Original Article

Neuropsychological Correlates of Community Function among Major Depressive Disorder Outpatients without Comorbidity in Hong Kong: An Exploratory Cross-Sectional Study

Abstract

Introduction: This exploratory cross-sectional study examined the effect of depression on neuropsychological and community function among major depressive disorder (MDD) outpatients without comorbidity in comparison with healthy controls (HCs). **Methods:** Sixty-nine participants (23 for each group) participated in the study. They were assessed on psychological, neuropsychological function, and community function skills. **Results:** The results revealed that first episode MDD and recurrent episodes MDD outpatients still have a significantly higher level of depression, impaired mental state, and executive function and worse community function compared with HCs. Intervariable relationships analysis revealed qualitative differences between the three groups. **Conclusion:** The study provides preliminary evidence that MDD outpatients may need more targeted cognitive and psychosocial interventions to improve their executive and community function skills. Larger-scale studies to increase the validity and generalizability of the pilot data are suggested.

Keywords: *Community function, executive function, major depressive disorder, neuropsychological function*

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Introduction

The debilitating effects of depression have been documented worldwide. Major depressive disorder (MDD) patients, whether single/first MDD (FMDD) and/or recurrent MDD (RMDD) episode (s),[1] have been reported to have cognitive deficits.[2-4] It has also been reported that MDD inpatients have poorer community function skills[5] and often benefit from psychiatric and psychosocial rehabilitation to restore these skills.[6,7] MDD outpatients, in contrast, have received significantly less attention from researchers. These outpatients are assumed to have a mild form of depression and are, thus, considered healthy to resume work or engage in fruitful community functions although they may still be on medication. However, this assumption might not always be the case as some MDD outpatients do have challenges[8] at their workplace and/or in their social life. This exploratory cross-sectional study, therefore, fills the aforementioned knowledge gap by examining the effect of depression on the neuropsychological and community function among FMDD and RMDD outpatients without comorbidity and analyzing the relationships between these variables compared with healthy controls (HCs). Furthermore, this study informs us on the neuropsychological and community performances of these outpatients compared with the healthy people and provide evidence whether these outpatients need rehabilitation programs such as the inpatients.

Methods

Participants

FMDD and RMDD outpatients without comorbidity were recruited from Yung Fung Shee Psychiatric Clinic (YFSPC) in Hong Kong. They were first diagnosed by psychiatrists and further screened for comorbidity using Structured Clinical Interview for Diagnostic and Statistical Manual for Mental Disorders (SCID).[9] Inclusion criteria for MDD outpatients included (1) no comorbidities of other psychiatric disorders, (2) no psychosis, (3) no

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neurological conditions, substance abuse, severe head injuries, hypothyroidism, and severe physical illness,[10] (4) being clinically stable, and (5) a Mini-Mental State Examination (MMSE) score of 21 or more as recommended by Chiu *et al*.[11] These criteria were adopted to recruit a pure form of MDD condition, resulting in the reduction of population/sample size among FMDD and RMDD outpatients. The HCs were conveniently sampled from the surrounding communities. In addition to the inclusion criteria for the MDD outpatients, HCs did not have depression diagnosis – this was verified by SCID. A total of 69 participants (i.e., 23 participants each for FMDD, RMDD, and HCs) participated in this study. This sample size, although small, conformed to the rule of thumb for neuroimaging studies that 20 or more participants were needed for each experimental group[12,13] as the participants used in this study participated in other neuroscience studies at the Cognitive Neuroscience Laboratory (Department of Rehabilitation Sciences of The Hong Kong Polytechnic University, PolyU Laboratory).

Measures

Cantonese version of Mini–Mental State Examination

This is a 30 item-scale used to screen participants for cognitive impairment. In this study, C-MMSE represents participants' mental state. It has an internal reliability of $\alpha = 0.86$.[11] The cutoff point for this study was 21 and above.[11]

Chinese version of Beck Depression Inventory-II

This 21-item inventory was used to assess the severity level of depression among participants. It also served as the basis for declaring a participant as clinically stable. It has a Cronbach alpha coefficient of 0.92.[14]

Trail making test A and B

Trail making test A (TMT-A) was used to examine psychomotor speed, while TMT-B was used to examine executive function of participants. This scale comprised the English TMT-A and Chinese version of TMT-B.[15]

Modified card sorting test

A modified card sorting test (MCST) was used to assess executive function (sensitive to frontal lobe defect) among participants. In this test, participants responded to 48 cards according to certain rules (set-shifting) to demonstrate their ability to display flexibility in the face of changing schedules of reinforcement.[16,17]

Chinese version of St. Louis Inventory of Community Living Skills

This scale was used to assess community function skills or functional recovery of participants. It has been reported to validly assess community living skills among psychiatric patients across domains such as personal care/physical, social skills, and intellectual skills using local samples in Hong Kong with a high Cronbach alpha of 0.96.[18]

Procedures

The participants were screened and recruited at YFSPC, a facility that serves three communities of about a million population. The neuropsychological assessment was done at PolyU. Participants were assessed on mental state (MMSE), depression (Beck Depression Inventory [BDI]-II), psychomotor speed (TMT-A), executive function (TMT-B and MCST), and community function skills (Chinese version of St. Louis Inventory of Community Living Skills [SLICLS]). The study was conducted for 18 months. All participants signed the consent form before the assessment.

Ethical Consideration

The Research Ethics Committee of the Hong Kong Hospital Authority (KC/KE-16-0114/ER-2) and The Hong Kong Polytechnic University (PolyU; HSEARS20160523001) approved this cross-sectional design study.

Statistical analysis

An Independent *t*-test was used to compare the MDD groups on depression-related characteristics given the normality of their data. Kruskal–Wallis H test was used to compare continuous variables among groups due to the nonnormal distribution of the data using Shapiro–Wilk test. If overall significance existed, Mann–Whitney U test with Bonferroni corrected *P* value ($P = 0.017$) was used to do pairwise comparison [Table 1]. Partial correlation with age and years of education treated as covariates was used for compiling the correlation matrices among each group of participants [Tables 2-4]. The data were analyzed using SPSS version 22 software (IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp).

Results

The independent *t*-test result revealed no significant difference between the MDD groups on onset age and current illness' episode except for illness duration ($P = 0.000$) where RMDD outpatients had a longer duration than FMDD outpatients. Furthermore, HCs were found to be younger than RMDD outpatients ($P = 0.001$) but had more years of education than both FMDD and RMDD outpatients ($Ps = 0.000$).

As Kruskal–Wallis H-test showed overall between-group significance (BDI-II; $\Sigma^2[2] = 21.382$, $P = 0.000$), Mann–Whitney U test was used which revealed that FMDD and RMDD outpatients had significantly higher depression levels than HCs ($P = 0.000$ and $P = 0.000$, respectively) but not between FMDD and RMDD outpatients. Furthermore, there was an overall between-group significance on mental state (MMSE;

Table 1: Summary of the comparisons between groups on neuropsychological outcomes and community function

Measures	Mean±SD			Inferential statistics			
	FMDD (*n*=23)	RMDD (*n*=23)	HC (*n*=23)	df	t/Σ^2	P	*Post hoc*
Onset age	36.65±9.98	33.70±9.28	-	44	1.041[a]	0.304	-
Illness duration	6.00±4.58	12.26±5.82	-	44	4.054[a]	0.000	RMDD > FMDD
Current episode's duration	6.00±4.58	3.91±3.70	-	44	1.707[a]	0.095	-
Number of episode	1±0	2.22±0.67	-	-	-	-	-
Age	37.02 (19)	44.54 (13)	23.43 (12)	2	13.112[b]	0.001	HC < RMDD**
Education (years)	28.02 (5)	25.52 (5)	51.46 (2)	2	24.411[b]	0.000	HC > FMDD**
							HC > RMDD**
MMSE	28.07 (3)	34.20 (3)	42.74 (1)	2	6.874[b]	0.032	HC > FMDD*
BDI-II	42.50 (19)	43.26 (14)	19.24 (7)	2	21.382[b]	0.000	HC < FMDD**
							HC < RMDD**
TMT-A	38.20 (14.06)	36.57 (14.51)	30.24 (11.36)	2	2.019[b]	0.364	-
TMT-B	44.09 (34.18)	37.67 (20.19)	23.24 (15.73)	2	13.031[b]	0.001	HC < FMDD*
							HC < RMDD*
MCST-cat	31.02 (1)	32.48 (1)	41.50 (0)	2	7.929[b]	0.019	HC > FMDD*
							HC > RMDD*
MCST-PE	39.37 (2)	39.87 (2)	25.76 (0)	2	9.187[b]	0.010	HC < FMDD*
							HC < RMDD*
MCST-NPE	45.26 (5)	35.85 (4)	23.89 (3)	2	13.242[b]	0.001	HC < FMDD**
MCST-TE	44.24 (6)	38.24 (6)	22.52 (4)	2	14.493[b]	0.001	HC < FMDD**
							HC < RMDD*
SLICLS-total	28.74 (19)	32.59 (18)	43.67 (9)	2	6.886[b]	0.032	HC > FMDD*
SLICLS-PC/PS	31.04 (8)	31.59 (7)	42.37 (5)	2	4.698[b]	0.095	-
SLICLS-SS	28.28 (6)	33.00 (6)	43.72 (2)	2	7.279[b]	0.026	HC > FMDD*
SLICLS-IS	27.59 (5)	34.50 (5)	42.91 (3)	2	6.854[b]	0.032	HC > FMDD*

*P<0.01, **P<0.001. [a]Independent *t*-test and [b]Kruskal-Wallis H-test were used to analyze the data. For Kruskal-Wallis H-test, mean ranks and interquartile range in parenthesis were used. A < B: A is less than B; A > B: A is greater than B. Participants for each group were made up of 20 females and 3 males (*n*=23). MMSE: Mini-mental state examination, BDI-II: Beck Depression Inventory-II, SLICLS: St. Louis Inventory of Community Living Skills, SLICLS-PC/PS: SLICLS-personal care/physical skill, SLICLS-SS: SLICLS-social skill, SLICLS-IS: SLICLS-intellectual skill, TMT-A: Trail making test A, TMT-B: Trail making test B, MCST-cat: Modified card sorting test-categories, MCST-PE: Modified card sorting test-perseverative errors, MCST-NPE: Modified card sorting test-nonperseverative errors, MCST-TE: Modified card sorting test-total errors, SD: Standard deviation, HC: Healthy controls, RMDD: Recurrent episodes major depressive disorder, FMDD: First episode major depressive disorder

$\Sigma^2[2]$ = 6.874, P = 0.032) and executive function which comprised TMT-B ($\Sigma^2[2]$ = 13.031, P = 0.001), MCST-categories (MCST-Cat.; $\Sigma^2[2]$ = 7.929, P = 0.019), MCST-perseverative error (MCST-PE; $\Sigma^2[2]$ = 9.187, P = 0.010), MCST-nonperseverative error (MCST-NPE; $\Sigma^2[2]$ = 13.242, P = 0.001], and MCST-total error [MCST-TE; $\Sigma^2[2]$ = 14.493, P = 0.001). The Mann–Whitney U test also revealed that HCs had better mental state and executive function than FMDD outpatients and RMDD outpatients, but there was no significant difference between FMDD and RMDD outpatients. There was no overall between-group significance on processing speed (P = 0.364).

For community function, the Kruskal–Wallis test showed overall between-group significance (Total; $\Sigma^2[2]$ = 6.886, P = 0.032). The Mann–Whitney U test then revealed that FMDD outpatients had significantly worse community function skills compared to HCs (P = 0.009). There were significant between-group differences at the subscale levels (i.e., social skills [-SS; P = 0.026] and intellectual skills [-IS; P = 0.032]), with FMDD outpatients having worse skills than HCs. However, no significant differences were found between FMDD and RMDD outpatients and between RMDD outpatients and HCs.

Partial correlation matrix among HCs revealed significant positive relationships between cognitive processing speed (TMT-A) and executive function (MCST-NPE), and executive function (MCST-TE) with the P values ranging from 0.000 to 0.022 [Table 2]. Among FMDD participants, significant positive relationships were found between mental function (MMSE) and executive function (MCST-Cat.) and between executive function (MCST-Cat) and social skills (SLICLS-SS). In addition, significant negative relationships were found between mental function (MMSE) and executive function (MCST-PE, -NPE and -TE) and between depression (BDI-II) and community function (SLICLS, -PC/PS, -SS, and -IS) with P values ranging from 0.000 to 0.048 [Table 3]. Among RMDD

Table 2: Partial correlation matrix of variables among healthy controls

	Measure	1	2	3	4	5	6	7	8	9	10	11	12
1	MMSE	-											
2	BDI-II	-0.37	-										
3	SLICLS-PC/PS	0.060	-0.16	-									
4	SLICLS-SS	0.060	-0.36	0.71***	-								
5	SLICLS-IS	0.17	-0.36	0.80***	0.85***	-							
6	SLICLS-total	0.09	-0.29	0.94***	0.90***	0.94***	-						
7	TMT-A	-0.06	-0.05	0.10	0.05	0.16	0.11	-					
8	TMT-B	-0.17	-0.20	-0.09	-0.01	0.00	-0.05	0.54*	-				
9	MCST-cat	-	-	-	-	-	-	-	-	-			
10	MCST-PE	0.24	-0.16	0.04	0.14	0.14	0.10	0.20	-0.12	-	-		
11	MCST-NPE	-0.39	-0.17	-0.04	0.15	0.02	0.03	0.50*	0.16	-	0.02	-	
12	MCST-TE	-0.29	-0.21	-0.03	0.19	0.07	0.06	0.54*	0.11	-	0.36	0.94***	-
	Mean±SD	29.26±1.21	4.52±5.68	44.83±3.75	25.87±2.3	25.87±2.32	96.57±7.77	29.4±7.77	42.28±10.44	6±0	0.3±0.88	3.48±2.5	3.78±2.7

*P<0.05, ***P<0.001. Covariate variables: Age and years of education; The significant correlations in italics are relationships within the same scale hence not used in the study. MMSE: Mini-mental state examination, BDI-II: Becks depression inventory-II, SLICLS: St. Louis Inventory of Community Living Skills, SLICLS-PC/PS: SLICLS-Personal care/physical skill, SLICLS-SS: SLICLS-social skill, SLICLS-IS: SLICLS-intellectual skill, TMT-A: Trail making test A, TMT-B: Trail making test B, MCST-cat: Modified card sorting test-categories, MCST-PE: Modified card sorting test-perseverative errors, MCST-NPE: Modified card sorting test-nonperseverative errors, MCST-TE: Modified card sorting test-total errors, SD: Standard deviation

Table 3: Partial correlation matrix of variables among first episode major depressive disorder participants

	Measure	1	2	3	4	5	6	7	8	9	10	11	12
1	MMSE	-											
2	BDI	-0.31	-										
3	SLICLS-PC/PS	-0.02	-0.53*	-									
4	SLICLS-SS	0.29	-0.62**	0.65**	-								
5	SLICLS-IS	-0.03	-0.59**	0.84***	0.65**	-							
6	SLICLS	0.07	-0.64**	0.94***	0.82***	0.93***	-						
7	TMT-A	-0.10	0.06	0.08	-0.03	-0.00	0.02	-					
8	TMT-B	-0.07	0.13	0.12	-0.29	0.01	-0.03	0.45	-				
9	MCST-Cat	0.64**	-0.22	0.18	0.45*	0.19	0.28	0.16	0.14	-			
10	MCST-PE	-0.63**	0.10	-0.13	-0.28	-0.10	-0.18	-0.03	-0.28	-0.88***	-		
11	MCST-NPE	-0.54*	0.10	-0.22	-0.39	-0.20	-0.28	-0.18	-0.13	-0.91***	0.81***	-	
12	MCST-TE	-0.61**	0.10	-0.19	-0.36	-0.17	-0.25	-0.13	-0.20	-0.94***	0.93***	0.97***	-
	Mean±SD	27.87±2.28	16.04±12.52	42.22±4.63	23.3±3.21	23.17±4.25	88.7±10.96	34±9.78	64.83±32.83	5.43±1.08	1.65±2.87	7.65±4.56	9.3±7.06

*P<0.05, **P<0.01, ***P<0.001. Covariate variables: Age and years of education; The significant correlations in italics are relationships within the same scale hence not used in the study. MMSE: Mini-mental state examination, BDI: Becks depression inventory, SLICLS: St. Louis Inventory of Community Living Skills, SLICLS-PC/PS: SLICLS-Personal care/physical skill, SLICLS-SS: SLICLS-Social skill, SLICLS-IS: SLICLS-intellectual skill, TMT-A: Trail making test A, TMT-B: Trail making test B, MCST-cat: Modified card sorting test-categories, MCST-PE: Modified card sorting test-perseverative errors, MCST-NPE: Modified card sorting test-nonperseverative errors, MCST-TE: Modified card sorting test-total errors, SD: Standard deviation

Table 4: Partial correlation matrix of variables among recurrent episode major depressive disorder participants

Measure	1	2	3	4	5	6	7	8	9	10	11	12
1 MMSE	-											
2 BDI	-0.06	-										
3 SLICLS-PC/PS	-0.05	-0.28	-									
4 SLICLS-SS	-0.06	-0.24	0.77***	-								
5 SLICLS-IS	0.30	-0.28	0.55*	0.65**	-							
6 SLICLS	0.04	-0.30	0.93***	0.91***	0.78***	-						
7 TMT-A	-0.53*	-0.06	0.02	-0.11	-0.21	-0.08	-					
8 TMT-B	-0.36	0.11	-0.13	-0.29	-0.29	-0.24	0.81***	-				
9 MCST-Cat	-0.03	0.15	0.15	0.03	0.07	0.11	0.03	0.12	-			
10 MCST-PE	-0.14	0.09	-0.38	-0.38	-0.55**	-0.48*	0.40	0.34	-0.47*	-		
11 MCST-NPE	0.05	-0.09	0.20	0.29	0.13	0.23	-0.07	-0.26	-0.77***	0.23	-	
12 MCST-TE	0.03	-0.06	-0.03	0.02	-0.09	-0.04	0.06	-0.11	-0.84***	0.57**	0.91***	-
Mean±SD	28.74±1.32	14.65±9.14	41.91±5.96	24.09±3.46	24.39±3.5	90.39±11.27	34.99±15.07	53.41±16.57	5.52±0.99	1.35±1.92	6±4.38	7.52±5.06

*P<0.05, **P<0.01, ***P<0.001. Covariate variables: Age and years of education; The significant correlations in italics are relationships within the same scale hence not used in the study. MMSE: Mini-mental state examination, BDI-II: Becks depression inventory-II, SLICLS: St. Louis Inventory of Community Living Skills, SLICLS-PC/PS: SLICLS-personal care/physical skill, SLICLS-SS: SLICLS-social skill, SLICLS-IS: SLICLS-intellectual skill, TMT-A: Trail making test A, TMT-B: Trail making test B, MCST-cat: Modified card sorting test-categories, MCST-PE: Modified card sorting test-perseverative errors, MCST-NPE: Modified card sorting test-nonperseverative errors, MCST-TE: Modified card sorting test-total errors, SD: Standard deviation

participants, significant negative relationships were found between mental function (MMSE) and cognitive processing speed (TMT-A) and between executive function (MCST-PE) and community function (SLICLS, and -IS) with the P values ranging from 0.000 to 0.031 [Table 4].

Discussion

The neuropsychological findings indicated that HCs had significantly better mental state and executive function than FMDD and RMDD outpatients. HCs had better executive function such as strategic planning, organized searching, set-shifting, and abstract reasoning compared with FMDD and RMDD outpatients. This makes good sense as FMDD and RMDD outpatients were found to be mildly depressed compared with HCs who were within the normal range on the severity scale.[14,19] These findings provide further evidence to support the results of previous studies.[2,19,20] It suggests that FMDD and RMDD outpatients still have clinical depressive symptoms and cognitive challenges related to frontal lobe dysfunction. This implies that outpatients with depression may have challenges working or performing tasks because they may not have fully recovered. Further and continuous treatment is, therefore, needed when they are struggling for survival in the community. Following this rationale, FMDD and RMDD outpatients should continue to receive evidence-based rehabilitation services such as attention processing training or cognitive remediation therapy[21,22] to improve their cognitive function.

Our study offers novel data and thus new insight into the community function levels of FMDD and RMDD outpatients and their continuing need for rehabilitation as outpatients dwelling in the community. In contrast with previous findings,[23,24] the results of this study show that FMDD outpatients had significantly worse performance in community function, specifically in their social and intellectual skills compared with HCs. This effect cannot only be explained by the consequence of depression, as both FMDD and RMDD outpatients had the highest score on the depression scale. Hence, the worse community function skills among FMDD outpatients can be attributed to the combination of the effect of depression and the first-time experience of the disorder which overwhelms them. RMDD outpatients, on the other hand, may have developed compensatory techniques to cope with the negative effects of the disorder over time. In Hong Kong and other places, psychosocial interventions aim only at improving community functions of severely ill inpatients[5,24,25] and rarely address the challenges of outpatients due to wrong understanding of the needs of outpatients and inadequate rehabilitation workforce. The insight from the present study suggests that MDD outpatients also require psychosocial interventions such as community living skills training and supported employment.

Moreover, the analysis of intervariable relationships revealed qualitative differences between the groups. Among

HCs, the positive relationship between processing speed and errors during the executive task reflects the relationship between time, task difficulty, and task performance. Among FMDD participants, a positive relationship between mental function and ability to complete tasks (MCST-Cat) supports the assumption that a highly functioning MDD person can complete a task however difficult it may be and vice versa. Similarly, a positive relationship between the ability to complete tasks (MCST-Cat) and social skills (SLICLS-SS) indicates that the better one's social skills the better their functional ability to complete tasks (MCST-Cat) and vice versa. Moreover, a better mental function was found to be related to less executive function errors (MCST-PE, MCST-NPE, and MCST-TE) and vice versa. In addition, we found a negative relationship between depression and all aspects of community function (SLICLS-PC/PS, SLICLS-SS, SLICLS-IS, and SLICLS-Total), which supports the assertion that severity of depression may adversely affect participants' community performances, even among outpatients.[26] This again provides evidence to show that depression is associated with the loss of community function skills. Among RMDD outpatients, mental function is negatively related to processing speed as well as less executive function errors (MCST-PE) related to better community function and vice versa. All these findings indicate significant qualitative differences between FMDD and RMDD outpatients compared with HCs.

Limitation

Due to the exploratory nature of this study, it had only a small sample size. Furthermore, the use of psychotropic medications on MDD outpatients as well as significant differences in age and years of education, which may have had effects on the results were not controlled. Hence, future studies should address these challenges and limitations to improve the validity and generalizability of the findings.

Conclusion

The findings suggest that MDD outpatients still have impaired neuropsychological and community functions, albeit the reason for this is not entirely clear. Therefore, there is a need for further research to enable a better understanding of the neural mechanisms underlying this finding. Last but not least, this study points out that continuous neuropsychological and psychosocial interventions should be provided to these MDD outpatients to help them cope with challenges in the community.

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Conflicts of interest

There are no conflicts of interest.

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