle-income countries (LMIC) such as Tunisia, where access to resources is very limited compared with high-income countries that have greater access to health care resources (Bruckner et al. 2011; Spagnolo et al. 2018; Koschorke et al. 2021). The cognitive deficits in clinical high risk (CHR) individuals are well-known and well-established as core features that are present even prior to the overt manifestation of psychosis. These cognitive deficits might not remit when symptoms do and thus are key factors

in limiting everyday functioning and risk for transition (Beck et al. 2019; Oliver et al. 2020). Although these studies have been conducted in mostly high-income countries, there is every reason to believe the same elements hold true for CHR individuals in LMICs. Taking empirically validated approaches that are culturally adapted for use in LMIC such as Tunisia are needed to help mitigate the negative mental health impact of CHR symptoms, cognitive deficits and functional impairments in young people.

There are known interventions for cognitive deficits in CHR that can be delivered in non-stigmatising ways, such as internet-based computer exercises that have been used as part of cognitive remediation (CR). CR is considered an evidence-based practice for remediating prominent cognitive deficits and improving role functioning in individuals in multi-episode psychosis (Wykes et al. 2011; Vita et al. 2021). In addition, two out of four CHR studies found CR also improved functional outcome in the domains of social functioning and social adjustment. Based on this work, CR can be considered an evidence-based practice for the remediation of cognitive and functional deficits in CHR individuals (Hooker et al. 2014; Glenthøj et al. 2015; Loewy et al. 2016; Choi et al. 2017), for reviews see Glenthøj et al. (2017) and Catalan, Salazar de Pablo, Vaquerizo Serrano, et al. (2021). Most remediation researchers have concluded that the application of CT does have promise for LMIC countries and should be provided as early as possible to take advantage of the full rehabilitative potential during this early phase of illness.

In this study, we aimed to evaluate the effect of Cognitive Training (CT) combined with the NEAR approach (CT-NEAR) delivered in a social rehabilitation framework in Tunisian CHR youth. The social rehabilitation intervention component was guided by principals of the Neuropsychological Educational Approach to Remediation (NEAR) to CT, which has been very effective in high-income countries in improving cognitive function (Medalia and Bowie 2016; Medalia, Erlich, et al. 2019; Medalia, Saperstein, et al. 2019). The study aim was to evaluate for the first time the impact of a CT program conducted in the context of NEAR as compared with Treatment as Usual (TAU) administered in a sample of Tunisian adolescents at CHR.

2 | Methods

2.1 | Participants

The initial sample consisted of 25 individuals who met criteria for CHR, which included 17 males and 8 females. The mean age at study entry was 16.0 (1.69) years (age range = 14–19 years) and the mean education level 1.55 (0.73), and all participants were single. These pilot study participants were assigned quasi-randomly to two groups cognitive training (CT-NEAR) ($n = 13$) or TAU ($n = 12$). However, three patients had poor attendance and dropped out and two converted to psychosis during the study. The final sample consisted of 20 patients who completed the study (see Table 1). The two groups were comparable according to age, sex and educational level ($p = 0.675$, $p = 1.00$ and $p = 0.75$, respectively). All participants received outpatient psychiatric treatment in the Child and Adolescent Department of Razi University Hospital in Tunis, Tunisia. Diagnosis was established by trained and certified research assessment staff through the Comprehensive Assessment of At-Risk Mental Stats (CAARMS), which included supplementary information from family members and treating professionals. Informed consent was obtained directly from patients 18 or older and for those under 18 years old consent was obtained by from the patient's parent with assent. This study was approved by the Razi University Hospital Human Research Protections committee according to the Helsinki Declaration (World Medical Association 2013).

2.2 | Inclusion and Exclusion Criteria

We included patients ages 14 years and older, who fulfilled criteria for being at CHR for psychosis according to CAARMS criteria. Patients who have completed at least primary school education and had sufficient levels of comprehension and communication in Arabic and French to understand the CT instructions during treatment sessions. Patients were excluded who met criteria for: a neurodevelopmental disorder/intellectual disability or severe cognitive disorders affecting language or communication; patients with a personal history of epilepsy, head trauma or severe neurological disease; patients with acute decompensation prior to study entry, which was evaluated clinically; patients actively using psychoactive substances or antipsychotics/benzodiazepines.

2.3 | Procedures

Patients were assessed using the CAARMS Arabic version (Braham et al. 2014). The lead author Zeineb Abbes, M.D. a Child and Adolescent Psychiatrist, was trained in the CAARMS in Sousse, Tunisia in 2015 by the group of Amel Braham and Souhail Bannour, who translated the CAARMS into Arabic (Braham et al. 2014). Two additional raters, Sana Taleb, M.D., and Selima Jelili, M.D., were trained to high levels of reliability in Tunis at Razi University Hospital by study co-author, Joseph Ventura (Ventura et al. 2021). The study took place over a period of 23 months (February 2019–January 2021). Patients were referred for a variety of clinical reasons (Table 1). The study used quazi-randomization in that subjects were enrolled in CT-NEAR study according to their availability to attend sessions in the cognitive rehabilitation program because they lived close to Razi University Hospital. However, there were patients in the TAU Condition who also lived near Razi University Hospital. CT-NEAR was provided in the context of a social rehabilitation program consisting of a Bridging Group, which involved in session discussions of cognition, sharing of cognitive strategies and assignment of tasks to be completed at home. The same neurocognitive assessor conducted the evaluations at baseline and at the completion of the intervention and that assessor was "masked" and so was not aware of the patient's group membership.

2.4 | Cognitive Training (CT) was combined With the Neuropsychological Educational Approach to Remediation (CT-NEAR)

Neurocognitive training and social rehabilitation were provided using the Neuropsychological Educational Approach

TABLE 1 | CT-NEAR versus TAU demographic characteristics, CHR status and reasons for referral for the completed sample total $n = 20$ (means, SDs and percentages).

Variables of interest	Total sample ($n = 20$)	CT-NEAR ($n = 10$)	TAU ($n = 10$)	*t*-test or Chi square (χ^2)	*p value*
Age at study entry	16.1 (1.69)	16.2 (1.8)	15.8 (1.6)	$t(18) = 0.451$	0.536
Sex				$\chi^2(1) = 1.00$	0.686
Males	14	7	7		
Females	6	3	3		
Education level				$\chi^2(2) = 0.234$	0.889
Middle school	12	5	6		
High school	8	4	3		
Vocational training	2	1	1		
Marital status					
Single	100%	10 (100%)	10 (100%)		
Married	0%	0%	0%		
CAARMS[a]—Criterion Group at Entry				$\chi^2(3) = 3.02$	0.382
Attenuated psychosis[b]	12	5	4		
BLIPS[c]	9	4	3		
Vulnerability[d]	2	1	1		
BLIPS plus vulnerability	2	0	2		
Reason for referral for evaluation				$\chi^2(5) = 11.63$	0.040
Decline in school performance	7	3	2		
Depression and/or anxiety	5	2	2		
Behavioural disturbances	5	0	3		
Suicidal ideation	3	2	1		
Cognitive disorders	3	3	0		
Social withdrawal	2	0	2		
Global Functioning Scale (GAF)[e]					
Global functioning	49.2 (16.1)	48.1 (18.2)	50.4 (14.6)	$t(18) = 0.311$	0.760

[a]Comprehensive Assessment of at Risk Mental States.
[b]Attenuated Psychosis Group.
[c]Brief Limited Intermittent Psychotic Symptoms Group.
[d]Vulnerability Group.
[e]Global Functioning Scale.

to CR (Medalia and Revheim 1999) applied to Tunisian CHR youth. NEAR is an evidence-based approach to CR focusing on learning and motivation during CT exercises (Medalia and Freilich 2008). The NEAR approach is a group-based treatment providing a positive learning experience and promoting independent learning.

The lead author and Head CT Coach Zeineb Abbes, M.D., and Sana Talab, M.D., Child and Adolescent Psychiatrists were trained in 2016 by Isabelle Amado in Paris. The training involved didactic lectures, reading material, role play and practice with the HAPPYneuron programs in French. The 10 patients assigned to a 12-week course of CT-NEAR were placed into three intervention groups of four patients each that were conducted once to twice per week and completed an average number 28.33 sessions. Sessions led by the cognitive coach lasted 1 h and a half (90 min): 45 min for the CT computer exercises and 45 min for the Bridging Group. This study of CT-NEAR involved using HAPPYneuron combined with NEAR which demonstrated the feasibility of conducting

CT at Razi University Hospital. The HAPPYneuron company produced a French language version of the software similar to the French Tunisian spoken in Tunisia. During each CT session, patients received individual computer neurocognitive training followed by a Bridging Group.

The aim of the Bridging Group was to assist the patients in generalising the skills learned in CT to their daily lives. All therapists who participated in the study received specialised training to run the NEAR program. Specific cognitive skills were taught to patients. The Bridging Group materials (hard copy handouts) had been translated into Arabic by the Tunisian team. The TAU received additional supportive therapy with family meetings, which was matched with CT-NEAR for therapist time. We believe that the software programs are the method (but not the sole means) by which the cognitive coaches helped the participant improve cognitive functioning. We believe that the Bridging Group was be an integral part of transferring learning to daily functioning (Bowie et al. 2014). The impact of these CT interventions would be expected to generalise to functional outcome even more easily in CHR individuals before chronic disability patterns have been established. Both groups received standard medication management.

2.5 | Neurocognitive Battery

A battery of neuropsychological tests was selected based on projects conducted in Paris, France and in Sousse, Tunisia that were then adapted and validated by the Tunisian study Team (Jelili et al. 2020; Bahri et al. 2023). The battery was administered by a trained assessor at baseline (pre) and at 1–2 weeks after the completion of the CT-NEAR intervention (post) that assessed various key domains of neurocognitive functioning (Table 2). However, due to space limitations, the descriptions emphasise the test functions assessed rather than descriptions of the tests, which are readily available. Also, to reduce the number of variables analysed, specific measures and sub-tests from measures were selected a priori that assessed relevant domains of cognition.

2.6 | Executive Functions

Raven's Progressive Matrices Test (*RPM*) (Raven and Court 1938) is progressive in the sense that questions become more difficult as the test progresses. The task is to determine the missing element in a pattern, which is presented in the form of a matrix. The RPM is a non-verbal test typically used to measure abstract reasoning by evaluating the subject's analytic abilities and is regarded as a non-verbal estimate of fluid intelligence.

Rey Complex Figure Test (*RCFT*) (Watanabe et al. 2005) is a widely used as a neuropsychological assessment tool to assess the visuo-constructional ability and visual memory of neuropsychiatric disorders. Sub-tests involve copying and assessing delayed recall. The score from the copy sub-test was used to assess executive planning.

Stroop Test (Jensen 1965; Roy et al. 2018) was used to measure a subject's selective attention capacity and skills, processing speed and evaluate overall executive processing abilities. The Stroop Color and Word Test (SCWT) assessed the ability to inhibit cognitive interference that occurs when the processing of a specific stimulus feature impedes the simultaneous processing of a second stimulus attribute, this is the well-known as the Stroop Effect.

Trail Making Test Part A and Part B (*TMT A*, *TMT B*) (Corrigan and Hinkeldey 1987). Part A measures attention, visual screening ability and processing speed. Part B is quite sensitive to executive functioning since the test requires multiple executive abilities for successful completion within the time limit.

2.7 | Memory

Grober and Buschke Test (Grober and Buschke 1987) is a memory test that used attention and cognitive processing requiring subjects to search for items in response to their category cues, during the learning process of long-term delay recall to test long-term memory. The Free and Cued Selective Reminding Test score was used (FCSRT).

Wechsler Adult Intelligence Scale III (*WAIS III*) *Spatial Span Task* (Delaloye et al. 2008) requires the examiner to read a sequence of numbers and the subject to recall that exact sequence of numbers in ascending order. This sub-test measures working memory, which includes immediate mental manipulation, cognitive flexibility and attention.

RCFT (Watanabe et al. 2005) (see description above). The *long delay recall* of the RCFT was used to assess visual memory.

2.8 | Speed of Processing

Wechsler Adult Intelligence Scale III (*WAIS III*) *Symbol Coding Sub-test* (Joy, Kaplan, and Fein 2004) requires the subject to register and copy symbols that are associated with either objects (i.e., Coding A) or numbers (Coding B). This sub-test involves psychomotor speed and processing speed, and to an extent cognitive flexibility.

Verbal Fluency Test-Arabic version (Azouz et al. 2009)–Arabic Version (VFT-AV) is a short screening test that evaluates cognitive function in that the subject is asked to list all the words he/she can think of that start with the letter band the letter K and to name as many fruits as possible in 60 s. The VFT-AV is scored by counting the total number of words or fruits the subject produced in 60 s.

2.9 | Functional Outcome Assessment

The Global Assessment of Functioning Scale (GAF; Jones et al. 1995) is commonly used by mental health researchers and professionals to evaluate an individual's global level of psychological, social and occupational functioning. Scores range from 100 to 1. Although the GAF does include ratings of symptoms, given that the GAF was our main outcome measure of functioning, the ratings emphasised functioning more than symptoms.

TABLE 2 | Neurocognitive and global assessment of functioning scores means (SDs) for the CHR Tunisian youth assigned to CT-NEAR ($n = 10$) compared with TAU ($n = 10$) intervention groups.

Neurocognitive and global functioning variables	CT-NEAR (mean, SD)		Treatment as Usual (TAU) (mean, SD)	
	Baseline	Post	Baseline	Post
Trail Making Test—A				
Time in seconds	62.70 (22.1)	60.00 (19.2)	84.80 (46.7)	88.30 (44.8)
Errors	1.30 (1.2)	0.50 (0.7)	1.90 (1.7)	2.70 (1.6)
Trail Making Test—B				
Time in seconds	193.20 (98.2)	189.00 (84.2)	204.50 (62.0)	226.70 (63.4)
Errors	3.40 (3.8)	2.40 (2.5)	5.90 (2.1)	6.50 (2.3)
Ravens Progressive Matrices	41.80 (12.4)	45.80 (10.9)	41.20 (6.8)	8.40 (5.9)
Stroop: Sub-test 1				
Correct read colors	95.30 (2.2)	96.80 (1.3)	94.80 (2.9)	94.30 (2.3)
Corrected errors	2.90 (2.3)	1.80 (0.6)	2.50 (1.7)	2.80 (1.3)
Non-corrected errors	1.80 (1.3)	1.50 (1.2)	2.70 (2.0)	2.90 (1.7)
Stroop: Sub-test 2				
Correct read colors	97.70 (1.8)	98.40 (1.1)	95.80 (2.8)	94.60 (3.5)
Corrected errors	1.50 (1.6)	1.10 (0.8)	1.90 (1.5)	2.70 (1.3)
Non-corrected errors	0.80 (1.1)	0.50 (0.5)	2.30 (1.8)	3.10 (2.2)
Stroop: Sub-test 3				
Correct read colors	91.20 (4.9)	93.80 (2.8)	85.60 (6.2)	83.90 (6.8)
Corrected errors	5.10 (2.0)	3.50 (1.4)	5.10 (3.5)	5.30 (2.4)
Non-corrected errors	3.70 (4.1)	2.70 (2.6)	9.30 (6.8)	10.00 (7.4)
RCFT: Immediate recall: Copy	50.10 (12.9)	50.70 (12.3)	42.20 (9.9)	38.40 (9.5)
Memory Drawing	32.2 (12.7)	33.5 (14.8)	17.4 (6.3)	13.9 (6.9)
RCFT: Delayed recall	250.10 (119.9)	235.80 (67.8)	204.80 (65.1)	237.00 (62.3)
Memory Drawing	156.90 (73.0)	168.10 (72.3)	186.50 (50.0)	175.10 (34.4)
Verbal Fluency Test letter b				
Total correct words generated	7.7 (3.65)	10.8 (4.13)	9.1 (0.82)	8.6 (2.2)
Total repetitions	0.1 (0.31)	0.3 (0.48)	0.3 (0.8)	1.0 (0.8)
Total intrusions	1.1 (1.37)	0 (0)	0 (0.0)	0.1 (0.9)
Verbal fluency Test letter k				
Total correct words generated	9.5 (4.2)	9.6 (4)	8.5 (3.9)	6.6 (2.0)
Total repetitions	0.1 (0.3)	0.1 (0.3)	0.4 (0.5)	0.6 (0.8)
Total intrusions	0.5 (1.2)	0.2 (0.6)	0 (0)	0.5 (0.97)
Verbal Fluency—animals				
Total correct words generated	22.3 (5.7)	23.8 (4.6)	18.4 (4.5)	14.8 (3.5)
Total repetitions	0.9 (1.10)	0.4 (0.69)	0.3 (0.63)	1.1 (0.9)

(Continues)

TABLE 2 | (Continued)

Neurocognitive and global functioning variables	CT-NEAR (mean, SD)		Treatment as Usual (TAU) (mean, SD)	
	Baseline	Post	Baseline	Post
Total intrusions	0.3 (0.6)	0.1 (0.3)	0 (0)	0.2 (0.6)
Verbal Fluency—fruits				
Total correct words generated	14.6 (3.5)	15.7 (3.8)	9.1 (2.5)	8.4 (2.0)
Total repetitions	0.3 (0.4)	0.20 (0.6)	0.70 (0.6)	1.1 (1.1)
Total intrusions	0.10 (0.3)	0.10 (0.3)	0 (0)	0.20 (0.4)
Grober and Buschke Test				
Short delay free recall: total correct words	28.8 (6.5)	30.2 (7.7)	28.8 (6.5)	26.7 (7.2)
Short delay cued recall: total correct words	13.3 (4.1)	12.30 (3.3)	9.50 (3.5)	9.20 (3.3)
Short delay free recall: total number of repetitions	3.80 (3.1)	3.50 (2.7)	2.30 (2.1)	3.10 (2.3)
Short delay free recall: total number of intrusions	1.80 (1.9)	0.50 (0.9)	0.30 (0.6)	0.30 (0.6)
Recognition trial: correct recognition	14.80 (1.6)	15.60 (0.6)	14.10 (1.1)	13.70 (1.4)
Recognition trial: false recognition	1.20 (1.6)	0.50 (0.8)	1.80 (1.2)	2.10 (1.3)
Long delay recall (free + cued): total correct words	13.60 (1.9)	14.80 (1.3)	12.80 (1.8)	11.50 (2.5)
WAIS-III—Span Task				
Digits Forward	4.80 (0.9)	5.30 (1.1)	4.30 (0.9)	4.20 (1.1)
Digits Reverse	3.10 (0.9)	3.10 (0.8)	2.60 (0.6)	2.30 (0.6)
WAIS-III—Symbol Coding				
Total Score	53.30 (17.4)	58.10 (16.6)	54.20 (15.6)	48.20 (13.4)
Global Assessment of Functioning				
Total Score	48.10 (18.2)	57.50 (18.9)	50.40 (14.6)	38.00 (15.3)

Abbreviations: Baseline = assessment conducted at study baseline; GAF = Global Functioning Scale; Post = assessment immediately after the intervention; RCFT = Rey Complex Figure Test; TMT A = Trail Making Test Part A; TMT B = Trail Making Test Part B; WAIS III = Wechsler Adult Intelligence Scale III Spatial Span Task.

2.10 | Statistical Analysis

To examine demographic characteristics, we calculated means and standard deviations for age and educational level and for categorical data, for example, sex, marital status, we used Fisher's exact Chi-squared test. For each neurocognitive domain measure, we conducted *t*-tests for independent samples to examine baseline differences. To examine group × time interaction for measuring treatment effects, we conducted a repeated measure-analysis of variance (RM-ANOVA) that compared the cognitive difference and global functioning scores of CT-NEAR versus TAU. For the two measures where there were statistically significant baseline differences, we repeated the RM-ANOVA using baseline neurocognitive scores as a co-variate to control for baseline differences.

3 | Results

The average number of sessions performed by the CT-NEAR group was a mean of 28.33 (SD = 1.52) sessions per group for an average duration of 43.5 h (SD = 1.50). The patients of the TAU group consulted with their psychiatrist and treatment provider every 2 weeks. Those sessions lasted 30–45 min each, with an average of 16.08 h (SD = 2.89) plus supportive therapy with family meetings that was matched for therapist contact with the CT-NEAR group.

3.1 | Neurocognitive Functioning

Analyses were conducted on the neurocognitive assessment and global functioning on the final sample of 20 patients (Table 3).

TABLE 3 | Examination of group×time differences in neurocognitive functioning and global functioning in CHR individuals receiving cognitive training versus TAU (means, SDs, and repeated measures ANOVA).

	CT-NEAR		Treatment as Usual (TAU)		RM-ANOVA	
Variables of interest	**Baseline mean (SD)**	**3-month mean (SD)**	**Baseline mean (SD)**	**3-month mean (SD)**	***F* ratio for Group×time interaction**	***p value***
Executive Functions						
Reasoning and Problem Solving						
Ravens Progressive Matrices	41.80 (12.4)	45.80 (10.9)	41.20 (6.8)	38.40 (5.9)	11.00	0.004
Rey Complex Figure Test copy[a]	50.1 (12.8)	50.70 (12.3)	42.2 (9.9)	38.4 (9.5)	5.73	0.028
Executive Attentional Interference						
Stroop—Interference Test 3[b]	91.20 (4.9)	93.80 (2.8)	85.6 (6.2)	83.90 (6.8)	11.20	0.001
Cognitive Flexibility						
Trail Making Test—TMT B[c]	193.2 (98.2)	189.0 (84.2)	204.5 (62.0)	226.7 (63.4)	1.58	0.091
Memory						
Long-Term Memory						
Grober and Buschke Test	13.60 (1.9)	14.80 (1.3)	12.80 (1.8)	11.50 (2.5)	21.00	0.001
Working Memory—WAIS-III						
Digit Span—Forward	4.80 (0.9)	5.30 (0.9)	4.30 (0.9)	4.20 (1.1)	9.52	0.006
Digit Span—Backward	3.10 (0.9)	3.10 (0.8)	2.60 (0.6)	2.30 (0.6)	1.32	0.264
Visual Memory						
Rey complex Figure Test	32.2 (12.7)	33.5 (14.8)	17.4 (6.3)	13.9 (6.9)	2.13	0.162
Short Delay						
Speed of Processing						
Symbol Coding Test	53.3 (17.4)	58.1 (16.6)	54.2 (15.6)	48.2 (13.4)	14.58	0.001
Trail Making Test—A[c]	62.7 (22.1)	60.0 (19.2)	84.8 (46.7)	88.3 (44.8)	2.80	0.111
Verbal Fluency						
Phonemic test—letter B	7.7 (3.6)	10.8 (4.1)	9.1 (2.8)	8.6 (2.2)	11.28	0.003
Phonemic test—letter K	9.5 (4.2)	9.6 (4.0)	8.5 (3.9)	6.6 (2.0)	2.90	0.105
Semantic test—Animals	22.3 (5.2)	23.8 (4.6)	18.4 (4.5)	14.8 (3.5)	16.60	<0.001
Semantic test—Fruits	14.6 (3.5)	15.7 (3.8)	9.1 (2.5)	8.4 (2.0)	10.80	0.004
Global Functioning						
Global Assessment of Functioning	48.1 (18.2)	57.5 (18.9)	50.4 (14.6)	38.0 (15.3)	12.77	0.020

[a]Rey Complex Figure Test—Copy; Short Delay of 20 min.
[b]Stroop Color Word Interference Test.
[c]Trail Making Test Part A and Trail Making Test Part B.

To reduce overlap of neurocognitive domains examined and the number of statistical analyses performed, not all measures or sub-tests were included in the statistical analysis.

3.1.1 | Executive Functions

Reasoning and Problem Solving was evaluated using the *RPM* indicating that the CT-NEAR group scored significantly higher at the completion of treatment as compared with TAU ($F = 11.01$, df = 1, $p = 0.004$). Executive Planning was examined with the *RCFT copy* and showed that the CT-NEAR group achieved higher scores as compared with TAU ($F = 5.73$, df = 1, $p = 0.028$). *Executive Attentional Interference* was examined with the *Stoop* Color-Word–interference sub-test and again showed that the CT-NEAR group had higher scores compared with TAU ($F = 11.20$, df = 1, $p = 0.001$). *Cognitive Flexibility* was examined with the (*TMT-B*) but there was no statistically significant difference in the two groups ($F = 1.58$, df = 1, $p = 0.224$). However, after controlling baseline differences, there was a trend that was not statistically significant showing greater improvement in the CT-NEAR group versus TAU ($F = 3.20$, df = 1, $p = 0.091$).

3.1.2 | Memory

The *Grober and Buschke Test* was used to evaluate *Declarative* (long-term memory) using the *FCSRT* and showed that the CT-NEAR group as compared with TAU improved significantly by the completion of the intervention in Long Delay Recall ($F = 21.00$, df = 1, $p = 0.001$). Working memory/short-term memory was examined with the *Digit Span* favouring CT-NEAR ($F = 9.52$, df = 1, $p = 0.006$). However, there was no statistically significant difference in short-term visual memory (RCFT) ($F = 3.92$, df = 1, $p = 0.162$) (even after controlling for baseline differences).

3.1.3 | Speed of Processing

Analysis of *WAIS–III-Symbol Coding Test* again showed the CT-NEAR group scored significantly higher compared with TAU ($F = 14.58$, df = 1, $p = 0.001$). We also found that the CT-NEAR group versus TAU improved on verbal fluency when assessed with the phonemic test (letter B) ($F = 11.28$, df = 1, $p = 0.003$) and semantically in naming fruits ($F = 10.80$, df = 1, $p = 0.004$). However, there were no statistically significant differences between the groups on TMT A ($F = 2.80$, df = 1, $p = 0.111$).

3.2 | Global Assessment of Functioning (GAF)

The GAF findings were consistent with the neurocognitive findings in that the CT-NEAR group compared with TAU significantly improved in their level of global functioning ($F = 12.77$, df = 1, $p = 0.020$).

4 | Discussion

The present study evaluated the impact of a Cogntive Remediation (CR) program delivered at Razi University Hospital's Child and Adolescent Unit in a social rehabilitation context for Tunisian youth at CHR. As far as we know, this is the first study from a LMIC in the MENA region to report on the implementation and findings from a CR program. Further, the first study that combined CR with a social rehabilitation program guided by the principals of NEAR (Medalia and Freilich 2008). We found robust, statistically significant improvements in several domains of cognitive functioning and global functioning for those individuals who participated in CT-NEAR as compared with TAU. We found CT-NEAR participation produced significant improvement in reasoning and problem solving skills, an improvement in inhibition capacities, in episodic memory during the delayed recall, in scores on phonemic and semantic verbal fluency test, and in processing speed. We found that global functioning also improved. The results of our study suggest that there are several potential benefits for CHR youth for improved cognition and functioning when delivering CR associated within a social rehabilitation program. However, replication will be needed through a full RCT.

CT is an empirically based intervention that has been shown to improve cognitive functioning in CHR individuals and those with established psychotic illness (Vita et al. 2021). CT targets cognitive functions, a domain that is typically not improved by pharmacological interventions. Further, CT as a form of therapy that can be delivered without side effects using strategy coaching and therefore is preferable for adolescents and young adults who are at higher risk of developing side effects if prescribed medications (Cella and Wykes 2019; Bilgrami et al. 2020; Vita et al. 2023). That is important because there are known links between cognitive functioning and daily functioning and despite the fact the conversion rate to psychosis is decreasing, the rate of functional impairment in CHR is high and we need to find ways to remediate that deficit (Beck et al. 2019). We also believe that CHR youth may respond more favourable to this form of non-stigmatising treatment at this stage in their psychosocial development compared with later at a more mature stage in life (Bechdolf et al. 2012; Fusar-Poli et al. 2013).

Our study had as a core feature, a Bridging Group that was delivered in a social rehabilitation context, which we believe was a key ingredient of successful CT (Lejeune, Northrop, and Kurtz 2021). During the Bridging Group, patients shared and discussed cognitive strategies with other participants they used while performing the CT exercises. Further, that the Bridging Group activities were also designed to promote the transfer of skills acquired during group in everyday life before chronic disability patterns have been established (Bowie et al. 2014). Texts, videos, real or role play scenarios were used to facilitate the generalisation and the transfer of learning to daily living. In addition, the group participants provided support to each other. In fact, we noticed that at-home tasks, which were assigned to patients who lacked autonomy helped them to gain more autonomy as evidenced by the statistically significant improvement in GAF scores in the CT-NEAR group ($p = 0.011$). This was reflected in the improvement in global functioning that was noted in the CT-NEAR group at the end of the treatment program.

We examined several domains of executive functioning because they are part of a neural network associated in children and adolescents with the development of skills related to teamwork, leadership, decision-making, working toward goals, critical

thinking, adaptability and being aware of our own emotions as well as those of others (Crone, Peters, and Steinbeis 2017; Ferguson, Brunsdon, and Bradford 2021). These skills underlie the capacity to plan and meet goals, display self-control, follow multiple-step directions even when interrupted and stay focused despite distractions. All these skills are associated with success in daily functioning, which relates to the importance placed on improving functional deficits in CHR rather than on conversation alone (Tor et al. 2020). Based on the findings of Urben et al. (2012) and Bolt et al. (2019) who evaluated inhibition and cognitive flexibility, we decided to examine this domain using the Stroop and other executive functioning tests (Hwang et al. 2019). In the CT-NEAR group compared with TAU, significant improvement in inhibition was observed at the end of the intervention.

Our findings suggest that the CT-NEAR program can improve episodic (long-term) memory. Indeed, patients of the CT-NEAR group were able to remember/recall more words during delayed recall at post-treatment assessment compared with baseline. A significant decrease in the number of intrusions made was noted. In the study of Rauchensteiner et al. 2011, CHR subjects were also able to memorise more words on delayed recall than at their baseline, in comparison with patients with schizophrenia (Rauchensteiner et al. 2011). Our findings are consistent with the results of Urben et al. who have also shown improvements in episodic memory for a review see Bilgrami et al. (2020).

Due to specific associations between processing speed and motor functions prediction of transition and role functioning (Bolt et al. 2019), we examined and observed a significant improvement in processing speed for the CT-NEAR group compared with TAU. Our results are in line with those of the literature such as Choi et al. (2017). Improvements were noted at the completion of the intervention. Similar results were found in Hooker et al. (2014) and Piskulic et al. (2015). In fact, Piskulic showed that improvements in processing speed were maintained for up to 9 months after the completion of the study. Processing speed is important because of its link to daily functioning (Kern et al. 2011).

Loewy et al. used in CHR individuals, as did we, the GAF to evaluate the global functioning. Participants in the CT group compared with TAU showed a significant improvement in global function (Loewy et al. 2016). Our results are consistent with those of Choi et al. (2017), Piskulic et al. (2015), and Holzer et al. (2014).

This pilot study does have limitations, so the results should be interpreted with some caution. The study used quazi-randomization rather than a full RCT. However, several factors mitigated the threat to external validity. The neurocognitive assessor was masked to the subject's group assignment not only at baseline but also at the conclusion of the intervention. The study sample size is small. However, given the robust nature of the findings in neurocognition, adding additional participants is not likely to render the findings non-significant. Also, the size of our sample did not differ markedly from that of the previous study assessing CR in a similar population ($N = 32$) in the study of Urben et al. (2012); $N = 36$ and in Rauchensteiner et al. (2011). Although CT-NEAR is computer driven, the two conditions were matched for therapist time so that the effects seen in the study can be attributed to the CT-NEAR intervention.

5 | Conclusions and Future Directions

The results of our study support the idea that CR is provided within a social rehabilitation context consisting of Bridging Group is feasible and could help CHR subjects to improve their cognitive functioning. In addition, we found that the impact of CT extended beyond cognition to global functioning such as school and social functioning.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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