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## **General Description of Cognitive Deficits in Schizophrenia and Assessment Tools in Lebanon: A Scoping Review**

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## **ABSTRACT**

Many cognitive functions are affected in schizophrenia patients, particularly memory, attention, motor skills, executive function, and social cognition. Cognitive assessment is one of the best indicators of the functional and social prognosis of schizophrenic patients. In Lebanon, no study has yet examined the assessment of cognitive functions in patients with neurological or psychiatric diseases in Lebanon. This review aims to provide an overview of the cognitive profiles of schizophrenia and describe the different cognitive tests used in Lebanon. The MEDLINE/PubMed database was used to conduct a literature review covering all studies related to cognition in psychosis patients from 1990 until March 2021. This screening resulted in 97 articles focused on cognition in psychiatric patients or cognitive tests in schizophrenia and required an in-depth analysis. The majority of measures developed to evaluate cognition in patients with schizophrenia were from Western countries, most of which are long and complex and may require several hours to administer. The number of neuropsychological tests available in Arab countries is unknown, although it is likely to be limited compared to what is available in Western countries. In Lebanon, some neuropsychological batteries have been locally used to assess cognition without being translated and validated to be adapted to the Lebanese sociocultural context. Clinicians in Lebanon underestimate the extent of cognitive impairment in schizophrenia patients as they have limited options, using untranslated tests or using translations that have not been validated. Future studies should target the development and adaptation of instruments that predict and measure cognition and functional ability.

**Keywords:** Cognition, Schizophrenia, Neuropsychological Tests, Cognitive Impairment, Psychosis.

## Highlights

- Many cognitive functions are generally impaired in patients with schizophrenia
- The number of neuropsychological tests available in Arab countries is unknown
- In Lebanon, some neuropsychological batteries have been locally used to assess cognition without being translated and validated
- Few studies conducted in Lebanon have used neurocognitive tests among schizophrenia.

## INTRODUCTION

Cognitive deficits are a core feature of schizophrenia, affecting up to 75% of patients (Millan et al., 2012). Many cognitive functions are generally affected in schizophrenic patients, particularly memory, attention, motor skills, executive function, and social cognition (Millan et al., 2012). Cognitive changes are often the first signs of schizophrenia, occurring years before the first acute psychosis episode and positive or negative symptoms of the disease (Meier et al., 2014, Bilder et al., 2006). Moderate to severe cognitive deficits are detectable, during illness, at the time of the first episode, and appear relatively stable after the initial decline, with progressive deterioration after age 65 in some patients (Bilder et al., 2000, Saykin et al., 1994).

Schizophrenia affects a wide range of cognitive functions, particularly attention, working memory, verbal learning and memory, and executive functions. Some studies have revealed mild to moderate deficits in attention, speech fluency, working memory, processing speed, verbal memory, and executive functioning. Other studies suggested a correlation between cognitive domains and symptomatic and functional dimensions of the disease (Zhu et al., 2019, Yu et al., 2015, Huang et al., 2020). Cognitive deficits in schizophrenia are comparable worldwide with significant linguistic and cultural variations, some performance differences having been identified in various regions of the world (Schaefer et al., 2013). These deficiencies had allowed some authors to conclude that schizophrenia had a neuropsychological profile (Reichenberg, 2010, Blanchard and Neale, 1994, Dickinson et al., 2004). Most schizophrenic patients demonstrate at least one cognitive impairment, but like other aspects of the disease, the severity and extent of these impairments vary among patients (Tripathi et al., 2018, Bowie and Harvey, 2006). Overall, generalized impairment is the most common finding across studies, occurring at all clinical stages and throughout life, regardless of the neuropsychological tests used (Schaefer et al., 2013, Hughes et al., 2003, Hyde et al., 1994). Most randomized controlled trials (RCTs) among schizophrenia patients have examined cognitive remediation and cognitive-behavioral treatment (O'Reilly et al., 2019, Grant et al., 2012, Best et al., 2019, Peña et al., 2016, Cassetta and Goghari, 2016). A recent RCT on 65 patients with schizophrenia or schizoaffective disorders found significant improvements in visual and working memory among those who participated in cognitive remediation training and those receiving treatment as usual at both the end of treatment and eight months follow-up (O'Reilly et al., 2019, Schaefer et al., 2013)

Cognitive assessment is one of the best indicators of the functional and social prognosis of schizophrenic patients. Current assessment methods involve batteries that vary considerably

in content, duration, procedures, and interpretations. Several cognitive assessment packages are available for patients with schizophrenia and psychosis, such as MATRICS (Measurement and Treatment Research to Improve Cognition in Schizophrenia) (Nuechterlein and Green, 2006), RBANS (Repeatable Battery for the Assessment of Neuropsychological Status) (Randolph, 1998), Woodcock-Johnson III cognitive abilities test (Woodcock et al., 2001), and BACS (Brief Assessment of Cognition in Schizophrenia) (Keefe et al., 2004). The number of neuropsychological tests available in Arab countries is unknown, although it is likely to be limited compared to what is available in Western countries (Fasfous et al., 2017). Population characteristics (cultural background, educational status, and age) differ between Arab and Western countries and influence the selection of appropriate neuropsychological tests (Casaletto and Heaton, 2017). The ambiguity in neuropsychological tests makes assessments less accessible to clinicians, leads to a search for alternate tests that may or may not apply to the examinee, and encourages neglect of non-neurological factors affecting psychiatric patients' performance (Fasfous et al., 2017). Assessment methods using tests validated in Western countries reduce research objectivity, increase the impact of measurement error, and impede generalizing cognitive evaluation in patients with schizophrenia (Fasfous et al., 2017). Therefore, designing appropriate standards and culture-specific neuropsychological testing is warranted because western-based normative evidence might not be relevant when applicable to other cultures. Hence, the need to adapt and validate a neurocognitive battery in Arabic to help researchers assess cognitive impairment in schizophrenia and guide clinical decisions on cognitive interventions and rehabilitation.

Cognitive deficits in various areas have been consistently replicated in schizophrenic patients. Thus, it would be of interest to emphasize these impairments, the most fundamental symptoms compared to delusions and hallucinations considered secondary manifestations, as described by Kraepelin, who was the first to identify schizophrenia (Kraepelin, 1919). Few studies have been conducted in Middle Eastern countries to explore the cognitive aspect in schizophrenic patients (El-Hadidy et al., 2013, Gohar et al., 2013, Ben et al., 2009, Hamid and Darweesh, 2018). A study of 30 psychiatric patients recruited from psychiatric hospitals in the United Arab Emirates found that these patients have cognitive impairment compared to a control group (Hamid and Darweesh, 2018). In Tunisia, researchers created and adapted a neurocognitive battery for patients with schizophrenia (Ben et al., 2009), while in Egypt, they translated and adapted a Social Cognitive Skills Training (SCST) program (Gohar et al., 2013). In Lebanon, some studies have evaluated the cognitive function among the elderly (El Zoghbi et al., 2013, Bou-Orm et al., 2018, Abou-Mrad et al., 2017). However, no study has yet examined the assessment of cognitive functions in patients with neurological or psychiatric diseases in Lebanon. Although the impact of schizophrenia is the same worldwide, and despite the abundance of valid tests, only a few were translated into Arabic and validated in Lebanon. Therefore, a detailed description of cognitive functions and tests in patients with schizophrenia is essential to understand neurocognitive disorders better and help in the therapeutic management of this psychiatric population. This review aims to provide an overview of the cognitive profiles of schizophrenia and describe the different cognitive tests used in Lebanon.

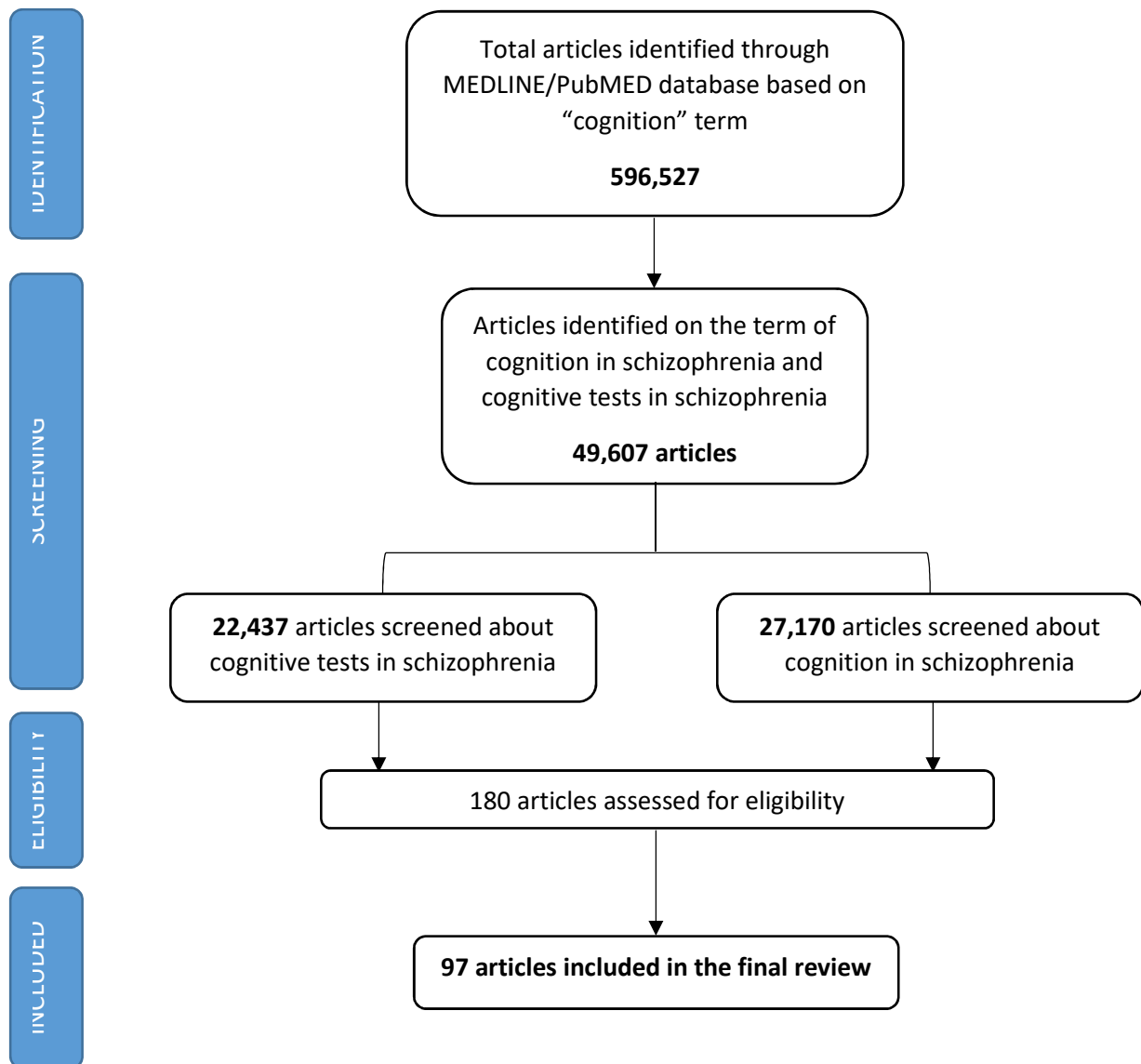
## **METHOD AND RESEARCH DESIGN**

The MEDLINE/PubMed database was used to conduct a literature review covering all studies related to cognition in psychosis patients from 1990 until March 2021, with no limitations on publishing language or research sources. The types of publication sought were observational

studies, clinical studies, clinical trials, comparative studies, controlled clinical trials, review articles, meta-analyses, systematic reviews, books, and documents.

The following key search terms were used to ensure retrieval of the largest number of papers on cognition in schizophrenia: “cognition”, “cognitive deficits”, “cognitive impairment”, “neurocognition”, “schizophrenia or schizoaffective”, “psychosis”, “psychiatric patients”, “neuropsychology”, “neuropsychological measures”, “Arab countries”, “cognitive assessment batteries”.

The term “cognition” used in the initial run of online databases yielded over 596,527 articles, the vast majority of which were irrelevant; thus, it was removed from the succeeding searches. Then the terms “cognition in schizophrenia” and “cognitive tests in schizophrenia” were entered and yielded a total of 49,607 articles. Of the 49,607 articles, 22,437 were about “cognitive tests in schizophrenia”, and 27,170 articles covered “cognition in schizophrenia”. Only 19 research articles were found when searching the term “cognitive tests in psychiatric patients in Arab countries”. After that, a screening of all abstracts and titles was performed to eliminate articles not relevant to the topic, those that did not follow the objective of the addressed research, concentrated mainly on psychopathology and conditions other than cognition, or primarily evaluated cognition aspects in other psychiatric disease or elderly patients. This screening resulted in 180 articles that required an in-depth analysis, of which 90 were eliminated, 50 due to irrelevance, and 40 because they were not focused on cognition in psychiatric patients or cognitive tests in schizophrenia. The remaining 97 articles were included in the final version of this paper (Figure 1).



**Figure 1: Flow chart of included articles**

## **PROFILE OF COGNITIVE FUNCTIONS IN SCHIZOPHRENIA**

### **Memory**

The literature describes two main types of memory: short-term memory (working memory) and long-term memory, divided into two sub-types, explicit/declarative memory (episodic memory and semantic memory) and implicit/non-declarative memory (procedural memory) (Van Der Linden, 1991).

#### ***Short-term memory***

Short-term memory, also known as working memory and sometimes called immediate memory, allows the temporary maintenance of information, thus allowing the accomplishment of tasks such as reasoning, understanding, and problem-solving (Van Der Linden, 1991). In patients with schizophrenia, short-term memory is deficient, making them unable to store and manipulate information (Danion et al., 1992). This deficiency is often

moderate to severe and characteristic of the disease (McGurk et al., 2004). These patients have difficulties maintaining information to submit it to an appropriate situation (Danion et al., 1992); the lack of associations between target information and contextual information disrupts their conscious recall process. Patients with schizophrenia also have difficulty using comments effectively, formulating plans, initiating them, and flexibly modifying a strategy once it is no longer effective (Spitzer, 1993). Moreover, they sometimes have problems recalling what they are doing when interrupted while performing a specific task. Forgetting the execution of an action in progress disrupts their behavior profoundly (Spitzer, 1993).

### ***Long-term memory***

Long-term memory, divided into explicit and implicit memory, enables the sustainable retention of information by promoting learning.

Explicit memory includes semantic memory and episodic memory. Semantic memory is general knowledge about the world (language, concepts, categories, rules, historical facts, etc.). Episodic memory allows individuals to remember and become aware of recent or older events by relating them to past events that they experienced in a particular spatial and temporal context. Explicit memory is among the most impaired cognitive functions in patients with schizophrenia (Guo et al., 2019). Its deficit is one of the strongest predictive factors of the functional prognosis of schizophrenic patients (Guo et al., 2019). This deficit can be observed from the first episode of the disease and persist beyond, making it a good marker of schizophrenia, where patients experience a loss of conscious recall, coherence, and psychic discontinuity (Heinrichs and Zakzanis, 1998). Thus, schizophrenic patients have difficulty controlling the behavior and beliefs appropriately because of the constant alteration of the past events recall function (Heinrichs and Zakzanis, 1998).

Implicit memory is an automatic, unconscious memory that corresponds to perceptual, cognitive, and motor skills learnings (driving a car, riding a bike, etc.). It has been considerably less studied than explicit memory in schizophrenic patients. Nevertheless, studies suggest that this aspect of memory is relatively preserved in this population, showing that patients with schizophrenia exhibit near-perfect performance or only slight impairment of procedural learning tasks (Spataro et al., 2016).

### **Attention**

Attention deficit is a fundamental aspect of schizophrenia, where patients fail to develop habituation to a warning signal and continue to react as if each stimulus is new. For this reason, patients with schizophrenia may be on continuous alert, as if “the environment” poses a permanent threat. These abnormalities could be related to a set of signs (hallucinations and delirium...) and environmental experiences of patients. It is noteworthy that attention deficit can disrupt many other cognitive functions, mainly working memory and executive functions, preventing the proper handling of many types of information. However, studies have shown that attention dysfunction accounts for only a small proportion of the variance of other cognitive functions in schizophrenia (Carter et al., 2010). Attention deficits are also traits and markers of vulnerability in patients with schizophrenia in a state of remission of their symptoms (Balogh et al., 2015), children of schizophrenic parents, and individuals with a schizotypal personality (Trestman et al., 1995).

### ***Selective attention***

Schizophrenic patients have difficulty extracting specific information from a context with multiple pieces of information (Peretti et al., 2004). Indeed, they find it hard to exploit contextual information (e.g., recognizing a stimulus) (Peretti et al., 2004) and select relevant information while inhibiting what is irrelevant. The deficit in selective attention in schizophrenic patients results in decreased detection capabilities, increased interference when



the task requires simultaneous treatment of two stimuli, and significantly longer response time (Peretti et al., 2004).

### ***Sustained attention or vigilance***

Sustained attention is the ability to maintain focus on a stimulus over a long period. This type of attention depends on alertness, the ability to detect the stimulus, resistance to distraction, thus mental control. Vigilance corresponds to the level of awakening manifested during a cognitive task. Schizophrenic patients have a deficit of alertness, defined as a difficulty in maintaining sustained attention for a relatively prolonged period .

### ***Divided or shared attention***

Multiple sources of information are permanently available in the environment. Parallel processing is the ability to process information from multiple sources simultaneously, e.g., speaking and walking at the same time, using the different types of information needed to perform both tasks concurrently. Patients with schizophrenia have impaired performance during tasks of shared attention. However, these alterations do not appear to be related to a lack of allocation of attentional resources since patients seem to use regular treatment strategies (Granholm et al., 1996).

### **Executive functions**

Executive functions involve multiple components; one view suggests at least five key components: 1) attention and inhibition, 2) task management, 3) planning, 4) monitoring, and 5) temporal coding. They allow flexible modification of thought and behavior in response to changes in cognitive and environmental contexts. Schizophrenic patients have a deficit in executive functions associated with ambivalence, conceptual disorganization, stereotypies, weirdness, mannerism, and psychomotor depletion. Deterioration of executive functions in these patients is responsible for a behavioral deficit, decreased efficiency, and a loss of autonomy. Numerous studies have shown that patients with schizophrenia have difficulty with most or all of the tasks that require monitoring, performance, and planning . Deficits of executive functions in schizophrenic patients are often related to the symptoms of the disease. Positive symptoms (hallucinations and delusions) have almost no correlation with executive dysfunction (Orellana and Slachevsky, 2013). In contrast, negative symptoms, such as emotional impairment and social withdrawal, have been linked to executive dysfunction . Furthermore, the lack of consciousness (lack of insight) is specifically related to executive function deficiency and not to other cognitive function deficits . The deficit in executive function can lead to a behavioral impairment that predisposes the patient with schizophrenia to a violent attitude following poor compliance with treatment . Additionally, it could contribute to an alteration of other cognitive functions, such as working memory and attention (Orellana and Slachevsky, 2013).

### **Social Cognition**

Social cognition is the set of mental operations necessary for social interaction; it generally involves understanding the emotions, intentions, beliefs, and behaviors of others (Green et al., 2008) and focuses on the role that cognitive processes play in social interactions (Park et al., 2015). Social cognition appears to mediate between non-social cognition and social functioning and be a primary factor in the disease recovery process (Vauth et al., 2004). Studies have shown that deficiencies in social cognition in schizophrenia remain stable in the early stages of the disease (before and during the first episode of the disease) and chronic states and that these alterations are essential determinants of social functioning (Green et al., 2011, Horan et al., 2011). Five areas of social cognition have been identified: theory of mind (ability to infer the mental states of others), social perception (identification of the emotions of others), social knowledge or social schema (knowledge of roles, social rules), attribution

bias (causal inferences), and emotional treatment (identification, use of emotions) (Green et al., 2008). The theory of mind and the perception of emotions are the two most widely studied domains in schizophrenic patients (Penn et al., 2008, Savla et al., 2012).

Studies on the perception of emotions in schizophrenic patients have shown a marked deficit in facial and vocal recognition (Behere, 2015, Amminger et al., 2012, Lado-Codesido et al., 2019). Facial identification and distinction impairment could be specific to negative emotions or generalized to positive and negative emotions. Two meta-analyses concerning the theory of mind have shown a deficit in this area in schizophrenic patients (Sprong et al., 2007, Bora et al., 2009). Persecutory delusions reflect false beliefs about others' intentions and behaviors that may arise from the theory of the mind. Frith suggested that deficits in the theory of mind underlie the origin of persecutory delusions, visual illusions, misidentification illusions, auditory hallucinations, certain aspects of the thought disorder, and negative symptoms (Frith, 2014). He hypothesized that the theory of mind in people with persecutory delusions develops ordinarily (unlike autistic individuals) but is "lost" in an acute psychotic episode (Frith, 2014).

Attribution theory provides a framework for understanding the causal explanations that individuals give to their own behavior and the behavior of others (Fiske and Taylor, 2013). It has been proposed that normal people attribute causation (a statement that includes or implies the word "because") every few hundred words. Normal subjects consistently demonstrate a bias of selfish attribution in explaining causes of events; that is to say, they tend to believe in their success (the "self-rewarding" bias) and to deny any responsibility in case of failure (the "self-protective" bias intended to reinforce their self-esteem). Patients with schizophrenia show an exaggeration of this selfish attribution bias. Schizophrenic patients tend to self-attribute external negative events; this trait is more likely correlated with positive symptoms, particularly persecutory delusions.

## **SCHIZOPHRENIC DISORDERS IN LEBANON**

Mental disorders are common in Arab countries, with reported psychological distress rates between 15.6% and 35.5%, higher in countries with complex emergencies (Charara et al., 2017). The 12-month prevalence of mental disorders varies between 11.0% and 40.1% (Charara et al., 2017). Depression and anxiety are the most common mental disorders, with higher rates in women than men (Charara et al., 2017). In the Arab world, reliable basic psychiatric epidemiological studies are scarce, which does not allow rational planning of psychiatric services, education, and research. A review on schizophrenia and psychotic disorders until the end of 2007 showed that the prevalence of psychotic disorders varied between 0.7% and 5.6%, with no evidence of gender difference (Rim and Moussaoui, 2011).

In Lebanon, mental health is a growing public health problem; more than 25% of people have been affected by mental and behavioral disorders, and 10.5% have experienced more than one disorder at some point in their life (Karam et al., 2006). Depression was the most common (lifetime prevalence 9.9%), followed by anxiety (16.7%), while mood disorders were 12.6% (Karam et al., 2006). Unfortunately, no recent reliable data has been collected from population-based studies to investigate the prevalence of schizophrenia in Lebanon. The burden of the disease affects everyone but can be particularly devastating among people from lower socioeconomic levels. The disability-adjusted life years (DALY) for neuropsychiatric disorders in Lebanon in 2002 was 99, including 34 for depression, 9 for bipolar, 11 for schizophrenia, and 4 for panic disorder (Organization, 2008).

## NEUROCOGNITIVE EVALUATIONS TESTS IN LEBANON

The majority of measures developed to evaluate cognition in patients with schizophrenia were from Western countries (Fasfous et al., 2017), most of which are long and complex and may require several hours to administer (Reichenberg, 2010). In Lebanon, some neuropsychological batteries have been locally used to assess cognition without being translated and validated to be adapted to the Lebanese sociocultural context. For example, the Wechsler Adult Intelligence Scale (WAIS) used at the Psychiatric Hospital of the Cross among patients with schizophrenia, or the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) applied at the psychological assessment center in the American University of Beirut Medical Center. Recently, a study done in Lebanon have validated the Brief Assessment of Cognition in Schizophrenia (BACS) among 120 Lebanese schizophrenic patients (Haddad et al., 2021a). The results showed that the Arabic version of the BACS has satisfactory psychometric properties, including high internal consistency, acceptable concurrent validity, and good overall discriminant validity (Haddad et al., 2021a). In 2015, Abou-Mrad et al. culturally adapted and validated a battery of neuropsychological tests (NPTs) to assess cognition in the Lebanese elderly population (Abou-Mrad et al., 2015). In this study, the NPTs selected by a team of Lebanese professionals were translated into Arabic and independently back-translated by a group of sociolinguists and cultural specialists to suit the Lebanese culture (Abou-Mrad et al., 2015). Tests selection was based on their potential to detect cognitive decline among the elderly population and cover major cognitive domains. The selected tests were as follows: AD8 (Alzheimer's Disease), 3MS (Modified Mini-Mental Status Examination), Lebanese linguistic naming, Brief Visuospatial Memory Test-Revised (BVM-T-R), Lebanese digit span, Cross-Linguistic Naming Test, Verbal fluency, Grober and Buschke (RL-RI-16 test), and The Montreal Cognitive Assessment Test (MoCA) (Abou-Mrad et al., 2015). In 2017, Abou-Mrad et al. administered these translated tests in a large sample of community older Lebanese adults to examine their psychometric properties (Abou-Mrad et al., 2017). In this study, test-retest reliability was computed for each tool over 2-5 weeks; reliability ranged from 0.55 to 0.90, and Cronbach alpha coefficients from 0.34 to 0.93 (Abou-Mrad et al., 2017). This study has established normative data that allows for the use of translated neuropsychological tests in Lebanon among the elderly (Abou-Mrad et al., 2017). Another dementia diagnostic battery has been validated in Lebanon, the 10/66 dementia research group (DRG). It consists of a cognitive tests battery (the Community Screening Instrument for Dementia (CSI-D) and the Consortium to Establish a Registry of Alzheimer's Disease (CERAD), animal naming test and modified 10-word list learning), a structured clinical interview (the Geriatric Mental State), and the CSI-D informant interview (Phung et al., 2014). The 10/66 DRG diagnostic assessment had excellent sensitivity (92.0%), specificity (95.1%), and positive predictive value (PPV, 92.9%) (Phung et al., 2014). Thus, this battery showed a great ability to diagnose dementia in an Arabic-speaking older population (Phung et al., 2014). Chaaya et al. also validated a screening test for dementia, the A-RUDAS (Arabic Rowland Universal Dementia Assessment Scale) (Chaaya et al., 2016) that had very good psychometric properties (good sensitivity (83%) and specificity (85%)) among different populations of older adults (Chaaya et al., 2016). Recently, Darwish et al. provided normative data for the Rey Complex Figure Test and Recognition Trial (RCFT) among a healthy Lebanese sample aged 30 years and above (Darwish et al., 2018) (Table 1 and Table 2).

Few studies conducted in Lebanon have used neurocognitive tests among patients with schizophrenia.

- A study conducted by Zoghbi et al. has evaluated the association of vitamin D (VD) levels with cognition and physical functioning among 196 patients with schizophrenia (Zoghbi et al., 2019), using the Brief Cognitive Rating Scale (BCRS) and the Morningside Rehabilitation Status Scale (Zoghbi et al., 2019). The results showed no significant difference between VD deficiency and BCRS scores after adjusting for all covariates (Zoghbi et al., 2019).
- Wehbe et al. compared cognitive and functional characteristics of 308 hospitalized schizophrenia patients with and without an obsessive-compulsive disorder (OCD) using the Memory Awareness Rating Scale (Wehbé et al., 2019). The results showed that patients with OCD were significantly associated with impaired memory function (Wehbé et al., 2019).
- Obeid et al. have used the D2 Concentrated Attention Test to check visual attention and the ability to concentrate among 40 schizophrenic patients and evaluated the effect of the psychological program compared to usual treatment on cognitive performance and social skills (Obeid et al., 2020). The results showed significantly higher attention scores in these patients after treatment with the psychological program (Obeid et al., 2020).
- Rebehmed et al. compared the intellectual efficiency of people with schizophrenia to healthy subjects (28 schizophrenic patients and 28 controls) using the Cattell intelligence test (Rebehmed F, 2020). The results showed that the healthy control group was significantly associated with a higher level of intelligence than patients with schizophrenia (Rebehmed F, 2020). In patients with schizophrenia, negative symptoms were negatively correlated with intelligence; however, no association was found between positive symptoms and intelligence (Rebehmed F, 2020).
- Atoui et al. have used the Reading the Mind in the Eyes Test-revised version and the Faux-Pas Test to assess an individual's ability to identify mental state and an embarrassing social situation between two persons, respectively, among 22 chronic schizophrenic patients and 21 healthy controls (Atoui et al., 2018). The results showed significant differences in empathy and theory of mind scores between the control and schizophrenia groups (Atoui et al., 2018).

## CONCLUSION

In summary, clinicians in Lebanon underestimate the extent of cognitive impairment in schizophrenia patients as they have limited options, using untranslated tests or using translations that have not been validated. Using such tests will lead to measuring errors and an evaluation of patients based on constructs that may not be relevant to their cultures. The lack of valid tests for Arabic-speaking countries has detrimental consequences on the provision of neuropsychological treatment. This situation that clinical neuropsychology still has a long way to make assessments fair and relevant to non-English speaking communities. Therefore, future studies should target the development and adaptation of instruments that predict and measure cognition and functional ability. An easy-to-use battery of cognitive tests validated and adapted to the socio-cultural framework in Lebanon would allow evaluating the different cognitive deficits in patients with schizophrenia for a therapeutic follow-up of patients. It would also help develop clinical applications to improve social skills and cognitive rehabilitation/remediation in this population.

## **DECLARATIONS**

### **Consent for publication**

Not applicable.

### **Conflict of interest**

None.

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None.

### **Authors' contribution**

JPC and BC designed the study; CH participated in drafting the initial manuscript; PS, HS, BC, JPC revised the article critically for important intellectual content. All authors reviewed and approved the final version of the manuscript.

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<b>Neuropsychological batteries</b>							
<b>Abbreviation</b>	<b>Name</b>	<b>Description</b>	<b>Items</b>	<b>Cognitive domain</b>	<b>duration</b>	<b>Study reference in Lebanon</b>	<b>Criteria met*</b>
BACS	Brief Assessment of Cognition in Schizophrenia	The (BACS) is a developed instrument that assesses the aspects of cognition found to be most impaired and most strongly correlated with outcome in patients with schizophrenia	Six subtests	Verbal memory, working memory, motor speed, verbal fluency, attention and speed of information processing, executive functions	30-35 min	Haddad et al. (Haddad et al., 2021a, Haddad et al., 2021b)	T, V
WAIS-IV	The Wechsler Adult Intelligence Scale (WAIS)	The WAIS is the most widely used IQ test, designed to measure intelligence and cognitive ability in adults and older adolescents (Kaufman and Lichtenberger, 2002)	Ten core subtests and five supplemental subtests	Verbal Comprehension, Perceptual Reasoning, Working Memory, Processing Speed	65-95 min	Not applicable	Not applicable
RBANS	Repeatable Battery for the Assessment of Neuropsychological Status	The RBANS is used to measure neuropsychological status in adults (Randolph et al., 1998)	Ten subtests which give five scores	Immediate memory, visuospatial/construction, language, attention, delayed memory	30 min	Not applicable	Not applicable
10/66 DGR	The 10/66 Dementia Research Group (DRG) cognitive test battery	The 10/66 is an assessment battery to diagnose dementia	four main tests	Global cognitive function, memory, verbal fluency	-	Phung et al. (Phung et al., 2014)	T, V

Neuropsychological screening tests							
MOCA	Montreal Cognitive Assessment Test	MOCA is a widely used screening assessment tool for detecting cognitive impairment (Nasreddine et al., 2005)	Eight sections	Memory, Visuospatial abilities, executive functions, Attention, concentration, Language, orientation	10 minutes	Abou-Mrad et al. 2015 (Abou-Mrad et al., 2015) Abou-Mrad et al. 2017 (Abou-Mrad et al., 2017) Zamrini et al 2014 (Zamrini et al., 2014) Darwish et al. 2015 (Darwish et al., 2015)	T, BT, AD, V, N
MMSE	Mini Mental Status Examination	MMSE is used extensively in clinical and research settings to measure cognitive impairment (Folstein et al., 1975)	Seven sections	Attention, memory, orientation, language, and visuospatial function	5–10 min	El Zoghbi et al. 2013 (El Zoghbi et al., 2013) Boulos et al. 2013 (Boulos et al., 2013)	T, BT
3 MS	Modified Mini Mental Status Examination	The 3 MS is a brief screening test for dementia it is an expanded scoring system for the MMSE (Teng and Chui, 1987).	Fifteen sections	Memory, attention, language, construction, and executive functioning	15–20 min	Abou-Mrad et al. 2015 (Abou-Mrad et al., 2015) Abou-Mrad et al. 2017 (Abou-Mrad et al., 2017) Zamrini et al 2014 (Zamrini et al., 2014)	T, BT, AD, V, N

A-RUDAS	Arabic Rowland Universal Dementia Assessment Scale	The A-RUDAS is a short cognitive screening instrument for dementia (Storey et al., 2004)	Six items	Testing memory, body orientation, praxis, drawing, judgment, and language	20 min	Chaaya et al. 2016 (Chaaya et al., 2016)	T, BT, AD, R, V
*T translated, BT back translated, AD adapted, R reliability assessed, V validity assessed, N normative data provided							

<b>Cognitive domain</b>	<b>Tests</b>	<b>Description</b>	<b>duration</b>	<b>Study reference in Lebanon</b>	<b>Criteria met*</b>
<b>Memory</b>	Free and Cued Recall (RL-RI-16 test)	It is used to detect any memory deficit through presenting subjects with four sets of four words, each of a different category. Subjects are asked to recall these words. The test contains sixteen main words to be identified by the subject and later recognized from among another forty eight words (Grober et al., 1988).	20 min	Abou-Mrad et al. 2015 (Abou-Mrad et al., 2015)	T, BT, AD
	The Memory Awareness Rating Scale (MARS)	The MARS assesses memory awareness in two domains: The Memory Functioning Scale assesses subjective views of memory functioning. The Memory Performance Scale assesses views of memory performance on specific aspects of memory functioning.	-	Wehbe et al. 2019 (Wehbé et al., 2019)	•
<b>Attention</b>	The D2 test of attention	The examinee task is to cross out within a limited period of time particular symbols from among the group of similar symbols presented to him/her. The	4 min	Obeid et al. 2020 (Obeid et al., 2020)	•

		test scores provide indices which allow to assess ability to concentrate as well as speed and accuracy of work performance.			
	Lebanese Digit Span (LDS)	Participants are read a string of increasingly longer Arabic sequences digits at one per second, and then asked to immediately recall them in the same order. In the reverse condition, different Arabic strings of numbers were presented at 1 per second and individuals were asked to recall them in reverse order.	120 seconds	Abou-Mrad et al. 2017 (Abou-Mrad et al., 2017)	T, BT, AD, V, N
<b>Processing speed</b>	Verbal fluency test (semantic and phonemic)	Participants have to produce as many words as possible from a category in a given time. The category can be semantic, including objects such as animals or fruits, or phonemic, including words beginning with a specified letter.	60 seconds for each category	Abou-Mrad et al. 2015 (Abou-Mrad et al., 2015) Abou-Mrad et al. 2017 (Abou-Mrad et al., 2017) Zamrini et al 2014 (Zamrini et al., 2014)	T, BT, AD, V, N
	The Symbol Digit Modalities Test	Patient substitutes a number, either orally or written, for randomized presentations of geometric figures	Less than 5 minutes	Darwish et al. (Darwish et al., 2015)	-
<b>Language</b>	Lebanese linguistic naming test (LLNT)	This test was adapted from the cross-linguistic naming test. Participants are presented 40 color images grouped into 5 categories depicting body parts, objects, animals, colors, and actions. Images are presented one at a time, and participants are asked to name what is represented (Ardila, 2007)	-	Abou-Mrad et al. 2015 (Abou-Mrad et al., 2015) Abou-Mrad et al. 2017 (Abou-Mrad et al., 2017)	T, BT, AD, V, N

				Zamrini et al 2014 (Zamrini et al., 2014)	
<b>Visuospatial ability and memory</b>	Brief Visuospatial Memory Test-Revised (BVMT-R)	An individual is given three learning trials to remember six designs and their locations on a page. The Total Recall score is the number of designs and locations correctly recalled on the three learning trials; delayed Recall is the number of designs and locations correctly recalled after a 25-min delay.	-	Abou-Mrad et al. 2015 (Abou-Mrad et al., 2015)  Zamrini et al 2014 (Zamrini et al., 2014)	T, BT, V, N
	Rey Complex Figure Test and Recognition Trial (RCFT)	The RCFT is used to assess the respondent's ability to use cues to retrieve information. The test consist of copying the design, and recalling it freely and through multiple choice, after a time lapse. The tasks yield five scores—time to copy, accuracy and placement of the design for the copy, 3-min delay (referred to as Immediate Recall), and 30-min (referred to as Delayed Recall) trial, and correct choices for the recognition trial.	45 min	Darwish et al. 2015 (Darwish et al., 2015)  Darwish et al.2018 (Darwish et al., 2018)	T, BT, AD, N
<b>Intelligence</b>	Cattell test	The Culture Fair tests consist of three scales with non-verbal visual puzzles. Scale I includes eight subtests of mazes, copying symbols, identifying similar drawings and other non-verbal tasks. Both Scales II and III consist of four subtests that include completing a sequence of drawings, a classification subtest where respondents pick a drawing that is different from other drawings, a matrix subtest that involves completing a matrix of patterns, and a conditions subtest which involves which, out of several geometric designs,	-	Rebehmed et al. (Rebehmed F, 2020)  Hallit et al. (Hallit et al., 2019)	-

		fulfills a specific given condition.			
*T translated, BT back translated, AD adapted, R reliability assessed, V validity assessed, N normative data provided					