Title: A SYSTEMATIC REVIEW OF BRIEF NEUROPSYCHOLOGICAL TESTS IN USE AMONG PATIENTS WITH PSYCHOTIC DISORDERS IN LOW AND MIDDLE INCOME COUNTRIES.

Running title: A systematic review of cognition assessment.

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ABSTRACT

Introduction: Assessment of cognitive impairment is recommended as part of the comprehensive care of psychotic disorders. Brief neuropsychological assessments are particularly needed in low resource settings, but few reviews have focused on work done in this context. We aimed to undertake a systematic review of work done in low- and middle-income countries on brief neuropsychological assessments of cognitive impairment in psychotic disorders.

Method: A systematic review was performed following PRISMA guidelines. We searched PubMed, Embase and PsycINFO for articles in which a brief neuropsychological test was used to assess cognitive impairment in patients with psychotic disorders in a low- and middle-income country (LMIC) context. Data on whether tests had been validated against the gold standard was abstracted. Data was also abstracted on the tests used, the domains assessed, personnel performing the tests, duration of tests and were abstracted.

Results: A total of 29 articles met the inclusion criteria; these studied 3,184 participants with psychosis and 1,261 controls. No test was validated against a gold standard such as the MATRICS consensus cognitive battery. There was marked variability in the tests used, but most were delivered using pen and paper and assessed for cognitive impairment in the reasoning and problem solving domain. All but two publications used highly skilled personnel to perform the assessments.

Conclusion: Although a few studies have focused on neuropsychological assessment of cognitive impairment in psychotic disorders in the LMIC context, none compared a brief neuropsychological test with a gold standard. Further work is therefore needed to determine the validity of brief neuropsychological assessment of cognitive impairment in psychotic disorders in these settings.

Key words: Cognition, psychosis, low and middle income countries, systematic review

INTRODUCTION AND BACKGROUND

Neuropsychological assessment for cognitive impairment is recommended as part of comprehensive care for patients with psychotic disorders (Association, 2013, Organization, 1992)(Keefe and Fenton, 2007). Cognitive impairment is a core feature of psychotic disorders that is present early in the course of the illness (Sheffield et al., 2018, Urs Heilbronner et al., 2016). Cognitive impairment may contribute a greater burden of disease than behavioral, positive or negative symptoms (Green et al., 2019, Green and Harvey, 2014, Emsley et al., 2008, Couture et al., 2006, Vigo et al., 2016, Harvey A Whiteford et al., 2013). Cognitive impairment has been associated with poorer outcomes like quality of life, educational achievement and general social functioning (Allott et al., Vaz-Serra et al.).

The gold-standard assessment for cognitive impairment is completion of a comprehensive neuropsychological test battery (Green et al., 2019). One such gold standard comprehensive battery for cognitive impairment in psychotic disorders is the MATRICS consensus cognitive battery (MCCB), which assesses for impairment in the cognitive domains of i) working memory, ii) attention/vigilance, iii) verbal learning and memory, iv) visual learning and memory, v) reasoning and problem solving, vi) information processing speed, and vii) social cognition (Green et al., 2019, Green et al., 2004). Comprehensive batteries like the MCCB typically require several hours to complete, with administration by a neuropsychologist, or highly trained psychometrist. This may not be possible in resource limited settings, such as low and middle income countries.

Brief neuropsychological assessments are typically used for screening to determine who should be referred for comprehensive neuropsychological testing (Roebuck-Spencer et al., 2017). They differ from comprehensive neuropsychological assessment in that they do not always assess for cognitive impairment in all cognitive domains, and they may vary in the tests administered, modes of administration, domains assessed, duration of assessments and psychometric properties (Athilingam et al., 2015). For example, while the brief neuropsychological assessment (BNA) test assesses for impairment in the domains of working memory and processing speed (Fervaha et al., Hurford et al., 2011), the Brief Cognitive Assessment Tool for Schizophrenia assesses for impairment in the domains of reasoning and problem solving as well as memory and processing speed (Hurford et al., 2011). While the brevity of such neuropsychological assessments is an advantage (Green et al., 2004, Ayres et al., 2007, Ngoma et al., 2010, Mugisha et al.) (Green et al., 2004, Ayres et al., 2007, Ngoma et al., 2010, Mugisha et al., 2017). (Mwesiga et al., 2020). (Nuechterlein et al., 2008), their validity is unclear. (Bakkour et al., 2014).

There is limited literature focused on brief neuropsychological assessment for cognitive impairment among patients with psychosis from low and middle income countries. It is therefore unclear which brief neuropsychological tests have been most often used in this context, (Wakida et al., 2019, Mugisha et al., 2017), and whether any have been validated

against a gold standard in order to assess sensitivity and specificity. It would be useful to know, in addition, what neuropsychological domains have been assessed, what the duration of assessment is, and which health workers have undertaken such studies.

We therefore undertook a systematic review the available literature on brief neuropsychological assessment for cognitive impairment in patients with psychotic disorders in low and middle income countries. Standard methods were used to summarize the literature on the tests used, the domains assessed, duration of assessments, cadres performing the assessments and whether the tests had been validated against a gold standard.

METHODS

The study protocol was registered in the open access online registry, PROSPERO, University of York, York, United Kingdom, registration number **CRD42018047872**. http://www.crd.york.ac.uk/PROSPERO/display_record.php?ID=CRD42018047872 .

Study selection

Exclusion and inclusion criteria were determined using the PICOS (Population, Intervention, Comparator, Outcomes, Study design, Setting) framework (Robinson et al., 2011). We considered articles written in English with no time limit on when the studies were conducted. The **population** of interest were participants with psychosis. Psychosis was defined as participants with schizophrenia spectrum and related psychotic disorders, bipolar affective disorder and depression with psychotic features. We selected these disorders given the current literature that highlights their shared genetic and neurobiological underpinnings (Rosen et al., 2012, Mark and Toulopoulou, 2016). The **intervention** included any study in which a brief neuropsychological test was used to assess cognitive impairment. The **comparator** was matched healthy controls. Among our **outcomes** the main outcome was whether the test had been validated against a gold standard. We also determined the tests commonly used, the domains they assessed, the time taken to perform the assessment and the level of persons performing the assessments. All **study designs** were included in the review. For longitudinal studies however we only considered the earliest assessment done, as were not focused on questions concerning long term follow up. The review was limited to low and middle income country **setting** as defined by the World Bank criteria (<https://data.worldbank.org/region/sub-saharan-africa>).

Data management

Data sources included (a) electronic search of databases, (b) search for gray literature such as conference proceedings and (c) using the reference bibliography of full text articles to identify potentially relevant studies. The electronic search strategy followed the PICOS approach

(Population, Intervention, Comparator, Outcome and Study design/setting), and was conducted in three data bases including PubMed, Embase and PsychINFO. The complete search strategy can be found in the appendices. The search strategy used Boolean logic to combine terms in the PICO framework. Full text articles were saved into Endnote (Brahmi and Gall, 2006), duplicates removed before two authors screened the titles in parallel to determine which articles were eligible for the review. Consensus was applied to arbitrate in the event of disagreement. For describing availability of neuropsychological tests, we collected the name of the screening instrument used. We also documented the domains assessed as well as the mode of delivery (Paper, Computer, and Mobile App) and the personnel performing the test. We also documented if a test had been validated against a complete battery.

Data Synthesis

The review was limited to a narrative synthesis. We described important features like year of publication, country, clinical setting, ethnicity and number of participants and healthy controls. Data was abstracted into an excel sheet and then exported to Stata version 14. (StataCorp. 2015. Stata Statistical Software: Release 14. College Station, TX: StataCorp LP).

RESULTS:

The search for articles was run on 18th October 2018. Duplicates were then removed from the list of articles. Two authors screened eligible titles and abstracts according to the study aims until a final list of articles was agreed on. The process is highlighted in figure 1 below.

PRISMA 2009 Flow Diagram

Figure 1: Article selection using PRISMA guidelines.

Study and participant characteristics.

29 studies were included into the final analysis. The articles were published between 1994 and 2018 with the majority (14/29) published between the years 2000 and 2010. Six (06) studies were from Central and South American countries, twelve (12) were from Asian countries and eleven (11) were from African countries. South Africa had the highest number of individual studies making up 7 of the 29 studies. 23 studies were conducted in an outpatient population, 5 carried out among inpatients and 1 in both outpatient and inpatient populations. In total the final table included 3,184 participants with psychosis and 1,261 controls. The different diagnostic characteristics of the participants are shown in Table 1.

Table 1: Summary of the publications included in the review.

Year	Author	Country	Study Design	Population	race	Total number of participants	Diagnostic type	Number
2009	Savitz	South Africa	CS	Outpatient	Caucasian	110	Bipolar with Psychosis	25
							Bipolar without psychosis	24
							HC	61
2017	Hendricks	South Africa	CS	Inpatient	Caucasian	29	Alcohol induced psychosis	13
							Alcohol use	16
1994	Gureje	Nigeria	CS	Inpatient	Black	128	Schizophrenia	43
							Mania	32
							HC	53
1997	Mattson	South Africa	CS	Outpatient	Caucasian	40	Schizophrenia positive symptoms	20
							Schizophrenia negative symptoms	20
2009	Ngoma	Democratic Republic of Congo	CS	Inpatient	Black	341	HC	153
							Brief Psychotic Disorder	68
							Schizophreniform	50
							Schizophrenia	70
2002	Harvey	South Africa	CS	Outpatient	Caucasian	29	Schizophrenia English speaking	5
					Black		Schizophrenia Afrikaans speaking	24
2008	Leppanen	South Africa	CS	Outpatient	African	81	Psychosis	36
							Siblings	23
							HC	22

2006	Leppanen	South Africa	CS	Outpatient	Black	84	Schizophrenia	44
							HC	40
2012	Nakasujja	Uganda	Longitudinal	Inpatient	Black	483	Mania	312
							Psychosis NOS	16
							Schizophrenia	100
							Depression	55
2008	Savitz	South Africa	CS	Outpatient	Caucasian	230	HC	65
							BPD I	49
							BPD II	19
2018	Sagar	India	Longitudinal	Outpatient	Oriental	178	BPD depressed	36
							BPD manic	41
							BPD euthymic	52
							HC	49
2005	Aleptekin	Turkey	CS	Outpatient	Caucasian	69	Schizophrenia	38
							HC	31
2015	Arau'jo	Brazil	CS	Outpatient	Caucasian	174	Schizophrenia	116
							HC	58
2007	Ayres	Brazil	CS	Outpatient	Caucasian	553	Schizophrenia	98
							BPD	41
							Depression with psychosis	31
							HC	383
2010	Cabral-Calderin	Cuba	Longitudinal	Outpatient	Caucasian	68	Schizophrenia	34
							HC	34
2017	Charernboon	Thailand	CS	Outpatient	Oriental	72	Schizophrenia	36
							HC	36
2009	Ayres	Brazil	CS	Outpatient	Caucasian	160	Schizophrenia	56
							Affective psychosis	34
							HC	70
2002	Ertugrul	Turkey	Case control	Outpatient	Caucasian	90	Schizophrenia	60
							HC	30
2011	Guo	China	Longitudinal	Outpatient	Oriental	698	Schizophrenia	578
							Schizophreniform	120
2014	Heeramun-Aubeeluck	China	Longitudinal	Outpatient	Oriental	101	FEP	101
2016	Hou	China	CS	Outpatient	Oriental	80	FEP	40
							HC	40
2011	Mehta	India	CS	Outpatient	Oriental	18	Schizophrenia	9
							HC	9
2014	Okasha	Egypt	CS	Outpatient	Black	90	BPD	60
							HC	30

2008	Pradhan	Brazil	CS	Outpatient	Caucasian	103	BPD	48
							Schizophrenia	32
				Inpatient			HC	23
2013	Santosh	India	CS	Outpatient	Oriental	100	Schizophrenia	100
2008	Schneider	Brazil	CS	Outpatient	Caucasian	94	BPD	66
							HC	28
2016	Tang	China	CS	Outpatient	Oriental	148	Schizophrenia	94
							HC	54
2007	Trivedi	India	CS	Outpatient	Oriental	45	BPD	15
							Schizophrenia	15
							HC	15
2017	Zhou	China	Longitudinal	Inpatient	Oriental	49	FES	32
							HC	17

Summary of clinical and sociodemographic factors of participants

There was no statistical difference between the mean age for participants [34.4 years (SD 9.25)] and the healthy controls [35.0 years (SD 0.74)]. Most of the participants had at least 11.99 years (SD 3.25) of education compared to 12.71 years (SD 3.82) in the healthy controls [Mean difference -0.74 (95%CI -0.8206999-1.6007; p-value 0.06)]. The mean age of illness onset was 26.3 years (SD 7.6). Only four studies assessed for intelligence using the Wechsler Adult Intelligence scale with mean scores of 92.43 (SD 10.6) for the participants and 105.5 (SD 13.8) for the healthy controls. On the Positive and Negative Signs and Symptoms of Schizophrenia scale the mean severity score was 65.96 (SD 13.98). Other sociodemographic and clinical measures are shown in table below.

Table 2: Summary of the sociodemographic characteristics of the participants and healthy controls.

Author	Psychosis severity Rater	Psychosis severity [MEAN (SD)]	Age of participants (Mean/SD)	Age of healthy controls (Mean/SD)	Age of onset of illness (Mean/SD)	Female gender in participants (%)	Female gender in healthy controls (%)	Number of years of education in participants (MEAN)	Number of years of education in healthy controls (MEAN/SD)	Intelligence test	Intelligence Score in participants (MEAN/SD)	Intelligence score in healthy controls (MEAN/SD)
Savitz,2009	ASRM	3.45 (3.6)	48 (14.9)	50.7 (18.9)	27.3 (11.1)	48	46	15.3 (2.3)	15.6 (3.7)	Wechsler Adult Intelligence Scale - General Knowledge subtest	11.3 (1.5)	11.1 (1.7)
Hendricks,2017	NR	NR	37.07	37.5	35.7	7.7	12.5	8.08	11.81	NR	NR	NR
Gureje, 1994	PANSS	NR	28.5	27.1	24.6	36	53	12.3	14.6			
	BPRS	NR										
Mattson, 1997	PANSS	36.19										
Ngoma, 2009	PANSS	54.54	28.14 (7.1)	28 (7.1)	27.3 (6.7)	54.7	57			NR		
	PANSS	62.56										
	PANSS	63.33										
Harvey, 2002			26.3 (4.6)			46						
Leppanen, 2008	NR	NR	38.9 (11.7)	40.9 (10.3)	NR	46.5	50	5.9 (3.0)	6 (3.1)	NR		
Leppanen, 2006	SAPS	3.8 (4)	36.4 (11)	37.1 (9.6)	22.5 (5.5)	32.4	17.5	NR	NR	NR		
Nakasujja, 2012	YMRS		30.31 (8.33)			42.3						
	BPRS											
	BPRS											
	PHQ											
Savitz, 2008	ASRM	2.72 (2.93)	47.75 (15.3)	50.11 (19.5)	26.8 (13.12)			14.8 (3.4)	15.19 (3.77)	South African Wechsler Adult Intelligence Scale (SA- WAIS) General Knowledge subtest	11.2 (1.7)	11.13 (1.7)

Sagar, 2018	YMRS (Median)	23.5	33.81 (12.1)	27.31 (4.47)	22.7 (8.06)	24.4	10.2			Verbal adult intelligence scale	91.54	99.52
	BPRS (Median)	6.67										
	HDRS (Median)	5.3										
Aleptekin, 2005	PANSS	66.28 (14.83)	37 (10.3)	38.13 (13.9)	24.96 (7.56)	39.5	58.1					
Arau'jo, 2015			38.5	39.1		48.3	55.4	8.02	7.62			
Ayres, 2007			32.2 (11.4)	32.1 (11.3)	30.1 (11.8)	52	52.7					
Cabral-Calderin	PANSS	66.41	34.97	34.97	25.74	44.2	47.06	12.7	12.85			
Charernboon, 2017	PANSS		37.1 (11.2)	37.1 (12.1)		55.6	72.2	13.8 (3.7)	13.8 (4.2)			
Ayres, 2009			29.6 (8.4)	31.76 (8.7)	26.6 (8.7)	35.7	45.7	9.95 (3.3)	11.2 (4.2)	Wechsler Abbreviated Scale of Intelligence	-0.36	
Ertugrul, 2002	PANSS	60.9 (17.2)	34.4 (11.1)	34.4 (10.6)	23.2 (6.4)	46.7	46.7					
Guo, 2011	PANSS	44.9 (14.7)	26.18 (7.4)			46.5		12.5 (2.81)				
Heeramun- Aubeeluck, 2014			26.4 (7.0)			51		12.8 (3.1)				
Hou, 2016	PANSS	76.1 (9.6)	26.4 (6.5)	24.4 (5.1)		40	52.5	26.4 (6.5)	24.4 (5.1)			
Mehta, 2011			30 (1.2)	29 (1.0)		33	33	9.9	10.3			
Okasha, 2014	YMRS		27.0 (5.7)	25.8 (3.9)		66.7	33.3	12.8 (3.2)	13.9 (2.7)	Wechsler Adult Intelligence Scale	97.3 (7.0)	112.5 (11.5)
Pradhan, 2008	PANSS	37.0 (4.63)	35.4 (10.7)	37.4 (12.3)	28.2 (10.5)	31.3	43.5	13.6 (2.4)	15.5 (2.7)	Wechsler Adult Intelligence Scale	93.5 (15.0)	106.0 (15.3)
Santosh, 2013	PANSS	2.6 (0.7)										
Schneider, 2008	YMRS	3.01 (2.6)	43.7 (11.9)	35.1 (14.1)		72.7	42.9	10.6 (3.6)	12.2 (3.0)	Wechsler Adult Intelligence Scale	86.5 (9.8)	98.6 (14.6)
Tang, 2016	BPRS	29.2 (3.7)	47.6 (6.4)	47.6 (10.1)	22.2 (2.74)			8.8 (2.2)	10.1 (3.2)			
	SAPS	9.8 (4.7)										
	SANS	41.6 (13.3)										
Trivedi, 2007			34.7 (10.5)	34.3 (11.2)		20	20	11.7 (3.7)	10.8 (2.5)			
Zhou, 2017	PANSS	41.8 (5.9)	26.2 (8.1)	25.5 (5.6)		31.6	23.5	13.5 (2.2)	12.6 (2.3)			

Results of individual studies

a) Validation of tests against a gold standard

No study attempted to validate the brief neuropsychological tests against a gold standard such as the MATRICS cognitive consensus battery. Only three studies compared the sensitivity and specificity of the brief tests against another battery. A summary of the publications is shown in table below.

Table 3: Studies in which a brief test was compared to a complete battery.

Author	Validated	Comparison group-selection criteria	Comparison group-size	Comparison tool	Sensitivity	Specificity	reliability	concurrent validity
Araújo, 2015	YES	HC	58	BACS- French	NR	NR	0.874	0.625
Mehta, 2011					84.2	81	0.71	
Xao, 2014	YES	HC	130	MOCA	68.8	81.5	0.905	0.902

6 studies however used at least 1 test that was like that found in the gold standard and these are highlighted in the table below.

Table 4: Studies that used tests also found in the MCCB.

Author	Year	Country	Subtest/Scale/Battery
Hendricks	2017	South Africa	Trail Making Test
Mattson	1997	South Africa	Trail making test
Ngoma	2009	DRC	Trail making test
Harvey	2002	South Africa	Wechsler Memory scale (revised)
			Continuous performance test (IP version)
Ayres	2009	Brazil	Wechsler Memory Scale (Version III)
Ertugrul	2002	Turkey	Wechsler Memory Scale Revised

The trail making test is one of three tests used in the gold standard to assess for impairment in the speed of processing domain. The mean (SD) scores from the studies in which the trail making test was used was 62.1 (28.8).

b) Tests used, and the domains assessed.

Table 2 summarises the test batteries used in the different studies, domains assessed, time to completion of the assessment, mode of delivery, and the person who performed the assessment. Briefly, most tests were performed by a neuropsychologist; or by trained research assistant/ graduate trainee. Only three studies (Savitz et al, 2009; Savitz et al, 2008;

and Harvey et al, 2002 used nonspecialised health professionals like nurses. In the publications that reported the time taken to administer the test, the average time of administration was 1.8 hours to complete all the required batteries.

Table 5: Summary of the tests used.

Author	Subtest/Scale/Battery	Domains assessed	Total Administration Time (Hours)	Mode of Delivery	Person administering test	Training received
Savitz, 2009	Digits span	WM, AV, VLM, RP, IP	1	Pen and paper	Neuropsychologist	NR
	Controlled Oral Word Association Test (COWAT)				Psychiatric nurse	Yes
	Rey Complex Figure (RCF)				Graduate students	Yes
	Stroop Colour and Word Test					
	Rey Auditory Verbal Learning Test (RAVLT)					
	Wisconsin Card Sorting Test (64 card version)					
Hendricks, 2017	Controlled Oral Word Association Test (COWAT)	VLM, AV, IP, WM, VSM, RP	NR	Pen and paper	Neuropsychologist	NR
	Trail Making Test					
	Rey Auditory Verbal Learning Test (RAVLT)					
	Visual Reproduction Trails					
	Rey Complex Figure (RCF)					
	Rey 15 Item					
	Wechsler Adult Intelligence Scale (WAIS) (South African)					
	clock drawing test					
Gureje, 1994	Verbal memory	VLM, RP, WM, AV	NR	Pen and paper	Neuropsychologist	NR
	Verbal fluency					
	Design fluency					
	Wechsler Adult Intelligence Scale (WAIS) (Performance subtests)					
	Wechsler Adult Intelligence Scale (WAIS) (Verbal subtests)					
Mattson, 1997	Rey Auditory Verbal Learning Test (RAVLT)	VLM, RP, IP, AV	NR	Pen and paper	Clinical psychologist	NR
	Wisconsin Card Sorting Test (Modified)					
	Austin Maze					
	Rey Complex Figure (RCF)					
	Controlled Oral Word Association Test (COWAT)					
	Trail making test					
	Stroop Colour and Word Test					
Ngoma, 2009	Rey 15 Item	VLM, VSM, WM, AV, MS, RP	NR	Pen and paper	Clinical psychologist	NR
	Rey Complex Figure (RCF)					
	Letter number sequence task					
	Test of attention					
	Trail making test					
	Motor speed					
	Controlled Oral Word Association Test (COWAT)					

	Stroop Color and Word test					
	Wisconsin Card Sorting Test (256 version)					
	Trail making test					
Harvey, 2002	Wechsler Memory scale (revised)	WM, VLM, AV, IP, RP	NR	Pen and paper	Research assistants	YES
	Rey Auditory Verbal Learning Test (RAVLT)					
	Continuous performance test (IP version)					
	Verbal fluency					
	Wechsler Adult Intelligence Scale (WAIS)					
	Wisconsin Card Sorting Test					
Leppanen, 2008	Facial affect recognition	social cognition	NR	Computer	NR	NR
Leppanen, 2006	Facial affect recognition	social cognition	NR	Computer	NR	NR
Nakasujja, 2012	WHO UCLA Auditory verbal learning test	VLM, AV, WM, RP, IP	NR	Pen and paper	NR	NR
	Symbol digit modalities test					
	Verbal fluency					
	Wechsler Adult Intelligence Scale version III (WAIS)					
Savitz, 2008	Wechsler Adult Intelligence Scale (WAIS)	AV, WM, VLM, IP, RP	1	Pen and paper	Neuropsychologist	NR
	Controlled Oral Word Association Test (COWAT)				Nurse	
	Rey Complex Figure (RCF)				Graduate students	
	Stroop Color and Word test					
	Rey Auditory Verbal Learning Test (RAVLT)					
	Wisconsin Card Sorting Test (64)					
Sagar, 2018	Post graduate institute memory scale	AV, WM, RP, VLM	1	Pen and Paper	Neuropsychologist	NR
	National Institute of Mental Health and Neuro-Sciences neuropsychology battery					
	Verbal working memory					
Aleptekin, 2005	Wechsler Adult Intelligence Scale (WAIS)	AV, WM, RP	NR	Pen and paper	NR	NR
	Controlled Oral Word Association Test (COWAT)					
Araújo, 2015	15words	VLM, WM, IP, VSM, AV, RP, TS	0.68	pen and paper	NR	NR
	Digit sequence task					
	Token motor task					
	Semantic or category fluency					
	Tower of London					
Ayres, 2007	Controlled Oral Word Association Test (COWAT)	VSM, AV, WM	NR	pen and paper		NR
	Wechsler Adult Intelligence Scale (WAIS)					
Cabral-Calderin, 2010	Emotional Expression Multimorph task	social cognition	NR	NR	NR	NR
Charernboon, 2017	Emotion perception	SC	NR	NR	NR	NR
	Theory of mind					
	Social knowledge					
Ayres, 2009	Short Cognitive test.	IP, AV, VLM, VSM, WM, RP	2	Pen and paper	NR	NR
	Wechsler Memory Scale (Version III)					
	Short Cognitive test.					
	Controlled Oral Word Association Test (COWAT)					

	Hayling and Brixton test					
Ertugrul, 2002	Wechsler Memory Scale Revised	AV, WM, RP, VSM	2	Pen and paper	NR	NR
	Wisconsin card sorting test					
Guo, 2011	Wechsler Adult Intelligence Scale (WAIS) (Revised)	IP, RP, WM, VSM	NR	Pen and paper	Neuropsychologist	NR
	Wisconsin card sorting test					
	Wechsler Adult Intelligence Scale (WAIS) (Revised)					
	Wechsler Memory Scale (Revised)					
Heeramun-Aubeeluck, 2014	Paced Auditory Serial	WM, IP, VLM, VSM	NR		NR	Yes
	Wechsler Memory Scale					
	Wechsler Adult Intelligence Scale (WAIS)					
	Trail making					
	Hopkins Verbal Learning Test (Revised)					
	Brief Visuospatial Memory Test (Revised)					
Hou, 2016	Trail making	IP, AV, VLM				
	Stoop colour word test					
	Hopkins Verbal Learning Test-Revised (					
Mehta, 2011	Social cognition rating scale in Indian Settings	social cog				
Okasha, 2014	Weschler memory scale	WM, VSM, VLM, AV, RP, VSM	3.5	pen and paper	Research assistants	
	Continuous performance tests					
	Wisconsin Card Sorting test					
Pradhan, 2008	Wisconsin Card Sorting Test	RP, VLM, WM, IP	3.5	pen and paper		
	Trail B					
	Controlled Words Association Test					
	PGI Memory scale					
	Bender Visual Motor Gestalt Test					
	Trail A					
Santosh, 2013	Trail making test part B	RP, IP, AV, WM, VLM				
	Trail making test part A					
	Stroop test					
	Digit span					
	Verbal fluency test					
Schneider, 2008	WAIS III	VSM, WM, IP				
Tang, 2016	Facial emotional recognition task	SC				
Trivedi, 2007	Wisconsin Card Sorting Test	RP, AV		computer		
	Continuous performance test					
Zhou, 2017	The Hopkins Verbal Learning Test-revised	WM, VLM, AV, RP		Computer		
	The Verbal Fluency Test, Chinese version					
	The Color Trails Test					
	Stroop Color Word Test Chinese version					
	Cambridge PM Test (C-CAMPROMPT					

The number of domains assessed differed, with 20% (6/29) of the publications assessing only one domain and 17% (5/29) assessing six domains. The proportions of domains assessed is shown in the bar graph (figure 2) below

Figure 2: Bar graph showing number of domains assessed in the publications

24.6% of the tests administered assessed for impairment in the reasoning and problem solving domain. Figure 3 highlights the proportions of tests that assessed the other domains.

Figure 3: Pie chart showing the proportion of domains assessed.

Discussion

We aimed to summarize the literature on brief neuropsychological assessment of cognitive impairment in patients with psychotic disorders from low and middle income countries. A number of studies of brief neuropsychological assessments have been undertaken, but none has been compared with a gold standard. In the three studies in which the brief tests were validated, none used the MCCB as a comparison tool. Also, only six studies included neuropsychological tests found in the MCCB in their assessments. These six studies utilised only 3 of the 10 tests found in the MCCB. It is not possible therefore to suggest which brief assessment tools are valid for assessment of cognitive impairment among patients with psychosis in low and middle income countries.

A large proportion of studies have been undertaken using pen and paper assessments. Some of the limitations of paper based assessments include human error in data collection, the time required to score the assessments and the burden of transporting and storing hard-copy questionnaires (Robbins et al., 2014b). Electronic assessments using mobile technology (mHealth applications, or “apps”) for smartphone and tablet devices are available for assessing cognitive function in persons living with HIV/AIDS(PLWHA) in the African context (Brian and Ben-Zeev, Robbins et al., 2014a) (Robbins et al., 2018). Evidence from both high income and low income countries suggests that mHealth apps are more efficient, accurate, accessible and interactive than assessments delivered via pen and paper (Istepanian R Fau - Jovanov et al., 2004, Nicholas et al., Robbins et al., 2014). The initial cost of acquiring mHealth applications is affordable and these require less financial and human resources than computerized tests and comprehensive assessments (Istepanian R Fau - Jovanov et al., 2004). Future research in the use of electronic assessments may be useful. mHealth applications may also be highly automated with standardized instructions and administration procedures such as scoring of the neuropsychological tests, so facilitating use by non-specialized community workers.

Only three studies used non-specialized health workers to perform the neuropsychological assessments. In low resource settings, such staff are usually at the forefront of care (Patel et al., 2010). (Evans-Lacko et al., 2019, Semrau et al., 2018). Further work on the value of training such workers is needed (Evans-Lacko et al., 2019).

It is essential that assessments must be culturally adapted for use in a setting. Most participants reviewed were stable, outpatients, with minimal severity (based on PANSS total scores). In many low and middle income countries however, there are high rates of patient disengagement from care (Tindall et al., 2018) and such stable patients like the ones reviewed in the publications may not commonly present. Future work on brief assessments among inpatients and at the first episode of psychosis are recommended.

Conclusion:

Although several studies have focused on neuropsychological assessment of cognitive impairment in psychotic disorders in the LMIC context, none was compared with a gold standard. Further work is therefore needed to determine the validity of brief neuropsychological assessment of cognitive impairment in psychotic disorders in these settings. It may be useful to train non-specialized health workers and to use mobile technology, but again further work is needed to confirm these suggestions

Acknowledgements: The Africa Centre for Systematic Reviews & Knowledge Translation (<https://chs.mak.ac.ug/afcen/>) was instrumental in providing training and support in the development of this review.

Conflict of interest: Dr. Robbins is supported by funding from the US National Institutes of Health (P30-MH43520; PI: Robert H. Remien; R01-HD095256; PI: Reuben N. Robbins; R21-HD098035; PI: Reuben N. Robbins). The other authors declare no conflict of interest.

Funding: This work was funded by the Neuropsychiatric Genetics of African Populations-Psychosis (NeuroGAP-Psychosis). This is a multi-country, multi-site case control study that aims to expand our understanding of the causes of schizophrenia and bipolar disorder through large-scale sample collection and analyses in understudied African populations (Stevenson et al., 2019). The first author is a doctoral student on the project. DJS is funded by the SAMRC. The funders have no role in the development of this protocol.

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