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Performance of Mini-Mental State Examination (MMSE) in long-stay patients with schizophrenia or schizoaffective disorders in a psychiatric institute

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ABSTRACT

Studies have found that age and education were associated with cognition in older adults. However, little is known how clinical factors (e.g. age of illness onset, length of hospital stay, type of antipsychotic medications, and duration of illness) are associated with cognitive functioning in patients with schizophrenia. This study aimed to examine the influence of socio-demographic and clinical factors on cognitive domains measured using Mini-Mental State Examination (MMSE) among patients with schizophrenia or schizoaffective disorders residing in a psychiatric institute in Singapore. A single-phase interview was conducted at the Institute of Mental Health (IMH) in patients diagnosed with schizophrenia or schizoaffective disorders (n=110). MMSE was administered to all participants. Data on socio-demographic characteristics, smoking, alcohol consumption, and medical history were collected. Age, gender, and level of education were significantly associated with MMSE scores. After adjusting for all socio-demographic correlates, longer length of hospital stay remained significant in predicting lower MMSE scores. Length of hospital stay was independently associated with cognitive functioning. Early interventions for cognition such as physical and mental exercises should be implemented for better prognosis.

1. Introduction

Cognitive impairment is one of the key problems in patients with schizophrenia. Studies have found that patients with schizophrenia have more cognitive deficits than healthy individuals even in the early stages of psychotic illness (Addington et al., 2005; Keefe and Harvey, 2012). Magnetic resonance imaging (MRI) studies have found significant decrease in cerebral grey matter volume, cortical volume, and thickness in patients with schizophrenia than healthy controls participants (Kubota et al., 2015) and postulated that these could lead to the cognitive decline (Mitelman et al., 2007). The cognitive deficits include domains of executive attention (Orellana et al., 2012), working memory (Collins et al., 2014), verbal skills (Bozikas et al., 2005), executive functioning, and speed of processing (Helldin et al., 2006). A review conducted by Lepage et al. (2014) reported that these neurocognitive deficits would affect an individual's functional status across different outcome domains (i. e. self-care, independent living, social and interpersonal functioning, vocational functioning etc.) (Lepage et al., 2014).

Mini-Mental State Examination (MMSE) is a brief measure of global cognition and is often used for evaluation of cognitive functioning. This instrument was developed by Folstein et al. (1975) to assess five domains of cognition: *orientation* with regard to time and place, *registration* of words, *attention and calculation*, *recall*, and *language* (Folstein et al., 1975). It is a validated and effective screening tool for cognitive impairment among elderly, community dwelling, institutionalized, and hospitalized adults (Tombaugh and McIntyre, 1992).

Studies conducted in different populations found that MMSE scores were influenced by socio-demographic factors such as age and education in Portuguese healthy adults (Santana et al., 2015) and ethnic differences in Singapore community-living elderly population (Ng et al., 2007). Age (Maltais et al., 2015) and level of education (Moore et al., 2004) were two prominent socio-demographic factors associated with MMSE in patients with schizophrenia and gender differences were also found in cognitive performance among older adults in Korea (Han et al., 2008). Younger age and higher education level were found to be associated with better MMSE scores, whereas females had more cognitive

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impairment. Education was found to be the best predictor of MMSE scores, followed by age and gender in elderly Koreans (Kim et al., 2012).

Other factors such as heavy smoking (Razani et al., 2004) and alcohol consumption (Manning et al., 2009) were also associated with cognitive impairment assessed using other cognitive tests. Studies suggest that smoking has a negative influence on cognition and the brain (Swan and Lessov-Schlaggar, 2007). Similarly among alcohol dependent patients, deficits in the visual episodic memory, slower reaction time, and reduced working memory span have been reported compared to healthy controls (Kopera et al., 2012).

In terms of clinical factors, age of onset (van der Werf et al., 2012), length of hospital stay (Kato et al., 1995), type of antipsychotic medication (Keefe et al., 1999), and duration of illness (Talreja et al., 2013) were found to influence cognitive functioning in patients with schizophrenia. A meta-analysis conducted by Rajji et al. (2009) revealed that cognitive deficits differ among patients based on their age of onset. Individuals with youth-onset schizophrenia have longer duration of illness and thus greater effect of chronicity than individuals with late-onset schizophrenia (Rajji et al., 2009). Separately, a study conducted in inpatients found that cognitive tests which measure memory for nonverbal visual stimuli, visual attention, and task switching were the best predictors of length of hospital stay (Kato et al., 1995). In terms of types of antipsychotic medications, first generation (typical) antipsychotics (e.g. chlorpromazine and haloperidol) possess detrimental effects on memory, motor functions, and higher order cognitive functions (Hill et al., 2010). In contrast to typical antipsychotics, second generation (atypical) antipsychotics were proposed to be a better treatment option for patient with schizophrenia wherein they have lesser side effects and address the cognitive impairments suffered by the patients (He et al., 2009; Keefe et al., 1999). Conflicting findings have been shown for other clinical factors such as duration of illness where Hyde et al. (1994) reported age, instead of duration of illness to be associated with cognitive decline in Boston Naming test, while Talreja et al. (2013) found significant association between duration of illness and MMSE scores in patients with schizophrenia.

Throughout the world, there is a shift towards managing and treating patients with schizophrenia in the community. Deinstitutionalisation started in 1970s in California and long-stay care in psychiatric hospitals has progressively been replaced by community mental health care in present England, USA, Eastern, and South-eastern Asian countries (Borsay, 2006; Chong and Subramaniam, 2014; Finkel et al., 2007; Fisher et al., 2001; Institute of Mental Health, 2014; Ito et al., 2012; Santana et al., 2015; Scheff, 2014). The reasons for such movement are numerous and complex and community care is assumed to be more humane, therapeutic, and cost effective (Chong and Subramaniam, 2014). Considering the move towards community care, there is a need to examine the cognitive functioning of patients who have been institutionalized to ensure that patients are capable of independent living outside the hospital.

Institute of Mental Health (IMH) is the only tertiary psychiatric hospital in Singapore providing psychiatric services to the mentally ill (Institute of Mental Health, 2014). This institute has about 2000 beds spread over 50 wards, with 24 wards dedicated for long-stay patients. According to a previous study conducted in IMH long-stay patients, most patients were in the older age group i. e. average age of 45.5 years for males and 55.8 years for females; most had primary school education and comprised 3 major ethnic groups (Chinese, Malay, and Indian) (Eu et al., 2001). Given this particular profile, the investigators felt that MMSE would be most suited for measuring cognitive impairments as it has a short administration time of approximately 10–15 mins (Molloy and Standish, 1997) and it is available in validated English, Chinese, and Malay language version (Feng et al., 2012; Ibrahim et al., 2009; Tombaugh and McIntyre, 1992). To date, two studies on MMSE have been conducted in Singapore. In 2007, Ng et al. (2007) utilised MMSE in older adults to identify those with and without dementia while another study looked at MMSE performance in Chinese older adults to detect early cognitive impairment (Feng et al., 2012; Ng et al., 2007). Past studies looking at MMSE are focused on detecting dementia among Singaporean older adults. In comparison, few studies have looked at MMSE in long-term institutionalized patients with schizophrenia in Singapore context.

While previous studies support the association of MMSE with age and education in patients with schizophrenia, few studies have examined the association of cognitive impairment with clinical factors such as age of illness onset (Johnstone et al., 1989; Rajji et al., 2009), length of hospital stay (Kato et al., 1995), types of antipsychotic medications (Désaméricq et al., 2014), and duration of illness (Talreja et al., 2013) in institutionalized long-stay patients with schizophrenia. The aim of the current study was to assess how much variance in MMSE scores could be explained by socio-demographic factors (i.e. age, gender, ethnicity, level of education, smoking behaviour, and alcohol consumption) and clinical factors (i.e. age of onset, length of hospital stay, types of antipsychotic medications, and duration of illness). The study also examined whether clinical factors (i.e. age of onset, length of hospital stay, type of antipsychotic medications, and duration of illness) were able to predict a significant amount of variance in MMSE scores after controlling for the possible confounders due to socio-demographic factors. Based on the extant literature, we hypothesized that (1) education level will predict the largest amount of variance; followed by age and gender and that (2) after adjusting for socio-demographic factors, youth-onset schizophrenia, longer length of hospital stay, typical antipsychotic medications, and longer duration of illness would predict a lower MMSE scores.

2. Material and methods

2.1. Participants

A cross-sectional study was conducted to assess the physical health status of long-stay patients with severe mental illness in a tertiary hospital. Patients were recruited at the Institute of Mental Health (IMH), Singapore through referrals by clinicians and nurses based on the study's inclusion criteria. Participants aged 21 years old and above were recruited from the long-stay wards. The criterion for classifying a patient as long-stay was a minimum duration of one-year hospitalisation. All patients were diagnosed by psychiatrists as suffering from schizophrenia or schizoaffective disorders (107 with schizophrenia and 3 with schizoaffective disorders), as defined by DSM-IV criteria (American Psychiatric Association, 1994). Patients, who were able to comprehend and provide written informed consent as well as take part in the study assessments and those without any impairment in communication at the point of recruitment, were recruited into the study. Patients with either dementia or intellectual disability were excluded based on medical case notes for the psychiatric diagnosis. Ethics approval for the study was given by the National Healthcare Group Domain Specific Review Board.

2.2. Socio-demographic characteristics

Due to the small sample size, most variables were re-coded into categorical variables. Education level was categorized according to the number of years completed in the Singapore education system, and was divided into three different education level; low (below primary school; ≤ 6 years of education), medium (secondary school; 7–11 years of education), and high (at least college or university; ≥ 12 years of education) (Singapore, 2015). Information on other socio-demographic characteristics such as gender, ethnicity, marital status, and health behaviours was also collected. Marital status was categorized as single, married, and others which included those who were widowed, divorced, and separated. Health behaviour included smoking behaviour and alcohol consumption. Patients were categorized as ex-smoker, smoker, and non-smoker based on their self-report. For alcohol consumption, patients were asked if there was any period in their life when they drank at least 12 drinks in a year, and response categories were at least 12 drinks a year, less than 12 drinks a year, and never drank alcoholic drinks.

2.3. Clinical information

Age of onset was checked from medical records and categorized into youth-onset schizophrenia (≤ 19 years old), late-onset schizophrenia (≥ 40 years old), and other age of onset (20–39 years old) (Rajji et al., 2009). Length of hospital stay was recorded in months and converted to years by calculating from the date of admission to the ward to the month of administering the study. Patients were classified on the basis of type of antipsychotic medications prescribed as those on typical antipsychotic drugs only, atypical antipsychotic drugs only, combination of typical and atypical drugs, and those who were not on antipsychotics. Duration of illness was recorded in months and converted to years based on the age of onset of illness to the month of administering the study.

2.4. Assessments

The details of the study were explained to all patients. Informed consent was taken on the first visit from all subjects who agreed to participate. In cases where patients were unable to comprehend English, the consent form was explained to the respondent in a language understood by him/her, in the presence of a witness. After consent was taken from the patients, medical history was checked with the medical case notes for the psychiatric diagnosis, age of onset, length of stay at the hospital, and types of antipsychotic medications consumed. On the second visit, patients were interviewed by trained researchers and data on socio-demographic and health behaviours were collected. Singapore MMSE was administered to all patients (Feng et al., 2012). For cases where patients were unable to read, language testing on reading skill which requires participant to read the phrase "Close your eyes" was not administered to them. Nevertheless, the present study showed that MMSE score had good internal consistency, with a Cronbach's alpha coefficient of 0.82. The MMSE has a maximum score of 30. Severity of cognitive impairment has been classified into three levels: 24–30 = no cognitive impairment, 18–23 = mild cognitive impairment and 0–17 = severe cognitive impairment. In addition, a paper by Feng et al. (2012) calculated the sensitivity and specificity estimates for Singapore MMSE. Accordingly, instead of the traditional cut-off score of 24, three new cut-off scores of 25, 27, and 29 were selected for subjects with no education, primary, and secondary school and above education levels respectively. Based on the participants' level of education, those scoring less than the new cut-off scores were determined to have cognitive impairment (Feng et al., 2012). Different language versions of the MMSE (English, Chinese, and Malay) were used to cater to patients' language ability, and the language was chosen according to the patient's familiarity and comfort.

2.5. Statistics

All statistical analysis was performed using the Statistical Package for the Social Sciences version 23.0. Mean and standard error were calculated for continuous variables, and frequencies and percentages were calculated for categorical variables. Using multiple linear regression analysis, socio-demographic factors including age, gender, ethnicity, marital status, level of education, smoking behaviour, and alcohol consumption were entered as independent variables to predict MMSE score (Table 3, Model 1). In Model 2, only clinical factors including age of onset (youth-onset schizophrenia, late-onset schizophrenia, and other age of onset), length of hospital stay, type of antipsychotic medications (excluding those who were not prescribed any antipsychotic medications, n = 3), and duration of illness were added as influencing factors. To test for any independent associations between each clinical factors and MMSE scores, multivariate analyses were run using hierarchical regression where age of onset, length of hospital stay, type of antipsychotic medications, and duration of illness were treated as main predictor of MMSE scores and adjusted for socio-demographic factors. All models were performed by multivariate linear regression using enter method. All statistical significant differences were set a $p < 0.05$.

3. Results

Table 1 shows the socio-demographic and clinical information of the patients. The sample consisted of 110 patients (88 Chinese, 16 Malay, and 6 Indian) with more men (85.5%) than women (14.5%). Out of 110 patients recruited, 59 patients completed MMSE in English; 42 completed in Chinese; and 9 completed it in Malay. The age range was 25–90 with a mean age of 55.9 (SE = 0.9) years. In terms of education, majority (50.0%) fell under the medium education level (7–11 years) while the rest were in low (≤ 6 years; 34.5%) and high (≥ 12 years; 15.5%) categories. There were a total of 20 patients (18.2%) with youth-onset schizophrenia, 75 patients (68.2%) with other age of onset, and 14 patients (12.7%) with late-onset schizophrenia. Patients' length of hospital stay ranged from 1.0 to 28.9 years, averaging 8.6 years (SE = 0.7).

Table 1
Socio-demographic and clinical information of the patients.

Sample (n = 110)	n	%	Mean	Standard error
Characteristics of study sample				
Age, years			55.9	0.9
Gender				
Male	94	85.5		
Female	16	14.5		
Ethnicity				
Chinese	88	80.0		
Malay	16	14.5		
Indian	6	5.5		
Marital status				
Single	84	76.4		
Married	5	4.5		
Others [a]	21	19.1		
Education, years			8.1	0.4
Low (≤ 6 years)	38	34.5		
Medium (7–11 years)	55	50.0		
High (≥ 12 years)	17	15.5		
Smoking behaviour				
Smoker	7	6.4		
Ex-smoker	68	61.8		
Non-smoker	35	31.8		
Alcohol consumption				
At least 12 drinks a year	18	16.4		
Less than 12 drinks a year	42	38.2		
Never drank alcoholic drinks	50	45.5		
Age of onset				
Youth-onset schizophrenia (≤ 19 years old)	20	18.2		
Other age of onset (20–39)	75	68.2		
Late-onset schizophrenia (≥ 40 years old)	14	12.7		
Length of hospital stay (years)			8.6	0.7
Type of antipsychotic medications				
Atypical	23	20.9		
Typical	44	40.0		
Typical and atypical (combination)	40	36.4		
No antipsychotic medications [b]	3	2.7		
Duration of illness (years)			27.0	1.0

[a] Includes widowed, divorced, and separated.
[b] Omitted in regression analysis due to small sample size (n = 3).

Table 2 shows the number of participants who have cognitive impairment based on the severity method and education-corrected cut-off score. The minimum and maximum MMSE score achieved by patients were 11 and 30 respectively and the mean score was 22.2 with a standard deviation of 4.6. According to the severity method of scoring for MMSE, 51 (46.4%) showed no cognitive impairment (scoring above 24), 39 (35.5%) showed mild cognitive impairment (below 24 but above 18), and 20 (18.2%) showed severe cognitive impairment (scoring below 18). However, based on the education-corrected cut-off method of scoring, 92 (83.6%) patients showed presence of cognitive impairment (Table 2) (Feng et al., 2012). Haloperidol (21.8%), risperidone (20.9%), and olanzapine (18.2%) were the three most common antipsychotic medications consumed by participants. 23 (20.9%) were on atypical antipsychotic medications only, 44 (40.0%) on typical antipsychotic medications only, 40 (36.4%) were receiving a combination of atypical and typical antipsychotic medications, while 3 (2.7%) were not on any antipsychotic medication. Duration of illness ranged from 14.1 to 69.8 years, averaging 27.0 years (SE = 1.0).

Table 2
Cognitive impairment according to MMSE scale in patients with schizophrenia or schizoaffective disorders.

Method	Score	Interpretation	n	%	n[a]	%[a]	Mean	Standard deviation
Severity	24–30	No cognitive impairment	51	46.4	18	16.4	22.2	4.6
	18–23	Mild cognitive impairment	39	35.5	92	83.6		
	0–17	Severe cognitive impairment	20	18.2				
		Total	110	100	110	100		

[a] Based on education-corrected MMSE cut-off scores. Education-corrected cut-off classification was based on highest education level attained by participant where cognitive impairment was labelled for those who scored less than 25 with no education, less than 27 with primary education, and less than 29 with secondary and above education Feng et al. (2012).

The socio-demographic factors explained significant portions of the variance in the MMSE score (Adjusted $R^2=14.9\%$; F (12, 94)= 2.547, $p=0.006$; Table 3, Model 1). The overall model was statistically significant where the MMSE score was significantly lower among older patients ($\beta=-0.11$, 95% CI, −0.20, −0.01, $p=0.024$), significantly higher among females ($\beta=3.22$, 95% CI, 0.41, 6.03, $p=0.025$), and those with high education level [vs. low education level] ($\beta=3.44$, 95% CI, 0.71, 6.17, $p=0.014$).

The association of clinical factors and MMSE scores are shown in Table 3, Model 2. The overall model was significant (Adjusted $R^2=17.0\%$, F (6, 97)=4.526, $p<0.001$). The MMSE score was significantly higher among patients with other age of onset [vs. youth-onset schizophrenia] ($\beta=2.53$, 95% CI, 0.37, 4.70, $p=0.022$) and significantly lower with increasing length of hospital stay ($\beta=-0.16$, 95% CI, −0.28, −0.04, $p=0.010$).

Further analysis was conducted to assess whether age of onset and length of hospital stay remained significant in predicting amount of the variance in MMSE score after adjusting for the possible effect of socio-demographic factors. Results of the hierarchical multiple regression partially supported our research hypothesis (Table 3, Model 3). Age of onset was borderline significant ($p=0.051$) while length of hospital stay remained significant in predicting MMSE score ($\beta=-0.14$, 95% CI, −0.27, −0.01, $p=0.035$). The best model for predicting MMSE score was the combination of socio-demographic and clinical factors (Adjusted $R^2=22.5\%$, F (18, 85)=2.659, $p=0.001$). Addition of age at onset, length of hospital stays, type of antipsychotic medication, and duration of illness into the first model, which included only the socio-demographic factors, significantly improved prediction (R^2 change=12.3%, F change=2.718, $p=0.018$).

4. Discussion

In a sample of 110 inpatients with schizophrenia or schizoaffective disorders, this study examined the cognitive impairment and predictive role of socio-demographic and clinical factors in cognitive functioning measured using MMSE. Our results showed support for our first hypothesis where education level predicted the largest amount of variance; followed by age and gender (Kim et al., 2012) (Table 3 model 1) and partial support for our second hypothesis where after adjusting for socio-demographic factors, only length of hospital stay was associated with MMSE scores (Table 3 model 3).

In terms of institutionalised patients with schizophrenia, studies have been conducted on similar populations. Harvey et al. (1997) conducted a study in New York and London and found similar cognitive impairment in long-stay patients with schizophrenia measured using MMSE (Harvey et al., 1997). Furthermore, a study by Diaz et al. (2011) looked into the cognitive performance of long-term institutionalized elderly patients with schizophrenia in Brazil and compared them with institutionalized patients without neurological or psychiatric diseases, matched for age, educational level and institutionalization time. They found worse performance in Cambridge Cognition Examination (CAMCOG) score in institutionalized patients with schizophrenia than among patients without neurological or psychiatric diseases. Lower scores were also reported in MMSE (Diaz et al., 2011).

Our findings also lend support to previous studies which found an association of age and education on MMSE scores. In Table 3 model 1, our study showed associations between age, gender, and education with MMSE scores. In a study conducted with adult participants across all ages, MMSE scores declined with age even after controlling for variables such as education (Crum et al., 1993). MMSE test measures five different cognitive domains which includes orientation and recall. The processing speed theory of cognitive aging suggests that as individuals grow older, the processing speed in memory and spatial ability would be affected and thus cognitive performance would decline (Finkel et al., 2007). Also, it is worth noting that as age increases, it is associated with increasing risk of dementia which would therefore influence the cognitive performance (World Health Organization [WHO], 2014). Despite the risk of dementia increasing with age, a 6 years longitudinal study by Friedman et al. (2001) found different rates of cognitive decline in institutionalized elderly patients with schizophrenia and patients with Alzheimer disease. Greater rate of cognitive decline were found in long-term institutionalized elderly patients with schizophrenia than patients with Alzheimer disease (Friedman et al., 2001).

A recent study conducted by Feng et al. (2012) found positive relationship between the level of education and cognitive performance in Singapore community-dwelling older adults (Feng et al., 2012). Also, in a study conducted in Brazilian sample of 73 elderly institutionalized patients with schizophrenia, there was a significant association between the years of education with MMSE performance. Findings in this study reported that even a low level of formal education has a profound impact on late-life cognition in institutionalized patients with schizophrenia (Vega et al., 2005).

In addition to age and education, gender was also significantly associated with MMSE scores. Some studies reported little to no significant relationship between gender and MMSE scores. Tombaugh and McIntyre (1992) did not find significant differences in MMSE scores between males and females (Tombaugh and McIntyre, 1992). However, other studies saw gender differences in cognitive performance in specific domains (Gallo and Jones, 2002; Royer et al., 1999). In a study conducted using MMSE in community-dwelling adults, females were found to perform slightly faster than males on verbal-processing tasks but made mistakes on serial subtractions (Gallo and Jones, 2002). Possible reason of the gender difference in cognitive performance could be due to brain-derived neurotrophic factor (BDNF). BDNF is a brain protein that may be involved in the pathophysiology of schizophrenia and a study found different level of BDNF between genders in patients with chronic schizophrenia (Zhang et al., 2014).

In the final model (Table 3, Model 3), no significant association was found between age, gender, and education after controlling for clinical factors. Possible underlying mechanism could be due to other factors such as severity of illness and dosage of medication load which may contribute for a larger portion of cognitive decline in patients with schizophrenia (Maltais et al., 2015).

Our study failed to demonstrate any influence of alcohol consumption on MMSE results which is in contrast with existing literature on inpatients with dual diagnosis of schizophrenia and alcohol use disorder (Manning et al., 2009). Possible reasons could be due to the care and conditions in the wards where alcohol consumption is strictly prohibited in patients. These patients are

Table 3
Unstandardized beta coefficient estimates (95% Confidence Interval) representing the hierarchical regression analysis of MMSE scores on clinical factors adjusted for socio-demographic factors.

	Model 1 (Adj R^{2a} = 14.9%)			Model 2 (Adj R^{2a} = 17.0%)			Model 3 (Adj R^{2a} = 22.5%)		
	Beta	95% CI[c]	*p*	Beta	95% CI[c]	*p*	Beta	95% CI[c]	*p*
Characteristics of study sample									
Age, years	−0.11	−0.20, −0.01	**0.024**				−0.06	−0.16, 0.04	0.207
Gender (Female)	3.22	0.41, 6.03	**0.025**				2.65	−0.13, 5.44	0.062
Ethnicity									
Malay vs. Chinese	−0.01	−2.52, 2.49	0.991				−0.18	−2.60, 2.24	0.883
Indian vs. Chinese	−0.73	−4.64, 3.18	0.713				−1.35	−5.16, 2.45	0.482
Marital status									
Single vs. married	1.08	−3.08, 5.23	0.608				1.62	−2.36, 5.59	0.422
Others[b] vs. married	−1.31	−5.84, 3.21	0.566				−0.90	−5.25, 3.46	0.684
Level of Education									
Medium vs. low	0.47	−1.44, 2.37	0.629				0.73	−1.15, 2.61	0.441
High vs. low	3.44	0.71, 6.17	**0.014**				2.48	−0.28, 5.24	0.077
Smoking behaviour									
Ex-smoker vs. non-smoker	1.40	−0.82, 3.63	0.214				0.86	−1.46, 3.18	0.464
Smoker vs. non-smoker	0.39	−3.68, 4.46	0.850				−0.61	−4.64, 3.42	0.765
Alcohol consumption									
More than 12 drinks a year vs. never drank	2.23	−0.49, 4.97	0.107				2.14	−0.47, 4.76	0.107
Less than 12 drinks a year vs. never drank	−0.38	−2.31, 1.56	0.702				−0.29	−2.24, 1.66	0.769
Age of onset									
Other age of onset vs. youth-onset schizophrenia				2.53	0.37, 4.70	**0.022**	2.36	−0.01, 4.74	0.051
Late-onset schizophrenia vs. youth-onset schizophrenia				−1.32	−4.67, 2.03	0.437	−0.74	−4.28, 2.81	0.681
Length of hospital stay, years				−0.16	−0.28, −0.04	**0.010**	−0.14	−0.27, −0.01	**0.035**
Type of antipsychotic medications									
Typical vs. atypical				−1.71	−3.86, 0.45	0.119	−1.31	−3.48, 0.85	0.232
Typical and atypical vs. atypical				0.30	−1.86, 2.46	0.781	−0.48	−2.69, 1.73	0.664
Duration of illness, years				0.01	−0.09, 0.11	0.865	0.04	−0.06, 0.13	0.457

Notes: n = 107 were used for regression analysis.
[a] Adj R^2 = Adjusted R^2.
[b] Includes widowed, divorced, and separated.
[c] CI = confidence interval.

regularly monitored for physical illness with their diet being supervised and exercises planned for them. Secondly, compared to the literature, the patients in our sample were not diagnosed with alcohol use disorder and thus were not influenced by the side-effect of heavy drinking on cognition. Lastly, the consumption of alcohol was measured by self report in our study. Patients may have reported their drinking habits from before they were admitted as inpatients and, thus, their responses recorded may not be an accurate reflection of their actual consumption behaviour.

Our findings lend support to previous studies which found an association of length of hospital stay with MMSE score. Length of hospital stay remained significant in predicting MMSE scores even after adjusting for socio-demographic and other clinical factors. Similar to our findings, other studies did not find significant associations between typical antipsychotic drugs or atypical antipsychotic drugs on cognitive functioning in patients (Nielsen et al., 2015). Furthermore, other studies did not look into the independent association between age of onset with cognitive deficits (Rajji et al., 2009) and duration of illness with MMSE scores after adjusting for socio-demographic factors (Talreja et al., 2013).

Possible underlying mechanisms have been proposed for the inverse relationship between length of hospital stay with MMSE. Length of hospital stay may determine the severity of cognitive impairment in inpatients where patients who have longer stay in hospital tend to have severe psychotic symptoms and thus greater cognitive impairment than those who have shorter stay. Institutional settings are more likely to induce passiveness than community settings (Goffman, 1961; Wing and Brown, 1970). Compared to patients who resided in the community centres, patients residing in psychiatric hospital have a significantly lower score on the Life Skills Profile (LSP), indicating higher disability (Eu et al., 2001). Conversely, it is possible that cognitive impairment may worsen the condition of psychiatric patients, and result in longer periods of hospitalizations (Kato et al., 1995).

Several limitations in our study deserve consideration. Firstly, the sample size was small. There were more males than females, fewer Indians, and married subjects which limited meaningful comparisons between these groups. Secondly, there might be a selection bias in our study. The group was selected based on whether they were able to comprehend and provide written informed consent as well as included only those without any impairment in communication. This might exclude those with severe symptoms, obvious cognitive and language dysfunctions in the study. Including these patients would have enabled us to study in a wider perspective those who are most affected by the psychiatric illness and thus further studies could look into this area of research. Thirdly, we did not employ scales measuring psychopathology such as the Positive and Negative Syndrome Scale (PANSS) or Clinical Global Impression – Schizophrenia (CGI-SCH) scale that measure patients' psychopathology objectively and this can be a confounder of the study (Haro et al., 2003; Kay et al., 1987). Finally, MMSE consists of questions that involve patients to give verbal responses and reading. Therefore, patients who were visually and hearing impaired or with communication disorders may perform poorly even when cognitively able. To reduce the likelihood of such occurrence, magnifying glass and Williams Sound Pocketalker® Ultra System H021 were provided for simple magnification of text and sound.

Despite these limitations, our study draws attention to the significance of length of hospital stay on cognitive performance measured by MMSE in long-stay patients diagnosed with schizophrenia or schizoaffective disorders in Singapore. The recruitment of patients was through referral from the clinicians or nurses who deemed these patients to be suitable to be interviewed. Arguably,

the study sample would be at the highest probability of being discharged by the hospital yet the results of the current study indicate that 92 out of 110 patients (83.6%) have presence of cognitive impairment based on the education-corrected method of scoring. While it is better that patients are reintegrated back into the society, service providers should not overlook the cognitive ability of patients while considering deinstitutionalisation.

Both physical and mental exercises should be considered for people with schizophrenia. At the Institute of Mental Health (Singapore), care and conditions should be continued and maintained. All patients in the hospital are strictly prohibited from smoking and alcohol consumption in the wards, regularly monitored for physical illness, and diet is supervised with exercise programs planned and incorporated into their daily routine. Studies reported that structured exercise especially aerobic exercises have various benefits including improvement in cognitive ability of the patients including reduction of risk for cerebrovascular and cardiovascular disease (Guimarães et al., 2015; Ratey and Loehr, 2011; University of California - Los Angeles, 2016). Mental exercises such as computerised tasks training, performing tasks repetitively, and using new strategies for learning were found to be effective in treating cognitive deficits in patients with schizophrenia (Bowie and Harvey, 2006). Although these training programs can be expensive and labour intensive, these could improve patients' cognition. Cognitive impairments can be used as a predictive tool for the functional ability outcome in schizophrenia (Addington and Barbato, 2012). Together with self-motivation and insight, functional ability is an important determinant of recovery (Walters and Agius, 2014).

In conclusion, the present study demonstrated that socio-demographic factors (i.e. age, gender, and level of education) and clinical factors (i. e. age of onset, and length of hospital stay) were associated with cognition, measured by MMSE – a brief measure of global cognition. Length of hospital stay remained significant in predicting MMSE scores after controlling for socio-demographic factors. Early introduction and sustained delivery of a combination of physical and mental exercises should be considered to improve the cognitive functioning of patients with schizophrenia or schizoaffective disorder.

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Conflict of interest

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