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Caregiver assisted home-based cognitive remediation for individuals diagnosed with schizophrenia: A pilot study

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ABSTRACT

Cognitive deficits in individuals diagnosed with schizophrenia are ubiquitous and, therefore, cognitive remediation is considered one of the prime targets of a comprehensive intervention program for schizophrenia. However, cognitive remediation is a resource consuming intervention and in lower and middle-income countries (LAMIC) such interventions are often neglected due to the resource constraints of the mental health services set-ups. Therefore, it is imperative to develop cognitive remediation programs that are less resource consuming for the mental health service delivery system. Keeping this in view, in the present pilot study, we tested the feasibility of a caregiver assisted home-based cognitive remediation program and compared its efficacy with a clinic-based cognitive remediation program. Findings show that it is feasible to conduct cognitive remediation program with the help of caregivers in patients' home settings and that the home-based cognitive remediation is as effective as the clinic-based cognitive remediation. The results of the study have been further discussed in the light of the practical implications, limitations and future research.

1. Introduction

Schizophrenia is a debilitating illness affecting various domains of socio-occupational functioning of the patients. Impaired cognitive functioning is an important reason for the compromised socio-occupational functioning in individuals diagnosed with schizophrenia (Kuperberg and Heckers, 2000). Cognitive deficits are manifested by both recent onset and chronically ill individuals diagnosed with schizophrenia and the deficit is seen across the cognitive domains such as attention, memory and executive functions (Fioravanti et al., 2005; Sponheim et al., 2010; Hegde et al., 2013). Impaired cognitive functions correlate more robustly with functional impairments than the positive or negative symptoms (Lee et al., 2013). Likewise, preserved cognitive functioning predicts better outcomes in terms of the functionality of the patients (Green, 2016; McGurk and Mueser, 2004). Hence, the outcome, in terms of real-world functioning of individuals diagnosed with schizophrenia, is better when cognitive remediation is an integral part of the overall rehabilitation strategy (McGurk et al., 2007).

Generally, cognitive remediation packages are resource-intensive as they require the patients to come to the clinic 2–3 times a week to attend 45–60 minutes training program (Wykes et al., 2007; Medalia and Freilich, 2008). Also, most of these training packages are computerized. It becomes difficult to use these cognitive remediation packages in resource constrained set-ups for various reasons; such as, overburdened clinicians having limited time to be involved in these long-term programs, resource crunch with the patients to visit clinics (generally, located at the tertiary referral centers) at regular intervals and poor computer literacy among patients. For example, in low- and middle-income countries (LAMIC), the psychosocial interventions in schizophrenia are badly neglected and one of the major reasons for such neglect is the lack of resources to carry out these interventions (Kumar, 2018). A recent survey in India on mental health professionals' opinions about psychosocial interventions in schizophrenia revealed that a major

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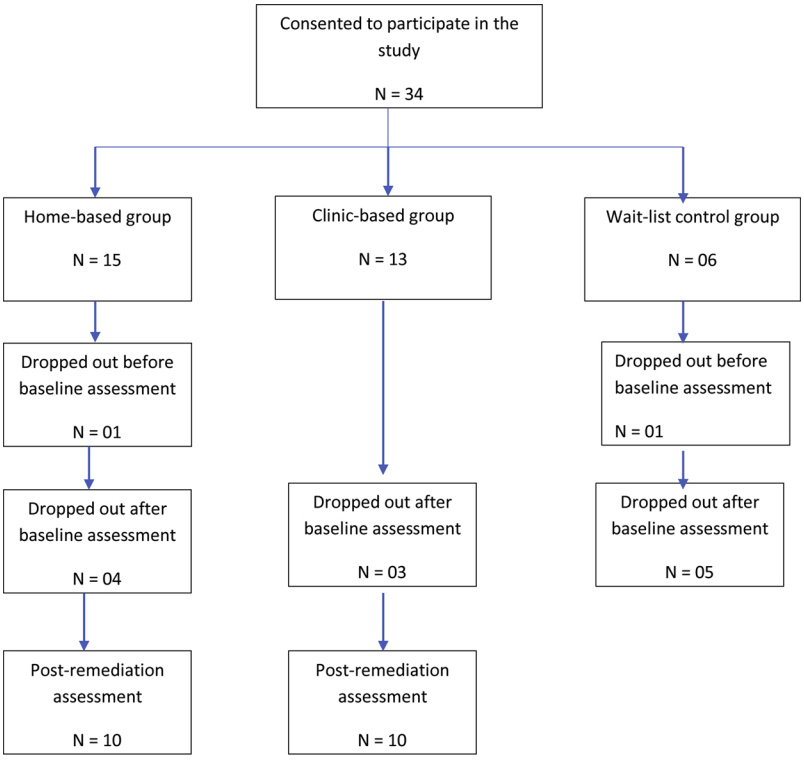

Fig. 1. Study profile.

hurdle towards the use of these interventions (including cognitive remediation) is the scarcity of resources both with the patients and the clinicians (Kumar, 2018).

Thus, there is an urgent need to develop such interventions for individuals diagnosed with schizophrenia which do not require regular involvement of highly trained clinicians and can be delivered through community resources, for example, with the help of frontline mental health workers (Waller et al., 2013) or caregivers under the supervision of mental health professionals. In view of this, the present pilot study was conducted to see effectiveness of a caregiver assisted home-based cognitive remediation program, in comparison to a clinic-based cognitive remediation program, for individuals diagnosed with schizophrenia.

To the best of our knowledge, there is only one previous study (Hegde et al., 2012) in which the feasibility of a caregiver assisted home-based cognitive remediation program for individuals diagnosed with schizophrenia has been evaluated. In that study its effectiveness was evaluated against treatment as usual (TAU) and the findings showed that home-based cognitive remediation is efficacious in improving cognitive functions in individuals diagnosed with schizophrenia. In the present study, we compared the efficacy of a caregiver assisted home-based cognitive remediation program with a clinic-based intervention to see if both these interventions are equally effective. We hypothesized that the home-based cognitive remediation would be as effective as the clinic-based cognitive remediation.

2. Method

2.1. Research design and sample

The study used a quasi-experimental pre-post intervention design with three groups of individuals diagnosed with schizophrenia: clinic-based cognitive remediation group, home-based cognitive remediation group and a wait list control group. The clinic-based group had to undergo twelve weeks of cognitive remediation at clinic under the supervision of a clinician and the home-based group had to undergo twelve weeks of cognitive remediation in home-setting assisted by a caregiver. Both the groups had to undergo pre- and post-intervention psychopathology and neuropsychological assessments. The wait list group participants had to undergo psychopathology and neuropsychological assessments twice at the interval of twelve weeks and then they could undergo cognitive remediation. The study was approved by the Institute Ethics Committee (IEC) of the National Institute of Mental Health and Neurosciences (NIMHANS), Bengaluru, India. All the patients coming to the 'schizophrenia clinic' of NIMHANS were screened (during a period of one and a half years) and those fulfilling the inclusion criteria were requested to participate in the study. A total of 34 individuals diagnosed with schizophrenia (as per the Diagnostic and Statistical Manual - IV criteria; American Psychiatric Association, 1994), residing in the community, consented to participate in the study. Inclusion criteria were individuals diagnosed with schizophrenia in an age range of 18–50 years, having minimum eight years of education and stabilized on a given dose of anti-psychotic(s) prior to start of the study. For the home-based remediation group an additional criterion was availability of a caregiver who was willing to assist the patient in undergoing cognitive remediation in his/her home setting. Patients having received cognitive remediation training in the past one year or electroconvulsive therapy in the past three months were excluded. Patients (and their family members) were explained the purpose of the study in detail and the division of the groups. They were told that they had the option to choose which group they wanted to join (as the feasibility of coming regularly to the clinic for the remediation training had to be kept in mind). Thirteen patients agreed for the clinic-based remediation program, 15 patients opted for the home-based cognitive remediation program and 6 wanted to be in the wait list control group. One patient each in the home-based remediation group and the wait-list control group, after consenting to participate in the study, refused to proceed further and did not participate in the pre-remediation assessments. Amongst those who underwent pre-assessments, three in the clinic-based remediation group, four in the home-based remediation group and five in the wait-list control group dropped out and did not come for the post-remediation assessments. Thus, both the clinic-based

Table 1
Data on socio-demographic and clinical variables.

	Clinic-based remediation group		Home-based remediation group	
	Mean (SD)		Mean (SD)	
Age	34.10 (9.07)		34.10 (6.31)	
Education	13.60 (2.99)		14.40 (2.84)	
Duration of illness	10.57 (9.18)		9.56 (5.79)	
	Pre- interventionMedian (range)	Post- intervention Median (range)	Pre- intervention Median (range)	Post- intervention Median (range)
SANS total	6.00 (9.00)	2.50 (6.00)	4.50 (6.00)	4.50 (11.00)
SAPS total	1.00 (9.00)	2.00 (6.00)	0.50 (5.00)	2.00 (7.00)

and the home-based cognitive remediation groups had 10 patients who completed the remediation training and underwent pre- and post-assessments. None of the wait-list control group participants came for the post-assessment. Thus, final comparisons could be conducted only between the home-based and the clinic-based cognitive remediation groups (see Fig. 1). The mean age of the clinic-based intervention group was 34.10 (SD = 9.07) and the home-based remediation group was 34.10 (SD = 6.31) years and they had 13.60 (SD = 2.99) and 14.40 (SD = 2.84) years of education respectively. The mean duration of illness of the clinic-based intervention group was 10.57 (SD = 9.16) and the home-based intervention group was 9.58 (SD = 5.77) years (Table 1). The two groups were comparable in terms of age (t = 0.01, p = n.s.), education (t = .61, p = n.s.) and duration of illness (t = .27, p = n.s.).

2.2. Procedure

Before starting the cognitive remediation, patients were assessed on the National Institute of Mental Health and Neurosciences (NIMHANS) Neuropsychological Battery (Rao et al., 2004), the Scale for the Assessment of Negative Symptoms (Andreasen, 1983) and the Scale for the Assessment of Positive Symptoms (Andreasen, 1983). These assessments were repeated on the completion of cognitive remediation. Patients were reimbursed their travel expenditure when they came for pre- and post-assessments.

2.2.1. Home-based cognitive remediation

In the home-based cognitive retraining group, a family member who stayed with the patient and showed willingness to help the patient in practicing cognitive tasks, was entrusted with the responsibility to monitor the patient's involvement in the task and also to help when required (e.g., while conducting the memory tasks). The average age of the caregivers was 43.20 years (SD = 18.23) and the average years of education was 13.40 (SD = 2.17). None of them had history of psychiatric illness. Each patient along with the caregiver responsible for monitoring the patient's cognitive remediation, were called once in two weeks to receive detailed training on tasks expected to be done in the next two weeks (e.g., the tasks to be done each day of the week, duration etc.). They were given paper-pencil tasks arranged consecutively for each day of a week (for six days; for example, the 'letter-cancellation task' for attention for the day one of the week one had a mention in a corner of the sheet that it was for the 'day one' of the 'week one'). They were given step-by-step instructions and could ask for any clarifications. The instructions were given in a simple manner explaining first the details of the task (e.g., for explaining the 'letter cancellation task' the patient and the caregiver would be told, "this task requires an individual to cancel certain letters on a sheet carefully.") and then the steps that he/she had to do (e.g., "in the first week, every day you have to cancel two letters, such as 'D' and 'N', on one sheet which has been marked for a given day. You have to ensure that you cancel all the Ds and Ns but do not cancel any other letter or do not leave any of the Ds or Ns."). Caregivers were requested to monitor and assist the patients in practicing cognitive remediation tasks. Patient and his/her caregiver were given clear instruction about which tasks were to be done on a given day and what would be the duration of the tasks. If a task had to be administered by the caregiver then they were explained in detail how they had to administer the tasks. For example, for 'list learning' the caregivers would be told, "you need to present each word at a speed of one per second and have a pause for one second between the presentation of two words. Once you finish presenting all the words of a given list, …….. (patient's name) will tell you all the words that s/he remembers. You need to tick all the words in the sheet meant for marking it. The words can be recalled in any order. Once s/he has finished recalling the words, you will present the list again in the same way." On an average, patient had to engage in the cognitive remediation tasks for 45 min every day (six days a week). If any patient missed the appointment after two weeks to receive the training modules (remediation tasks), s/he was contacted by a research staff and suggested to visit and collect the materials as soon as possible.

2.2.2. Clinic-based remediation

In the clinic-based remediation group, the patient had to come to clinic six times a week to practice cognitive remediation tasks in the clinic (monitored and assisted by a clinician). If any patient had to miss the session on a particular day (due to any work or travel), s/he was given tasks for that day as homework which was reviewed by the clinician when s/he came to the clinic for remediation sessions. Also, the patients were suggested to not miss the cognitive remediation sessions frequently. The order of presentation of the task, the content of the tasks and the duration were similar for both the clinic-based and home-based remediation groups. The post-intervention assessment was done after completion of 12 weeks of remediation.

2.3. Details of the cognitive remediation tasks

A structured cognitive remediation program targeting domains of cognitive deficits commonly observed in individuals diagnosed with schizophrenia was developed. The intervention package was of 12 weeks duration. Cognitive remediation tasks were developed in a manner that it could offer variety as cognitive retraining was of several weeks duration (see Table 3). Monotonous tasks could retard improvement by decreasing the patients' motivation. The tasks in each domain of cognitive functions ranged from less difficult to more difficult levels (hierarchically ordered according to the increasing complexity level). The intervention package included remediation tasks targeting attention, memory (including working memory), cognitive flexibility and problem solving (see Table 3).

2.4. Assessment tools

Cognitive assessment targeting the domains of attention, working memory, verbal memory, visual memory, set-shifting, category fluency and planning was done with the help of the National Institute of Mental Health and Neurosciences (NIMHANS) Neuropsychological Battery (Rao et al., 2004). This battery includes standard tests of attention, motor speed, working memory, verbal and visual memory, set-shifting

and planning. It has comprehensive norms (age and education) for the Indian population and is widely used in India for neuropsychological assessment. Tests that were used in the present study from the NIMHANS neuropsychological battery were: digit vigilance for sustained attention (Lewis and Rennick, 1979), animal naming test for category fluency (Lezak, 1995), verbal and visual N-Back 2 for verbal and visual working memory (Smith and Jonides, 1999), tower of London for planning (Shallice, 1982), Complex figure test for visuo-spatial memory (Rey, 1941), Wisconsin Card Sorting Test (WCST; Heaton, 1981) for set-shifting and auditory verbal learning test for verbal learning and memory (Rao et al., 2004).

2.5. Psychopathology assessment

*Scale for the Assessment of Negative Symptoms (SANS) (*Andreasen, 1983*):* This scale has items related to five domains of negative symptoms - affective flattening, alogia, avolition-apathy, anhedonia and attentional impairments. All the items are rated on a scale of 0–5.

*Scale for the Assessment of Positive Symptoms (SAPS) (*Andreasen, 1984*):* Developed to assess positive symptoms, this scale assesses following symptoms- hallucinations, delusions, bizarre behaviour and formal thought disorder with each item rated on a 0 to 5-point scale.

2.6. Statistical analyses

We first ran Shapiro-Wilk tests to determine whether the data met the assumptions of parametric statistical tests. Variables where the Shapiro test was significant, non-parametric statistics were used.

So far as the parametric tests are concerned, independent sample t-tests were conducted to compare the clinic-based and the home-based groups on socio-demographic and clinical variables (age, education and duration of illness). Repeated measures ANOVAs with the assessment points scores (pre- and post-intervention) of various cognitive tests as the within factor (to assess the effect of the intervention on the level of performance on various cognitive tests) and group (clinic- and home-based) as the between factor, were conducted.

Among the cognitive tests, the scores on the verbal and visual working memory did not meet the assumptions of parametric statistical tests and, therefore, non-parametric tests were conducted. The Mann-Whitney test was used for the comparison of clinic- and home-based remediation groups on verbal and visual working memory pre-intervention scores. Wilcoxon sign-rank test was used for within group comparison of the pre-post cognitive remediation scores on verbal and visual working memory tests of each group (clinic- and home-based groups). Likewise, the psychopathology scores also violated the assumptions of parametric tests and therefore, non-parametric tests were used (Mann-Whitney *U* test for comparison of the two groups on baseline. Wilcoxon sign rank test for within group comparisons of pre- and post-test scores).

3. Results

3.1. Neuropsychological test scores

Average scores (pre- and post-intervetnion on different neuropsychological tests) of the clinic-based and the home-based groups have been shown in Tables 2a and 2b. A series of 2 × 2 repeated measures ANOVAs (with pre- and post-intervention scores on a given test of cognitive function as the within factor and remediation groups as the between factor) showed a significant effect of intervention on the scores of the test of *attention* (in terms of decrement in the number of errors on the digit vigilance task) [F (1, 14) = 11.42, $p < .01$, $\eta_p^2 = 0.44$], *verbal memory* (on the list learning test) [F (1, 18) = 15.82, $p < .001$, $\eta_p^2 = 0.46$], *immediate visual recall* (on the Complex Figure test) [F (1, 17) = 12.36, $p < .01$, $\eta_p^2 = 0.42$], *delayed visual recall* (on the Complex Figure test) [F (1, 17) = 12.77, $p < .01$, $\eta_p^2 = 0.42$], *set-shifting* (WCST number of perseverative errors and number of categories completed) [perseverative errors F (1, 18) = 4.51, $p < .05$, $\eta_p^2 = 0.20$; categories completed F (1, 18) = 7.41, $p < .01$, $\eta_p^2 = 0.29$], *planning* (the total number of problems solved in minimum moves on the Tower of London) [F (1, 18) = 12.00, $p < .01$, $\eta_p^2 = 0.40$] and *category fluency* (Animal Naming Test performance) [F (1, 18) = 8.53, $p < .01$, $\eta_p^2 = 0.32$]. On the other hand, none of the group main effect or the assessment points (pre- and post-intervention) x group intervention main effect was significant.

For working memory variables, as the Shapiro-Wilk test was significant, we conducted non-parametric statistics to compare the performance on verbal and visual N.Back 2 tasks of the two groups on baseline (pre-intervention) and the within-group comparisons of pre- and post-intervention scores. Both on verbal and visual working memory N-Back 1 tasks, the clinic-based and home-based remediation groups had comparable performance pre-intervention (verbal N.Back 1 Mann-Whitney $U = 31.50$, $p =$ n.s. and visual N.Back 1 Mannn-Whitney $U = 33.50$, $p =$ n.s.). Further, there was no significant within-group difference in pre- and post-intervention scores either in verbal N.Back 1 (clinic-based group pre-post intervention Wilcoxson sign-rank $Z = -0.00$, $p =$ n.s.; home-based group pre-post intervention Wilcoxson sign-rank $Z = -0.71$, $p =$ n.s.) or visual N.Back 1 (clinic-based group pre-post intervention Wilcoxson sign-rank $Z = -1.08$, $p =$ n.s.; home-based group pre-post intervention Wilcoxson sign-rank $Z = -1.15$, $p =$ n.s).

On verbal working memory N-Back 2 task, the two groups did not differ on pre-intervention scores (Mann-Whitney $U = 37.50$, $p =$ n.s.). So far as the within-group comparison of the pre-post scores are

Table 2a
Performance on neuropsychological tests pre- and post-cognitive remediation by the clinic-based and the home-based groups.*

	Clinic-based remediation group				Home-based remediation group			
	N	Pre-intervention Mean (SD)	N	Post- intervention Mean (SD)	N	Pre- intervention Mean (SD)	N	Post- intervention Mean (SD)
Verbal memory (list learning) total number of correct recall (sum of total trials)	10	47.90 (8.79)	10	54.70 (8.84)	10	43.70 (9.54)	10	55.90 (6.97)
WCST number of perseverative errors	10	38.20 (19.74)	10	19.00 (16.06)	10	26.50 (12.02)	10	24.80 (10.38)
WCST number of categories completed	10	2.30 (1.41)	10	4.10 (1.85)	10	2.00 (2.00)	10	2.90 (1.79)
Tower of London (problems solved in minimum number of moves)	10	8.00 (2.05)	10	9.60 (2.01)	10	7.90 (3.17)	10	9.50 (2.41)
Animal Naming Test score	10	11.90 (2.84)	10	14.70 (2.45)	10	12.40 (4.19)	10	14.10 (4.79)
Sustained attention (number of errors)	7	10.57 (11.10)	7	1.85 (1.57)	9	7.00 (3.90)	9	2.00 (1.22)
Visual memory immediate recall score	10	19.95 (5.06)	10	24.00 (8.32)	9	19.28 (8.59)	9	24.89 (4.42)
Visual memory delayed recall score	10	20.70 (6.57)	10	24.15 (8.10)	9	17.89 (7.84)	9	24.67 (3.90)

* Mean and SD of the neuropsychological test scores of only those patients have been given who underwent both pre- and post-intervention assessments on a given test (some patients didn't perform on some tests pre- or post-intervention).

Table 2b
Performance on neuropsychological tests (verbal and visual working memory tasks) pre- and post-cognitive remediation by the clinic-based and the home-based groups.*

	Clinic-based remediation group				Home-based remediation group			
	N	Pre-intervention Median (Range)	N	Post-intervention Median (Range)	N	Pre-intervention Median (Range)	N	Post-intervention Median (Range)
Verbal working memory N. Back 1 (number of hits)	9	9.00 (0.0)	9	9.00 (0.0)	10	9.00 (2.00)	10	9.00 (1.00)
Verbal working memory N. Back 2 (number of hits)	9	6.00 (4.00)	9	7.50 (4.00)	10	7.00 (6.00)	10	7.50 (4.00)
Visual working memory N. Back 1 (number of hits)	7	8.00 (5.00)	7	8.00 (2.00)	10	8.00 (3.00)	10	8.50 (3.00)
Visual working memory N. Back 2 (number of hits)	7	5.00 (5.00)	7	6.00 (5.00)	10	5.00 (4.00)	10	6.00 (3.00)

* Median and range have been shown as the Shapiro-Wilks test was significant for these variables (for one or both the groups). Further, median and range of the neuropsychological test scores of only those patients have been given who underwent both pre- and post-intervention assessments on a given test (some patients didn't perform on some tests pre- or post-intervention).

concerned, the home-based group did not have significant change in score post-intervention (Wilcoxson sign-rank Z = -0.84, p = n.s.); whereas, there was significant change in the post-intervention score of the clinic-based intervention group (Wilcoxson sign-rank Z = -1.95, $p < .05$). On visual working memory N.Back 2 task, the two groups did not differ in their performance pre-intervention (Mann-Whitney U = 31.00, p = n.s.). However, in within-group comparison of the pre-post scores, contrary to the verbal N.Back 2 task, the clinic-based group did not have significant change in score post-intervention (Wilcoxson sign-rank Z = -1.28, p = n.s.); whereas, there was significant change in the post-intervention score of the home-based intervention group (Wilcoxson sign-rank Z = -2.09, p = < .05).

3.2. SAPS and SANS scores (pre-post intervention comparison)

The two groups did not differ on their baseline SAPS and SANS scores (Mann-Whitney U = 23.00, p = n.s.; Mann Whitney U = 14.50, p = n.s. respectively). Within-groups comparisons (pre- and post-remediation scores) for SAPS and SANS scores show that post-intervention there was no significant change in positive or negative symptoms in either group (Wilcoxon sign-rank Z for the clinic-based group for SAPS pre-post scores = -0.71, p = n.s. and for SANS = -1.63, p = n.s.; for the home-based group for SAPS = -.96, p = n.s., SANS = -.18, p = n.s.).

4. Discussion

The present pilot study assessed the feasibility of a caregiver assisted home-based cognitive remediation program for individuals diagnosed with schizophrenia and compared its effectiveness with a clinic-based cognitive remediation program. The findings indicate that (1) with the assistance of caregivers, a home-based cognitive remediation program can be conducted and (2) similar to the clinic-based cognitive remediation program the home-based cognitive remediation program results in improvement in various cognitive domains (the only exception was working memory in which the clinic-based group showed improvement in verbal working memory N.Back 2 score whereas the home-based group showed improvement in visual working memory N.Back 2 score).

Except the mode of conducting the cognitive remediation for the two groups (in the clinic-based program the patient had to come to the clinic and the remediation program was supervised and assisted by a clinician, whereas in the home-based program the patients practiced the remediation tasks in home with assistance from a caregiver), there were no differences between the two remediation programs (in the content of the remediation tasks, domains of cognitive remediation and the duration). Thus, the results suggest that the home-based cognitive remediation program can be successfully conducted for individuals diagnosed with schizophrenia with the help of caregivers. Limited resources create major hurdles in delivering psychosocial interventions for individuals diagnosed with schizophrenia and the present study shows that home-based cognitive remediation can be effectively done without active involvement of a clinician. It can, thus, ease the load on clinics and a patient may not remain deprived of a needed intervention because of the time constraint of clinicians or scarcity of professionals.

Another important finding of this study is that cognitive remediation can be delivered to chronically ill individuals diagnosed with schizophrenia both in home and clinic settings. In both the groups, the average duration of illness was approximately 10 years and the pre-post significant change in scores on cognitive function tests implies that individuals with chronic illness also respond to efforts to remediate the cognitive deficits. It is possible that the intensity of intervention (frequency of sessions per week) in both groups played a major role in the observed improvement. Medalia and Richardson (2005) analysed the factors that could be good predictors of the outcome of cognitive remediation and found that the intensity of the intervention is one of the

Table 3
Remediation tasks used for retraining.

Domain	Task	Description
Attention	Letter cancellation	A set of letters are presented in a random order. The participant is required to strike out, depending on the level of complexity, only a given letter or multiple letters from the set of letters. For example, a) Cancel letter 'a' b) Cancel letters 'b' and 'f' c) Cancel letter 'm' but do not cancel if any 'm' is preceded by 'a' d) Cancel letter 'd' but do not cancel if any 'd' is succeeded by 'a' e) Cancel letter 'm' only if occurs before 'a'
	Colouring	A design is presented to the participant. S/he is required to colour the design and while colouring, s/he should make sure that it is done within the outline of the design and the strokes are even. The complexity of the design is increased gradually.
	Finding hidden objects	The participant is given a picture of a scene and pictures of various objects which s/he has to find in the scene
	Bead sorting	The participant is given beads of different colours, shapes and sizes and s/he has to sort them according to shape, colour and size
	Digit symbol	Similar to the digit symbol substitution test (Wechsler, 1958) a reference set of digits (from 1 – 9) with their corresponding symbols is provided. The participant is given a paper on which symbols are given and s/he has to put the corresponding digits as quickly as possible.
	Words in passage	A passage is presented to the participant. He needs to listen carefully and remember the number of times a given word occurs in the passage. Along with this, he is also required to answer a few questions about the passage.
	Visual scanning	Similar to the Trail making test (Reitan and Wolfson, 1985) in first set the participant is presented with numbers scattered on a sheet of paper. S/he needs to draw lines to connect one number to the consecutive number. In the second set the participant has to begin with a number and connect it to the corresponding alphabet based on the same order in which English alphabets occur from A–Z.
Memory	Memorization/ Recognition	The participant is presented with a picture of a scene for 15 seconds. S/he is asked to observe the scene carefully as later s/he would be shown a list of items and s/he would be required to identify the items seen by her/him.
	Reading passage and remembering facts	The participant is asked to read a passage carefully and s/he is told that later s/he would be asked to recall facts from the passage as much as possible.
	List learning	Similar to the Rey's Auditory Verbal Learning Test (Rey, 1941) a list of words is presented and the participant is supposed to recall as many words as possible in the order of his/her choice.
	Learning visual patterns	The participant is presented with a visual pattern for10 seconds and then a blank matrix is provided. The participant is required to fill it according to the pattern s/he was shown.
	Route memorization	The participant is presented with a map of routes. Later, on a blank map s/he is asked to locate pathways to one location from another.
	Visual N.Back 1	Cards with dots/ circles are presented one by one. The participant needs to remember the location of the dot/circle appearing on the cards, so that, whenever a dot/circle appears in the same location consecutively s/he taps the table to indicate that the locations of the dots are matching.
	Remembering designs	The participant is presented with certain designs. S/he needs to observe it carefully for 10 seconds and then is asked to draw the same design without looking at the design.
	Remember the previous word	The participant is instructed that s/he will be shown three/four letter words. Each word will be written on one card and cards will be presented consecutively. S/he has to pay attention and memorize the words as randomly, in the middle of presentations, a blank card will be presented which will indicate that s/he has to tell the word presented immediately before the blank card.
	Star counting (De Jong and Das-Smaal, 1990)	There is a set of stars and there are plus and minus signs (randomly) in between. On the top left corner, a two-digit number is written. Also, on the top, a single digit is written with the word forward (e.g., 3 forward) and a single digit with the word backward (e.g., 2 backward). The participant is asked to start with the double digit written on the left upper corner and add or subtract numbers (as per the digits written with 'forward' or 'backward') with each star according to the preceding plus or minus signs.
Reasoning and problem-solving	Find hidden words	The participant is presented with a matrix which consists of alphabets. Hidden in the matrix of alphabets are some meaningful words which the participant has to locate and circle.
	Mirror images	The participant is presented with a design. Below that there are four designs and s/he has to decide which design is the mirror image of the stimulus design.
	Where next	In each trial the participant is presented with three designs whose placement on each card follows a pattern. S/he is presented with a blank box following the three designs. S/he has to choose the right answer from the four options given to fill up the blank box
	Decoding words	The participant is presented with 26 alphabets, each of which corresponds to a symbol. S/he is then given a set of symbols. Each set of symbols denotes meaningful English words. Each symbol represents an English alphabet from A-Z. S/he has to substitute the symbols with its corresponding alphabet to decode the word
	Number game	The participant is given a series of numbers having some order. In the series any number will be missing. The participant has to decode the order in which the numbers have been written so that s/he can guess which number is missing.
	Mazes	The subject is given a picture of a maze. S/he needs to trace the path from the beginning of the maze till the end. However, the tracing of the path would only begin once s/he has mentally formed a pathway. S/he is not allowed to retrace any path or lift the pencil once s/he has begun

most important predictors of positive outcome. In this study, the frequency of session per week was 6 which is substantially more than the usual practice (2–3 times a week) (Medalia and Richardson, 2005) which might have a significant impact on the process of neural plasticity.

4.1. Strengths and limitations

To our knowledge, this is the first study to compare the efficacy of caregiver assisted home-based and clinic-based cognitive remediation programs on individuals diagnosed with schizophrenia. Having

standardized assessments and a pragmatic design involving caregivers to assist in the cognitive remediation of patients are strengths of the study.

However, the study has several limitations. The sample size (of the patients who completed the intervention) of both the clinic- and home-based groups were quite small and this increases the chance of type II error. Therefore, it limits the generalizability of the findings. Also, due to the lack of a wait-list control group data, it is difficult to comment on the extent of change that might have happened due to the time-gap between the pre- and post-intervention assessments. However, we must mention here that it is highly unlikely that an individual with chronic mental illness will have a significant change in his/her cognitive functions without any intervention in three months duration (the temporal gap between pre- and post-assessments). Also, as mentioned in the 'Method' section, we intended to have a wait-list group; however, very few patients chose to be in the wait list group and those who agreed did not come for the post-assessment. Thus, we did not have data for this group. Another limitation of this study is that there was no randomization of the sample, as practical logistic issues made it difficult to use randomization in this study. Though the groups being comparable on psychopathology and cognitive assessment scores at baseline assessment suggests that the two groups did not differ in any of the characteristics, random grouping of participants is ideal. There will always remain a possibility that patients with certain characteristics (such as high motivation) chose to come regularly for the clinic-based intervention. Further, lack of the follow-up data about whether the post-intervention cognitive improvements were sustained and whether the improvement in cognitive functioning impacted the socio-occupational functioning of the patients are other limitations of the study. Last but not least, there is a possibility that the caregiver assisted home-based intervention place additional burden on caregivers.

4.2. Implications and future research

Overall, in view of very small sample size, the findings of this study should be considered tentative until replicated. However, the present pilot research indicates that it is worth exploring the usefulness of caregiver assisted home-based cognitive remediation on a larger sample. Development of such intervention programmes will be a major step towards facilitating the availability of empirically supported psychosocial interventions in resource-limited LAMIC set-ups. Future research should explore the effects of reducing the number of sessions (2–3 times a week), duration of intervention (e.g., 6–8 weeks) and the chronicity of illness (recent onset versus chronic). Also, in this study the home-based group received very close monitoring from the clinicians (receiving remediation modules at a regular interval and the option to consult the clinician over the phone if there was any confusion). In day-to-day clinical practice, in a resource-limited set-up, such monitoring may not be available and this may affect the outcome. Hence, future research should also address this concern whether the home-based group would manifest similar improvements when the level of monitoring from clinicians is decreased. Finally, there should be assessment of the long-term outcome in terms of the effect of cognitive remediation on functionality of the patients as without other interventions (such as skills training), the effect of cognitive remediation on functionality of the patients may be limited (Bowie et al., 2012).

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Conflict of interest

There is no conflict of interest attached with this manuscript.

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