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### ► To cite this version:

Chadia Haddad, Pascale Salameh, Hala Sacre, Jean-Pierre Clément, Benjamin Calvet. The use of the Montreal Cognitive Assessment (MoCA) screening tool to evaluate cognitive deficits in Lebanese in-patients with schizophrenia. *Asian Journal of Psychiatry*, 2022, 70, pp.103029. 10.1016/j.ajp.2022.103029 . hal-03584054

**HAL Id: hal-03584054**

**<https://unilim.hal.science/hal-03584054v1>**

Submitted on 22 Jul 2024

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## **The Use of Montreal Cognitive Assessment (MoCA) Screening Tool to Evaluate Cognitive Deficits in Lebanese In-Patients with Schizophrenia.**

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# **The Use of Montreal Cognitive Assessment (MoCA) Screening Tool to Evaluate Cognitive Deficits in Lebanese In-Patients with Schizophrenia.**

## **Abstract**

### **Background**

The Montreal Cognitive Assessment (MoCA) is a brief cognitive impairment screening tool suitable for a rapid diagnosis of cognitive functioning. The primary objective was to examine the ability of the MoCA to detect cognitive impairment and functioning (autonomy and social cognition) among Lebanese patients with schizophrenia. The secondary objective was to evaluate factors related to cognition.

### **Methods**

A cross-sectional study conducted between July 2019 and Mars 2020 that enrolled 120 in-patients diagnosed with schizophrenia. The MoCA tool and the BACS were used to evaluate the patients' cognitive functioning.

### **Results**

The MoCA adjusted total score was significantly correlated with the BACS total score ( $r = .72, p < .001$ ). The cut-off value of MoCA for detecting mild cognitive impairment was 21, moderate cognitive impairment was 20.50 and severe cognitive impairment was 19.5. The multivariable analysis showed that the MoCA total score and the BACS score resulted in a non-significant association with autonomy. Also, higher cognition (higher BACS) ( $B = .10, p < 0.001$ ) was significantly associated with a higher MoCA total score. However, higher depression ( $B = -.20, p = .01$ ) was significantly associated with lower MoCA. A regression analysis taking the autonomy (ADL scale) as the dependent variable showed that the MoCA total score with the BACS score resulted in a non-significant association of the autonomy ( $p > 0.05$ ).

### **Conclusion**

The Arabic version of the MoCA can be a useful tool for screening cognitive impairment in patients with schizophrenia.

**Key words:** Montreal Cognitive Assessment (MoCA), schizophrenia, social cognition neuropsychological tests, cognitive impairment.

## 1. Introduction

Cognitive deficits are one of the main symptoms of schizophrenia strongly associated with clinical and functional outcomes and occurs over the course of illness and even before the onset of the disease (Elvevag & Goldberg, 2000). Due to its clinical importance, measuring cognitive deficits in schizophrenia patients is well established in clinical settings, where clinicians intend to evaluate the cognitive function daily to improve their treatment plan or for further neurocognitive evaluations or rehabilitation programs (Green & Nuechterlein, 1999).

The gold standard for the detection of cognitive deficit in schizophrenia is using a neuropsychological test battery performed by a trained professional (Hurford, Marder, Keefe, Reise, & Bilder, 2011) such as the MATRICS Consensus Cognitive Battery (Nuechterlein et al., 2008) and the Brief Assessment of Cognition in Schizophrenia (BACS) (Keefe et al., 2004). However, this method is not routinely used, as it is not readily available and feasible in most clinical settings (Hurford et al., 2011). A brief cognitive impairment screening test would be suitable for a busy clinician to enable a rapid diagnosis of cognitive functioning in patients. One of such tools is the Montreal Cognitive Assessment (MoCA). The MoCA is a one-page 30-point test that assesses a broad area of cognitive functions, administered in approximately 10 minutes (Nasreddine et al., 2005). It was initially developed and validated by Nasreddine et al. and was designed to detect mild cognitive impairment in older adults with dementia (Nasreddine et al., 2005), with a sensitivity of 100% and specificity of 87% in detecting mild Alzheimer's disease using a cut-off score of 26 (Nasreddine et al., 2005), and has subsequently been adopted in numerous other settings clinically such as patients with stroke (Copersino et al., 2009; Cumming, Bernhardt, & Linden, 2011), learning disability (Edge, Oyefeso, Evans, & Evans, 2016), sleep disorder (Gagnon, Postuma, Joncas, Desjardins, & Latreille, 2010), substance use disorders (Copersino et al., 2009). Also, MoCA was applicable among patients with severe mental illness (Dautzenberg, Lijmer, & Beekman, 2020; Gierus et al., 2015; Musso, Cohen, Auster, & McGovern, 2014). In addition, the MoCA was validated among 57 outpatients with major depressive disorder and the results of this study showed that the MoCA is reliable and valid for screening neurocognitive deficits in depressed patients (Srisurapanont, Eurviriyankul, Suttajit, & Varnado, 2017).

Three published studies have validated the use of MoCA in patients with schizophrenia (Fisekovic, Memic, & Pasalic, 2012; Ramírez, Saracco-Álvarez, Escamilla-Orozco, & Orellana, 2014; Yang et al., 2018). The first study done by Fisekovic et al. (2012) among 30 patients with schizophrenia reported a moderate positive correlation between the MoCA and

the Mini-Mental State Examination (MMSE) ( $r=0.40$ ) (Fisekovic et al., 2012). The second, conducted by Ramirez et al. (2014) among 100 patients diagnosed with schizophrenia, tested the concurrent validity of MoCA with the MMSE and the cognitive subscale of The Positive and Negative Syndrome Scale (PANSS) (Ramírez et al., 2014); it found a moderate correlation between the MoCA and MMSE ( $r=0.62$ ) and the cognitive subscale of PANSS ( $r=0.55$ ) (Ramírez et al., 2014). The third study done by Yang et al. (2018) among 64 patients with schizophrenia tested the concurrent validity of the MoCA with the BACS and found a moderate correlation ( $r=0.61$ ) (Yang et al., 2018); it also revealed that the MoCA was significantly correlated with functional measures measured by the Brief UCSD Performance-based Skills Assessment (UPSA-B) that examine functional capacity in two areas of everyday functioning – communication and finances ( $r=0.51$ ) (Yang et al., 2018).

Cognitive impairment is closely associated with functional disabilities in patients with schizophrenia (Green, 1996). Indeed, cognitive deficits in schizophrenia interact with different facets of everyday functioning, including independent living and autonomy (Bell & Bryson, 2001; Perlick, Rosenheck, Kaczynski, Bingham, & Collins, 2008; Twamley et al., 2002). Also, several studies have shown the predictive capacity of cognition on functional performance (Harvey & Strassnig, 2012; McClure et al., 2007). Patients with schizophrenia have severe deficiencies in their personal and social functions, leading to difficulties in multiple areas, such as everyday activities, interpersonal and social interactions (Bellack et al., 2007; Couture, Penn, & Roberts, 2006). Also, studies have examined the relationship between cognitive deficits and psychotic symptoms, such as depression, negative, and positive symptoms (J. Addington, Addington, & Maticka-Tyndale, 1991; Huang et al., 2020; Williams et al., 2000; Zhu et al., 2019), using a wide variety of neurocognitive tests. Findings revealed that positive and negative symptoms are associated with different patterns of cognitive deficits (Frith, Leary, Cahill, & Johnstone, 1991; Liddle & Morris, 1991; O'Leary et al., 2000). Moreover, depressive symptoms are also correlated with cognitive deficits, particularly attention and working memory (Williams et al., 2000). People with major depression has a negative effect, such as persistent fatigue, psychomotor retardation, demotivation, and mood disturbances, which impacts their abilities to perform neuropsychological tests.

Few studies have evaluated the validity of MoCA in the Arab countries (Benabdeljlil, Azdad, & Mustapha, 2017; Rahman & El Gaafary, 2009; Saleh et al., 2019). The Arabic version of MoCA was translated by Nasreddine (Nasreddine et al., 2005). In Lebanon, the original MoCA Arabic version is not commonly used in psychiatric illness, therefore, not undergone any form of adaptation in this population. A recent research done by Hayek et al. among 164

older adults presented normative information on MoCA in Lebanon (Hayek, Tarabey, Abou-Mrad, Fadel, & Abou-Mrad, 2020a). However, to the best of our knowledge, no study has validated the Arabic MoCA among patients with schizophrenia in Lebanon to date. It is essential to validate the MoCA in specific populations, such as patients with schizophrenia, as these may present different characteristics than older persons, which may influence the test characteristics. There is also a need for a rapid screening test for the evaluation of cognitive function in schizophrenia. Therefore, the primary objective of this study was to examine the ability of the MoCA as a screening tool to detect cognitive impairment among Lebanese patients with schizophrenia. The validity of the MOCA tool was evaluated by a concurrent validity with the BACS battery and a construct validity of the tool was performed in the group of patients with schizophrenia hospitalized in a psychiatric hospital. The secondary objective was to evaluate factors such as clinical symptoms, depression and autonomy related to MoCA performance.

## **2. Material and methods**

### **2.1. Study design and participants**

A cross-sectional study conducted between July 2019 and Mars 2020 at the Psychiatric Hospital of the Cross-Lebanon (HPC) enrolled 120 in-patients diagnosed with schizophrenia. Patients included had to meet the following inclusion criteria: age between 18-60 years, educational level of more than five years, meeting the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) criteria for schizophrenia, patients in the remission phase, receiving antipsychotic medication, and being clinically stable. Exclusion criteria included brain trauma, neurological problem, or current substance use disorder that would influence cognitive performance. This study is an independent study from a large project that used the same method previously applied (Haddad, Salameh, Hallit, Obeid, et al., 2021).

### **2.2. Ethics approval and consent to participate**

The Ethics and Research Committee at the Psychiatric Hospital of the Cross approved this study (HPC-024-2018) in compliance with the Hospital's Regulatory Research Protocol. The purpose and requirement of the study were explained to each participant. All study participants, or their legal guardian, provided informed written consent prior to study enrollment.

### **2.3.Procedure**

The sample was selected from a list generated by the hospital's software. Out of 180 patients meeting the inclusion criteria, 120 patients were enrolled, and 60 were excluded (40 males and 20 females). Excluded were those who refused to participate (22), left the hospital (21), refused to continue the assessment (13), and had difficulty in performing the cognitive tests (4). Those who agreed to participate received no financial compensation in exchange for their participation. Well-trained, study-independent personnel collected the data through personal interviews with the patients.

### **2.4.Measures**

A case record form was used in Arabic language, the native language in Lebanon. The first part assessed the sociodemographic and clinical characteristics of the participants, including age, gender, education level, marital status, monthly income, family history of mental disorders, types of schizophrenia, length of hospitalization, duration of illness, and the number of hospitalizations.

The second part included the following measures:

#### ***The Montreal Cognitive Assessment scale (MoCA)***

The Arabic version of the MoCA test was used in this study (MONTREAL COGNITIVE ASSESSMENT). This one-page 30-point test assesses various cognitive domains, including the short term memory recall task, visuospatial abilities, executive function, naming, attention, concentration, working memory, language, abstract reasoning, and orientation (Nasreddine et al., 2005). The administration time takes 5-10 minutes. The total score ranges from 0 to 30, with a score of 26 or greater indicating "normal" cognitive functioning (Nasreddine et al., 2005). The MoCA total score takes into account the years of education; the total score of individuals who completed 12 years or less are adjusted by adding 1 point, as suggested in the MoCA manual (Nasreddine et al., 2005). The Cronbach's alpha value was .80.

#### ***The Brief Assessment of Cognition in Schizophrenia (BACS)***

The BACS recently validated in Lebanon (Haddad, Salameh, Hallit, Obeid, et al., 2021) is a neuropsychological tool used to evaluate cognitive functioning in patients with schizophrenia (Keefe et al., 2004). It consists of six subscales, including list learning (verbal memory), digit sequencing (working memory), token motor task (psychomotor function), Semantic Fluency (verbal fluency), Symbol Coding (Attention and speed of information processing), and Tower of London (executive function) (Keefe et al., 2004). The Cronbach's alpha value was .85.

#### ***The Positive and Negative Syndrome Scale (PANSS)***

The Positive and Negative Syndrome Scale (PANSS), validated in Arabic (Hallit, Obeid, Haddad, Kazour, & Kazour, 2017), is a 30-item questionnaire, organized into three subscales: positive symptoms (7 items), negative symptoms (7 items) and general psychopathology (16 items) (Kay, Fiszbein, & Opler, 1987). All items are scored from 1 (absence of symptoms) to 7 (extremely severe symptoms) (Kay et al., 1987). The total score was calculated by summing all the answers, with higher scores indicating more severe symptoms (Kay et al., 1987). The Cronbach's alpha values were as follows: .68 (total score), .77 (positive symptoms), .78 (negative symptoms), and .84 (general psychopathology).

#### ***Activities of Daily Living (ADL)***

The ADL is a 6-item scale that assesses overall functional activity in: 1) bathing, 2) dressing, 3) going to toilet, 4) transferring (movement), 5) continence, and 6) feeding (Katz, 1963). The Arabic version of the scale was validated by Nasser and Doumit in a sample of Lebanese elderly living in nursing homes (Nasser & Doumit, 2009). In the Arabic version, the six components are scored 0, .5, or 1. The total ADL score ranges from 0 to 6, where 6 entails complete independence and 0 complete dependence. The total mean percentage score was calculated by summing the scores on the 6 items, dividing by 6, then multiplying by 100. A score of 0–33 indicated “severe dependence”, 34–66 indicated “moderate dependence”, and a score of 66 or above indicated “no to mild dependence”. The Cronbach's alpha value was 0.684.

#### ***Calgary Depression Scale for Schizophrenia (CDSS)***

The CDSS is a nine-item structured interview scale developed by Addington et al. to assess depression in schizophrenics. Eight structured questions assess depression, hopelessness, self-depreciation, guilty ideas of reference, pathological guilt, morning depression, early wakening, and suicide, followed by one observation item (observed depression). Higher scores represent a greater level of depression (D. Addington, Addington, & Maticka-Tyndale, 1993). The Cronbach's alpha value was .84.

### **2.5.Data analysis**

Data analysis was done using the Statistical package for the social sciences (SPSS) software version 25. In this study, the MoCA total scores were adjusted for years of education. No missing values in the database. A descriptive analysis was performed where categorical variables were expressed as absolute frequencies and percentages and quantitative variables as means and standard deviations.



Analyses were conducted in five steps. First, the construct validity of the MoCA scores was assessed using the principal component analysis. Kaiser-Meyer-Olkin measure of sampling adequacy and Bartlett's test of sphericity were calculated to ensure the model's adequacy. Factors with eigenvalues values greater than one were retained and the scree plot method was used for determining the number of components to extract (Kanyongo, 2005). Only items with factor loading greater than 0.4 were considered (Ellis, 2017). Moreover, the reliability of the MoCA was assessed using Cronbach's alpha. A confirmatory factor analysis (CFA) was also done, the Chi-square ratio was measured to the degrees of freedom, with ratios greater than 3 suggesting poor fit (Byrne, 2012). The comparative fit index (CFI) and the root mean square error of approximation (RMSEA) were used to evaluate the goodness-of-fit of the model (Byrne, 2012). RMSEA values  $\leq 0.08$  or CFI values  $> 0.90$  indicate a good-fitting model (Byrne, 2012).

Second, the Pearson correlation was used for linear correlation between MOCA and BACS and their subscales. Third, Receiver Operating Characteristic (ROC) curve analysis was performed to evaluate the diagnostic performance of MoCA in the detection of mild, moderate, and severe cognitive impairments; Area under the Curve (AUC), sensitivity, and specificity were calculated on MoCA cut-off scores. The ROC curve analysis of the MoCA was based on the BACS composite score (z-score) calculated by averaging the total score from the mean total score of the BACS of a healthy control group (Haddad C, 2020). The mild, moderate, and severe z-scores of the BACS were defined as follows: mild cognitive impairment [-2.0;-1.5], moderate cognitive impairment [-3.0;-2.0], and severe cognitive impairment lower than -3.0. Pearson correlations were employed to investigate relationships between MoCA performance, age, autonomy, depression, and social cognition. The Student t-test was used to examine the effect of gender on the MoCA total score, and the ANOVA F test to examine the effect of education level on the MoCA total score. Lastly, linear regression modeling using the forward method was employed to examine the factors related to MoCA. In addition, a linear regression modeling using the forward method was employed to examine the additional variance MoCA or BACS had in predicting ADL (autonomy) score. Significance was set at a  $p < .05$ .

### **3. Results**

#### **3.1.Sociodemographic characteristics**

Table 1 summarizes the sociodemographic characteristics of the participants. The mean age of schizophrenia patients was  $48.4 \pm 7.6$  years, with 59.2% males. The majority (81.7%) were single, with low monthly income (53.3%), 50% had a secondary level of education, and 35.3% had a family history of psychiatric disease. Half of the sample have severe cognitive impairment as defined by the BACS (50%). The mean lengths of illness and hospitalization were  $20.6 \pm 12.4$  and  $12.4 \pm 8.5$  years, respectively. The mean number of hospitalization was  $6.3 \pm 5.65$  times. The mean total PANSS score was  $82.88 \pm 27.05$ , the mean depression was  $5.39 \pm 5.19$  and the mean autonomy was  $5.68 \pm 0.71$ .

**Table 1: Sociodemographic and clinical characteristics of the studied sample (N=120)**

	Frequency (%)
<b>Gender</b>	
Male	71 (59.2%)
Female	49 (40.8%)
<b>Education level</b>	
Complementary	41 (34.2%)
Secondary	60 (50.0%)
University	19 (15.8%)
<b>Marital Status</b>	
Single	98 (81.7%)
Married	10 (8.3%)
Divorced	10 (8.3%)
Widowed	2 (1.7%)
<b>Monthly income</b>	
No income	27 (22.5%)
< 1000 \$	64 (53.3%)
1000 - 2000 \$	27 (22.5%)
> 2000 \$	2 (1.7%)
<b>Family history of psychiatric illness</b>	
Yes	42 (35.3%)
No	77 (64.7%)
<b>Cognitive impairment defined by the BACS</b>	
Normal	16 (13.3%)
Mild	12 (10.0%)
Moderate	32 (26.7%)
Severe	60 (50.0%)
	<b>Mean <math>\pm</math> SD</b>
<b>Duration of hospitalization in years</b>	12.47 $\pm$ 8.56
<b>Duration of illness in years</b>	20.64 $\pm$ 9.79
<b>Number of hospitalization</b>	6.32 $\pm$ 5.65
<b>Age in years</b>	48.43 $\pm$ 7.62
<b>Total PANSS score</b>	82.88 $\pm$ 27.05
Positive PANSS score	19.92 $\pm$ 9.49
Negative PANSS score	17.47 $\pm$ 7.95
General psychopathology PANSS score	45.48 $\pm$ 16.79
<b>Autonomy (Total ADL)</b>	5.68 $\pm$ 0.71

### 3.2. Description of the MoCA and BACS score

Table 2 describes the mean MoCA and BACS tests and subtests among the participants. The mean MoCA total score was  $16.0 \pm 6.7$ , with the highest mean found for the orientation ( $M=4.3$ ,  $SD= 2.0$ ) and attention subtests ( $M=3.3$ ,  $SD=1.9$ ). The mean BACS total score was  $109.9 \pm 47.2$ , with the highest mean found for motor speed ( $M=35.7$ ,  $SD=15.0$ ).

**Table 2 : Description of MoCA and the BACS**

	Mean ± SD
<b>MoCA score total</b>	<b>16.0 ± 6.7</b>
Visuospatial/ executive	1.8 ± 1.6
Naming	2.4 ± 0.9
Attention	3.3 ± 1.9
Language	1.1 ± 0.9
Abstraction	0.8 ± 0.8
Delayed recall	1.5 ± 1.5
Orientation	4.3 ± 2.0
<b>BACS score total</b>	<b>109.9 ± 47.2</b>
Verbal memory (List learning)	20.9 ± 9.6
Working memory (Digit sequencing)	10.6 ± 5.5
Motor speed (Token motor task)	35.7 ± 15.0
Verbal fluency (Semantic, alphabetical)	20.4 ± 9.2
Attention and speed of information processing (Symbol coding)	12.2 ± 12.4
Executive function (Tower of London)	9.9 ± 7.7

MoCA: The Montreal Cognitive Assessment scale, BACS: The Brief Assessment of Cognition in Schizophrenia

### 3.3. Factor analysis of the MoCA

Among the schizophrenia sample, a factor analysis was run to test the construct validity of the MoCA. All items of the MoCA test could be extracted from the list, and the scale converged on a 1-factor solution using the promax rotated matrix with an eigenvalue greater than 1, accounting for 47.4 percent of the variance (Bartlett sphericity test  $p < .001$ ,  $KMO = .831$ ). In addition, for the entire test, a high Cronbach's alpha was found (0.79) (Table 3). The results of the CFA analysis showed that the fit indices were as follows: the Maximum Likelihood Chi-Square = 40.72 and Degrees of Freedom = 35, a  $\chi^2/df = 1.16$ . For non-centrality fit indices, the Steiger-Lind RMSEA was 0.053 [0.001–0.11] and the CFI was equal to 0.956.

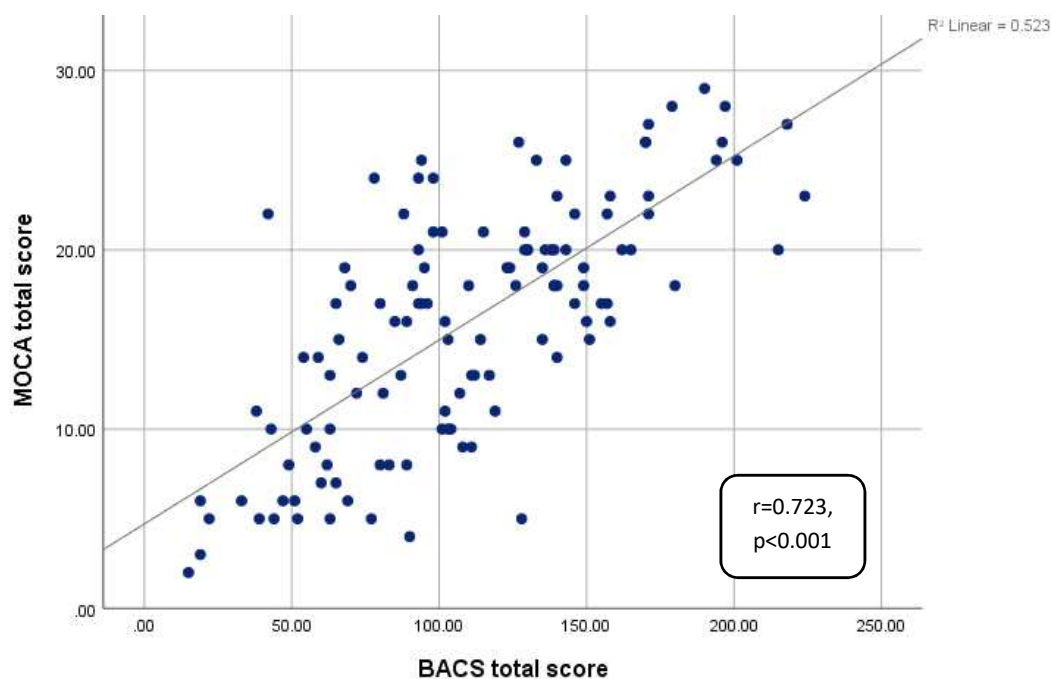
**Table 3: Factor loading of MoCA in patients with schizophrenia**

	Factor 1
Attention	.83
Visuospatial/ executive	.73

Orientation	.70
Language	.68
Delayed recall	.67
Naming	.60
Abstraction	.58
<b>Cronbach's alpha</b>	<b>.80</b>
<b>Percentage of variances explained</b>	<b>47.40%</b>

### 3.4. Correlations between MoCA and BACS measures

Table 4 shows the correlations between the MoCA test and BACS measures. A significant positive correlation was found between the BACS total score and the adjusted MOCA total score ( $r=0.723$ ,  $p<0.001$ ) (Figure 1). Also, the six BACS subscales were significantly associated with the MoCA adjusted total score including verbal memory ( $r =.56$ ,  $p < .001$ ), working memory ( $r=.68$ ,  $p < .001$ ), motor speed ( $r=.50$ ,  $p<0.001$ ), verbal fluency ( $r=.64$ ,  $p < .001$ ), symbol coding ( $r = .55$ ,  $p < .001$ ), and Tower of London ( $r =.61$ ,  $p < .001$ ) (Figure 1).



**Figure 1:** Correlation between the “Montreal Cognitive Assessment scale (MoCA)” and “the Brief Assessment of Cognition in Schizophrenia (BACS)” total score.

**Table 4: Pearson correlation between the MoCA and BACS**

	MoCA total score	Visuospatial/executive	Naming	Attention	Language	Abstraction	Delayed recall	Orientation
<b>BACS (score globale)</b>	.72 <sup>b</sup>	.59 <sup>b</sup>	.48 <sup>b</sup>	.59 <sup>b</sup>	.56 <sup>b</sup>	.44 <sup>b</sup>	.40 <sup>b</sup>	.52 <sup>b</sup>
<b>Verbal memory (List learning)</b>	.56 <sup>b</sup>	.40 <sup>b</sup>	.31 <sup>b</sup>	.40 <sup>b</sup>	.41 <sup>b</sup>	.34 <sup>b</sup>	.40 <sup>b</sup>	.45 <sup>b</sup>
<b>Working memory (Digit sequencing)</b>	.68 <sup>b</sup>	.56 <sup>b</sup>	.47 <sup>b</sup>	.59 <sup>b</sup>	.55 <sup>b</sup>	.43 <sup>b</sup>	.39 <sup>b</sup>	.44 <sup>b</sup>
<b>Motor speed (Token motor task)</b>	.50 <sup>b</sup>	.35 <sup>b</sup>	.43 <sup>b</sup>	.39 <sup>b</sup>	.31 <sup>b</sup>	.27 <sup>b</sup>	.23 <sup>a</sup>	.37 <sup>b</sup>
<b>Verbal fluency (Semantic, alphabetical)</b>	.65 <sup>b</sup>	.51 <sup>b</sup>	.38 <sup>b</sup>	.52 <sup>b</sup>	.54 <sup>b</sup>	.37 <sup>b</sup>	.41 <sup>b</sup>	.51 <sup>b</sup>
<b>Attention and speed of information processing (Symbol coding)</b>	.55 <sup>b</sup>	.56 <sup>b</sup>	.33 <sup>b</sup>	.43 <sup>b</sup>	.50 <sup>b</sup>	.41 <sup>b</sup>	.27 <sup>b</sup>	.33 <sup>b</sup>
<b>Executive function (Tower of London)</b>	.61 <sup>b</sup>	.51 <sup>b</sup>	.42 <sup>b</sup>	.61 <sup>b</sup>	.46 <sup>b</sup>	.34 <sup>b</sup>	.33 <sup>b</sup>	.35 <sup>b</sup>

<sup>a</sup>p<0.05; <sup>b</sup>p<0.01. MoCA: The Montreal Cognitive Assessment scale, BACS: The Brief Assessment of Cognition in Schizophrenia.

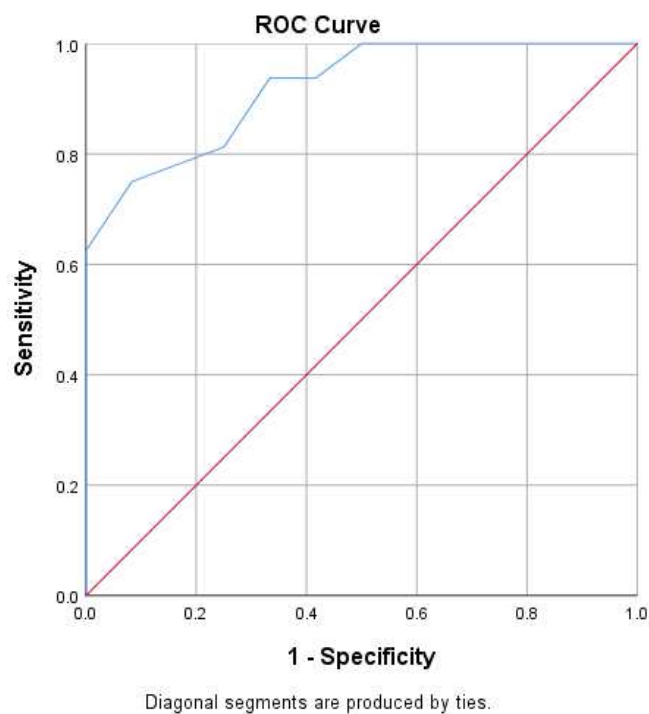
### 3.5.ROC analysis

The MoCA values in the detection of cognitive impairments were as follows:

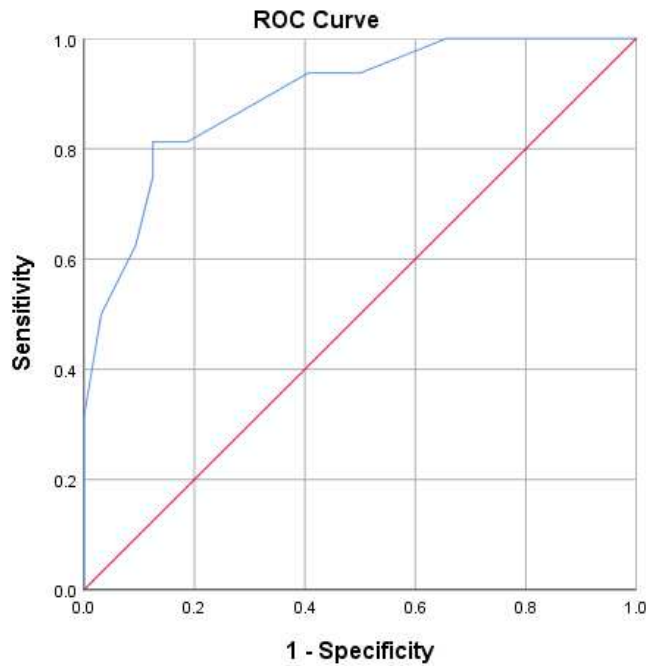
Mild cognitive impairments (Figure 2): AUC = .919 (95% CI = .823–1.000,  $p < .001$ ); optimal cut-off score = 21; sensitivity = .81; specificity = .75.

Moderate cognitive impairments (Figure 3): AUC = .895 (95% CI = .801–.989,  $p < .001$ ); optimal cut-off score = 20.5; sensitivity = .81; specificity = .81.

Severe cognitive impairments (Figure 4): AUC = .955 (95% CI = .913–.998,  $p < .001$ ); optimal cut-off score = 19.5; sensitivity = .93; specificity = .85.

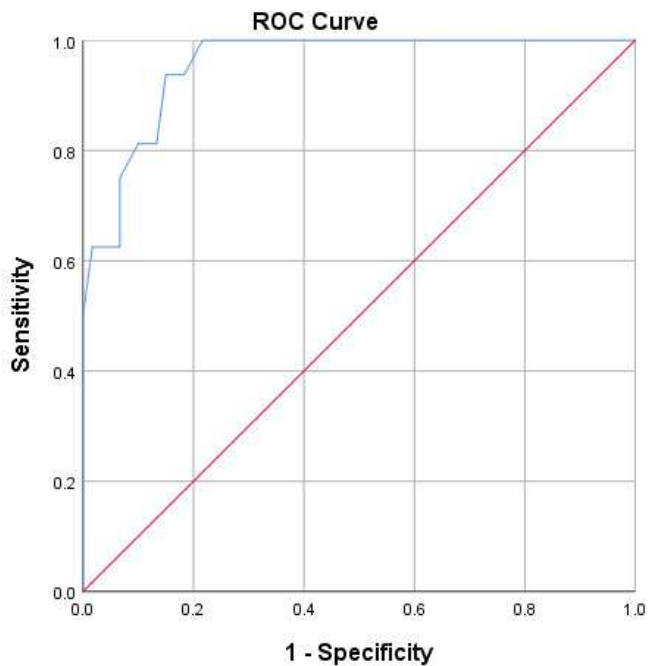


**Figure 2:** ROC curve of the MoCA for the predicted probability for being having either a mild cognitive impairment or a normal cognitive function. Area under the curve = 0.919 [0.823–1.000] ( $P < 0.001$ ); at value = 21.00, Se = 81.3% and Sp = 75.0%.



Diagonal segments are produced by ties.

**Figure 3:** ROC curve of the MoCA for the predicted probability for being having either a moderate cognitive impairment or a normal cognitive function. Area under the curve = 0.895 [0.801–0.989] ( $P < 0.001$ ); at value = 20.50, Se = 81.3% and Sp = 81.2%.



Diagonal segments are produced by ties.

**Figure 4:** ROC curve of the MoCA for the predicted probability for being having either a severe cognitive impairment or a normal cognitive function. Area under the curve = 0.955 [0.913–0.998] ( $P < 0.001$ ); at value = 19.50, Se = 93.8% and Sp = 85.0%.

### 3.6. Correlation between the MoCA and quantitative variables

A higher total PANSS score ( $r=-.27$ ,  $p = .003$ ), higher general psychopathology PANSS subscale ( $r=-.35$ ,  $p<0.001$ ), higher social cognitive complaint ( $r=-.38$ ,  $p<.001$ ), and higher duration of illness ( $r=-.18$ ,  $p=.04$ ) were significantly associated with lower cognition (lower MoCA score). A higher autonomy (higher ADL score) ( $r=.26$ ,  $p = .004$ ) score was significantly associated with higher cognition (higher MoCA score) (Table 5). MoCA total score was not correlated with age ( $p = .55$ ) and gender ( $p = .27$ ); however, a significant association was found with education level ( $p = .01$ ).

**Table 5: Pearson correlation between the MOCA and the quantitative variables**

	MOCA total score	
	Correlation coefficient	p-value
<b>Age</b>	-.05	.55
<b>Duration of hospitalization in years</b>	-.11	.25
<b>Duration of illness in years</b>	-.18	<b>.04</b>
<b>Number of hospitalization</b>	-.15	.09
<b>Total PANSS score</b>	-.27	<b>.003</b>
Positive PANSS score	-.05	.58
Negative PANSS score	-.12	.18
General psychopathology PANSS score	-.35	<b>&lt;.001</b>
<b>Autonomy (Total ADL)</b>	.26	<b>.004</b>
<b>Depression</b>	-.17	.06

MoCA: Montreal Cognitive Assessment scale, PANSS: Positive and Negative Syndrome Scale, ACSO: Self-Assessment of Social Cognition Impairments, ADL: Activities of Daily Living.

### 3.7. Regression analysis

Two Linear regression models were used to evaluate factors related to autonomy (ADL scale) and cognition (MoCA scale) (Table 6).

In the first analysis, taking the ADL score as the dependent variable, the BACS total score was introduced in the first model, and the results showed that higher cognition (higher BACS) ( $B = .06$ ,  $p = .01$ ) was significantly associated with higher autonomy (higher ADL score) (Table 6, Analysis 1, Model 1). In the second regression model, MoCA was significantly associated with autonomy ( $B = .48$ ,  $p = .004$ ) (Table 6, Analysis 1, Model 2). In model 3, the addition of the MoCA total score with the BACS score resulted in a non-significant association of the two tests with autonomy (Table 6, Analysis 1, Model 3).



In the second analysis, the MoCA was considered as dependent variable and the results showed that higher cognition (higher BACS) ( $B = .09$ ,  $p < .001$ ) was significantly associated with a higher MoCA total score. However, higher depression ( $B = -.18$ ,  $p = .02$ ) and higher total PANSS score ( $B = -.04$ ,  $p = .01$ ) were significantly associated with lower MoCA (Table 6, Analysis 2).

**Table 6 : Multivariable analysis**

**Analysis 1: Linear regression analysis taking the autonomy scale (ADL scale) as the dependent variable.**

		Unstandardized Beta	Standardized beta	p-value	Confidence interval	
					Lower	Upper
<b>Model 1</b>						
BACS score	total	.06	.25	.01	.01	.11
<b>Model 2</b>						
MoCA		.48	.27	.004	.15	.80
<b>Model 3</b>						
BACS score	total	.02	.10	.45	-.04	.09
MoCA		.35	.20	.13	-.10	.82

Adjusted R square: in model 1: .035, in model 2: .050, in model 3: .046

Variables entered: gender, BACS total score and MOCA total score.

**Analysis 2: Linear regression analysis taking the Montreal Cognitive Assessment scale (MoCA) as the dependent variable.**

	Unstandardized Beta	Standardized beta	p-value	Confidence interval	
				Lower	Upper
<b>BACS total score</b>	.098	.690	<.001	.080	.115
<b>Total PANSS score</b>	-.038	-.154	.016	-.069	-.007
<b>Depression scale</b>	-.182	-.142	.024	-.340	-.024

Adjusted R square: .555

Variables entered: age, gender, education level, BACS total score, depression, autonomy, Total PANSS score, and duration of illness.

#### 4. Discussion

The purpose of the current study was to evaluate whether the MoCA can detect cognitive deficits in patients with schizophrenia. Overall, the results support the use of the MoCA for understanding neurocognitive deficits in patients with schizophrenia. There were four notable findings from this study. The MoCA demonstrated adequate concurrent validity, good ability in detecting mild to severe cognitive impairments in patients with schizophrenia, good reliability with one-factor structure, and it was associated with the severity of psychotic and depressive symptoms.

The MoCA demonstrated adequate concurrent validity as a cognitive screening tool as our results showed a moderate agreement between the MoCA and the BACS composite score and the six of its subscales. The lowest correlation was found between the MoCA and the token motor task. The significant associations found in our study may be due to the wide overlap of the cognitive domains tested on both measures, such as verbal memory, executive function, verbal fluency, and working memory. The fact that MoCA does not measure the psychomotor functioning of a domain, measured mainly by the BACS, could explain the low correlation between the MoCA and the token motor task. Our findings are consistent with those of Yang et al. (2018), showing a significant correlation between the MoCA and BACS among 64 patients with schizophrenia, but no significant association was found between the MoCA and the token motor task (Yang et al., 2018). Oppositely, a study done by Musso et al. (2014) among 28 patients with severe mental illness found no significant correlation between the MoCA and BACS scores (Musso et al., 2014). The inconsistency between studies may be attributable to the size differences, the type, and the demographic characteristics of the research sample. Also, our results showed an adequate concurrent validity with the general psychopathology PANSS subscale, consistent with those of Ramírez et al. (2014), reporting a moderate correlation between the MoCA and the cognitive subscale of the PANSS among 100 patients with schizophrenia ( $r = 0.55$ ;  $p < 0.001$ ) (Ramírez et al., 2014). In patients with schizophrenia, the severity of the syndromic framework is not stable with time; thus, even though sufficient concurrent validity is found between the cognitive subscale of PANSS and MoCA, it is essential to assess whether the MoCA is as susceptible as PANSS to cognitive changes observed over the course of the disease.

Our results suggest that the MoCA may be a suitable screening tool for mild, moderate, and severe cognitive impairments in schizophrenia, with an optimal MoCA cut-off score  $< 21$  in detecting mild impairments,  $< 20.5$  moderate impairment and  $< 19.5$  in detecting severe

impairments. Our values were lower than those reported by Yang et al. (2018), where the score for detecting mild impairment was  $<25$  and that for severe impairment was  $<23$  [16]. However, our results are in agreement with those of other studies, reporting lower cut-off scores than the recommended one  $<26$  (Damian et al., 2011; Rossetti, Lacritz, Cullum, & Weiner, 2011). In Egypt, a study evaluating the validity of the MoCA among 205 elderly people with neurocognitive disorders found that the cut-off was 21/22, with a sensitivity of 92.5% and specificity of 98.2% for detecting mild neurocognitive disorders, and 16/17 with a sensitivity of 90.7% and specificity of 97.4% for detecting major neurocognitive disorders (Saleh et al., 2019). Another study among 164 older Lebanese adults without cognitive complaints found that the MoCA value fell at or below an observed score of 21 (Abou-Mrad et al., 2017). The fact that the majority of selected patients have a cognitive disability due to their extended institutionalization could explain the low cut-off score reported in our results. Future cohort studies are needed in the schizophrenia population to detect accurately the cut-off value of MoCA that discriminates between mild to severe cognitive impairment in patients with schizophrenia.

The reliability of MoCA reflected by a Cronbach's alpha value of 0.80 demonstrates that the scale was reliable for detecting cognitive impairment in patients with schizophrenia, consistent with the results of Ramírez et al. (2014), showing a Cronbach's alpha of 0.70 (Ramírez et al., 2014), and those of a recent study by Dautzenberg et al. (2020) among 710 psychiatric outpatients, where Cronbach's alpha was 0.761 (Dautzenberg et al., 2020). Further studies are needed in the Arab countries to evaluate the MoCA as a screening tool in schizophrenia patients, in terms of internal consistency, validity, and reliability, in the absence of data about cognitive impairment among this population.

The regression analysis showed that higher depression and higher psychotic symptoms were significantly associated with lower cognition, in line with previous studies (Forsell, Jorm, & Winblad, 1994; Martín-Santiago et al., 2016; O'Leary et al., 2000; Perini et al., 2019; Stoudemire, Hill, Morris, & Dalton, 1995). A Lebanese study done among 120 patients with schizophrenia have found that depression was related to self-report social cognition complaint (Haddad, Salameh, Hallit, Sacre, et al., 2021). It is well known that patients with schizophrenia exhibit a wide range of clinical symptoms, including hallucinations and delusions, incoherence in thinking and language, as well as irregularities in emotional expression, social interaction, and volition (O'Leary et al., 2000). As clinical symptoms are linked to anomalies in brain systems, these symptoms could overlap with components of networks that produce cognitive functions (O'Leary et al., 2000). Evidence suggest that

psychotic symptom among patients with schizophrenia is associated with a broad impairment of cognitive function. Moreover, depression is related to poor performance on cognitive tests as there is a lack of motivation and commitment in performing the task. Also, person with depressive symptoms may have negative feelings such sadness and feeling down for long periods of time; losing their energy and interest in things (Perini et al., 2019). These symptoms can affective their ability to think well, concentrate and could impair their cognitive function (Perini et al., 2019).

Regarding the relation between the MoCA and the sociodemographic parameters, the results showed that the total score of the MoCA steadily increases with the educational level, even with adding a single point at the end of the test, whereas age and gender were not relevant, consistent with previous studies, showing that age and gender did not affect the MoCA score (Bernstein, Lacritz, Barlow, Weiner, & DeFina, 2011; Luis, Keegan, & Mullan, 2009; Wu, Dagg, & Molgat, 2014; Yang et al., 2018). As for the education, some studies found that the relationship with the MoCA was not significant (Musso et al., 2014; Yang et al., 2018), while others reported a significant effect (Bernstein et al., 2011; Rossetti et al., 2011; Wu et al., 2014). A study by Hayek et al. (2020) using the MoCA to evaluate the cognitive function in a sample of 164 Lebanese older people from the general population found that educational level affected subjects' performance, while age did not seem to influence the total MoCA score (Hayek, Tarabey, Abou-Mrad, Fadel, & Abou-Mrad, 2020b). The explanation could be that in younger individuals, as in our sample, the MoCA domains such as spatial orientation and visuospatial capacities are not affected by age, unlike attention, episodic, and working memory (Calso, Besnard, & Allain, 2016). Also, higher education may sets an individual up for a lifetime of advantageous experiences (occupation and leisure activities, higher income, better quality neighborhoods) that have an impact on enhancing cognition (Zahodne, Stern, & Manly, 2015).

### **Limitation and Strength**

Our study has several limitations. The population consists of chronically hospitalized patients whose cognitive function might be severely impaired (Mathews, Arnold, & Epperson, 2014), which may create selection bias. Also, a modest sample size limits the generalizability of the results. Information bias might have occurred since accurate details could not be provided from participants in the face-to-face interview. Test-retest validity of the MoCA and other forms of validity such as face validity were not performed. The MoCA could not be

administered to illiterate participants as some of the subtests require literacy. Also, the MoCA was not intended to evaluate schizophrenia's particular cognitive deficits since schizophrenia has also been associated with impaired verbal learning and processing speed deficits. Minor changes to the current administration and scoring can be made to integrate new domains for an extended testing period. No scale has been used in the study that measured the functional outcome. Residual confounding bias could occur since there could be factors related to cognition that have not been tested. As the main strength of this study is the first one in the Arab countries that have used a brief cognitive screening tool to assess cognition among patients with schizophrenia. Also, the MoCA used in this study was already translated and validated into Arabic language. Although the sample size was not large enough however it was sufficient to detect a clinically meaningful results.

### **Conclusion**

The Arabic version of the MoCA can be a useful tool for screening cognitive impairment in patients with schizophrenia. In Lebanon, the use of a screening tool such as the MoCA to evaluate the cognitive function in patients with schizophrenia is rare. Thus, our findings could help clinicians apply this validated rapid instrument in their daily clinical practice and include cognitive rehabilitation strategies in the treatment plan of patients with schizophrenia.

Further studies are warranted to examine other aspects of reliability, validity, and cut-off of the Arabic MoCA to confirm our results.

### **List of abbreviations**

BACS: Brief Assessment of Cognition in Schizophrenia, MOCA: Montreal Cognitive Assessment, HPC: Hospital of the Cross-Lebanon, B: Unstandardized Beta, MMSE: Mini-Mental State Examination, PANSS: The Positive and Negative Syndrome Scale, DSM-5: Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition; ADL: Activities of Daily Living; ACSO: Self-Assessment of Social Cognition Impairments; CDSS: Calgary Depression Scale for Schizophrenia; SPSS: Statistical package for the social sciences; ROC: Receiver Operating Characteristic; AUC: Area Under the Curve.

### **DECLARATIONS**

**Consent for publication**

Not applicable.

**Availability of data and materials**

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

**Competing interests**

The authors declare that they have no competing interests.

**Funding**

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

**Author contributions:** JPC and BC designed the study; CH participated in the acquisition, analysis, and interpretation of the data, and drafted the initial manuscript; PS, HS and BC assisted in drafting the article and critically revised it for important intellectual content. All the authors approved the final version of the article.

**Acknowledgements**

This work was supported by the Psychiatric Hospital of the Cross – Lebanon (HPC), the Psychiatric hospital center in Limoges (CH Esquirol) and the UMR INSERM 1094 Limoges – France. The authors would like to thank Vanessa Mortada and Layale Hanna, who helped recruit participants and the people (patients and employees) who participated in this study. The authors would also like to thank Ms. Pamela Sharman that helped in revising the paper for English language.

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