# A systematic review of research on neuropsychological measures in psychotic disorders from low and middle-income countries: The question of clinical utility

Schizophrenia Research: Cognition 22 (2020) 100187

Contents lists available at ScienceDirect

Schizophrenia Research: Cognition

journal homepage: www.elsevier.com/locate/scog

Review Article

# A systematic review of research on neuropsychological measures in psychotic disorders from low and middle-income countries: The question of clinical utility

Emmanuel K. Mwesiga[a,c,e,*], Dickens Akena[a,e], Nastassja Koen[b,c], Richard Senono[d], Ekwaro A. Obuku[e], Joy Louise Gumikiriza[a], Reuben N. Robbins[f], Noeline Nakasujja[a], Dan J. Stein[c]

[a] Department of Psychiatry, Makerere University, Uganda
[b] SA MRC Research Unit on Risk & Resilience in Mental Disorders, South Africa
[c] Department of Psychiatry and Neuroscience Institute, University of Cape Town, South Africa
[d] Infectious Disease Institute, Makerere University, Uganda
[e] Africa Centre for Systematic Reviews and Knowledge Translation, College of Health Sciences, Makerere University, Uganda
[f] New York State Psychiatric Institute, Columbia University Irving Medical Center, United States of America

ARTICLE INFO

*Keywords:*
Cognition
Psychosis
Screening
Low and middle-income countries
Systematic review

ABSTRACT

*Introduction:* Several studies of neuropsychological measures have been undertaken in patients with psychotic disorders from low- and middle-income countries (LMICs). It is, however, unclear if the measures used in these studies are appropriate for cognitive screening in clinical settings. We undertook a systematic review to determine if measures investigated in research on psychotic disorders in LMICs meet the clinical utility criteria proposed by The Working Group on Screening and Assessment.

*Methods:* Preferred Reporting Items for Systematic Reviews and Meta-Analyses were employed. We determined if tests had been validated against a comprehensive test battery, the duration and scope of the tests, the personnel administering the tests, and the means of administration.

*Results:* A total of 31 articles were included in the review, of which 11 were from Africa. The studies included 3254 participants with psychosis and 1331 controls. 3 studies reported on the validation of the test against a comprehensive cognitive battery. Assessments took 1 h or less to administer in 6/31 studies. The average number of cognitive domains assessed was four. Nonspecialized staff were used in only 3/31 studies, and most studies used pen and paper tests (17/31).

*Conclusion:* Neuropsychological measures used in research on psychotic disorders in LMICs typically do not meet the Working Group on Screening and Assessment clinical utility criteria for cognitive screening. Measures that have been validated in high-income countries but not in LMICs that do meet these criteria, such as the Brief Assessment of Cognition in Schizophrenia, therefore deserve further study in LMIC settings.

## 1. Introduction

Various neuropsychological measures have been developed for cognitive screening in patients with psychotic disorders (Reichenberg, 2010; Keefe and Fenton, 2007). This is because cognitive impairment is a key predictor of outcomes like quality of life in patients with psychotic disorders. Cognitive impairment contributes a larger portion of disease burden than behavioral, positive or negative symptoms of psychosis (Green et al., 2019; Emsley et al., 2008; Whiteford et al., 2013). Cognitive screening is therefore an essential component of routine care for patients with psychotic disorders (American Psychiatric Association, 2013; World Health Organization, 1992). Cognitive screening in psychotic disorders involves administering neuropsychological measures to assess for cognitive impairment. Although various cognitive domains can be impaired, research by the Measurement and Treatment Research to Improve Cognition in Schizophrenia (MATRICS) initiative recommended seven key domains for neuropsychological assessment in patients with psychotic disorders. These are i) working memory, ii) attention/vigilance, iii) verbal learning and memory, iv) visual learning and memory, v) reasoning and problem solving, vi)

* Corresponding author at: Department of Psychiatry and Mental Health, University of Cape Town, South Africa.
*E-mail address:* emwesiga@chs.mak.ac.ug (E.K. Mwesiga).

https://doi.org/10.1016/j.scog.2020.100187
Received 4 May 2020; Received in revised form 2 August 2020; Accepted 17 August 2020
Available online 24 August 2020

information processing speed, and vii) social cognition (Green et al., 2004; Nuechterlein et al., 2008).

The American Psychological Association's Working Group on Screening and Assessment (WGSA) have provided guidelines for assessing whether neuropsychological measures are appropriate for cognitive screening in clinical settings (American Psychological Association, 2014). WGSA was a collaboration of the American Psychological Association's Board of Professional Affairs and the Committee for the Advancement of Professional Practice of the American Psychological Association to help distinguish cognitive screening from comprehensive psychological evaluations (Roebuck-Spencer et al., 2017). Briefly, the guidelines state that for a measure to have clinical utility for cognitive screening it must be: a) able to identify early on individuals at high risk for impairment, b) be sensitive enough to determine those who need further review; c) be brief and narrow in scope; d) be administered as part of a routine clinic visit; e) be administered by clinicians or support staff or with electronic devices and; f) be used to monitor progress and outcomes (Roebuck-Spencer et al., 2017). Several brief neuropsychological measures such as the Brief Assessment of Cognition in Schizophrenia (BACS) have been shown to meet these criteria in high-income countries (HIC) (Fervaha et al., n.d.; Hurford et al., 2011).

In low- and middle-income countries (countries with a gross national income of less than $5101 https://data.worldbank.org/income-level/low-and-middle-income) there is a growing literature on neuropsychological measures for psychotic disorders (Araújo et al., 2015; Ayres et al., 2007; Nakasujja et al., 2012b; Ngoma et al., 2010). Such work has been useful in demonstrating the large burden of impairment and its association with poor outcomes (Ayres et al., 2007). However, it is unclear if measures that have been researched are appropriate for cognitive screening. In particular, it is unclear whether these neuropsychological measures meet the criteria for cognitive screening as outlined by the WGSA. It would be useful to know if the tests are used early in the course of the illness, whether these assessments have been validated against comprehensive neuropsychological batteries, duration and scope of the tests, setting where the tests are performed, the personnel administering the tests and whether the tests are used for follow up of patients.

Here we aimed to determine if the neuropsychological measures used in research on patients with psychotic disorders in low- and middle-income country contexts meet the six WSGA clinical utility criteria for cognitive screening. A systematic review was undertaken following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009). The study protocol was registered prior to data collection 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.

## 2. Methods

### 2.1. Study selection

Exclusion and inclusion criteria were determined using the PICOSS (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 was 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 neuropsychological measures were performed in at least one cognitive domain. This was done to ensure that neuropsychological measures that are used for assessment and not screening, such as the MATRICS consensus cognitive battery, were excluded. The **comparator** was healthy controls. Our **outcomes** included the clinical diagnosis, whether these assessments had been validated against comprehensive batteries, duration and scope of the tests, setting where the tests were performed, the personnel who administered the tests and whether the tests are used for follow up of patients. All **study designs** irrespective of sample size were included in the review. The review was limited to the low and middle-income country **setting**. This was done due to the disparity in care between high income (GNI > $5101) and low-income countries (GNI < $5101).

### 2.2. Data sources, search strategy, screening and abstraction

In consultation with a librarian (RS), data sources included (a) electronic search of databases, (b) search for gray literature (conference proceedings, clinical trial registers) 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 databases including PubMed, Embase and PsychINFO. Only English language articles were included into the review. The complete search strategy is in the supplementary files. The search strategy used Boolean logic to combine terms in the PICOS framework. Articles were saved into Endnote (Brahmi and Gall, 2006), duplicates removed and two authors (EKM & JLO) independently screened the titles and abstracts to determine which articles were eligible for the review in parallel, before retrieving full texts. A consensus meeting was held when there was disagreement. For each study, abstracted data included name of the test, the domains they assessed, duration of assessments, personnel administering the tests, the types of assessments (paper vs computerized), and whether the tests had been validated against a gold standard.

### 2.3. Quality assessment

Studies with a poor risk of bias assessment were not excluded from the final analysis. However, duplicate publications were removed to limit publication bias. Bias assessment was undertaken by the primary reviewer (EKM) in consultation with DA, JLG and EAO.

### 2.4. Data synthesis

We performed a structured narrative synthesis were words and text are used to summarize and explain the findings of the review (Popay et al., 2006). Quantitative data was analyzed using Stata version 14. (StataCorp. 2015. Stata Statistical Software: Release 14. College Station, TX: StataCorp LP).

The criterion (a) of a test being able to identify early on individuals at high risk for impairment was assessed by abstracting the clinical diagnosis to determine which tests were performed early at the first episode of psychosis. The criterion (b) of a test needing to be sensitive enough to determine those who need further review was assessed by determining the tests that had been validated against a comprehensive neuropsychological battery. The criterion (c) of a test being brief and narrow in scope was assessed by the number of domains assessed and the duration of the assessment. The criterion (d) of a test administered as part of a routine clinic visit was assessed by determining the setting (inpatient versus outpatient) in which the tests were performed. These settings were chosen since neuropsychological assessments are performed on resolution of psychotic symptoms which is often in outpatient not inpatient settings (Harvey, 2013; Reichenberg, 2010). The criterion (e) of a test administered by clinicians or support staff with electronic devices was assessed by determining the mode of delivery of the test (pen and paper versus computerized) and the personnel administering the tests. Finally, the criterion (f) of a test used to monitor

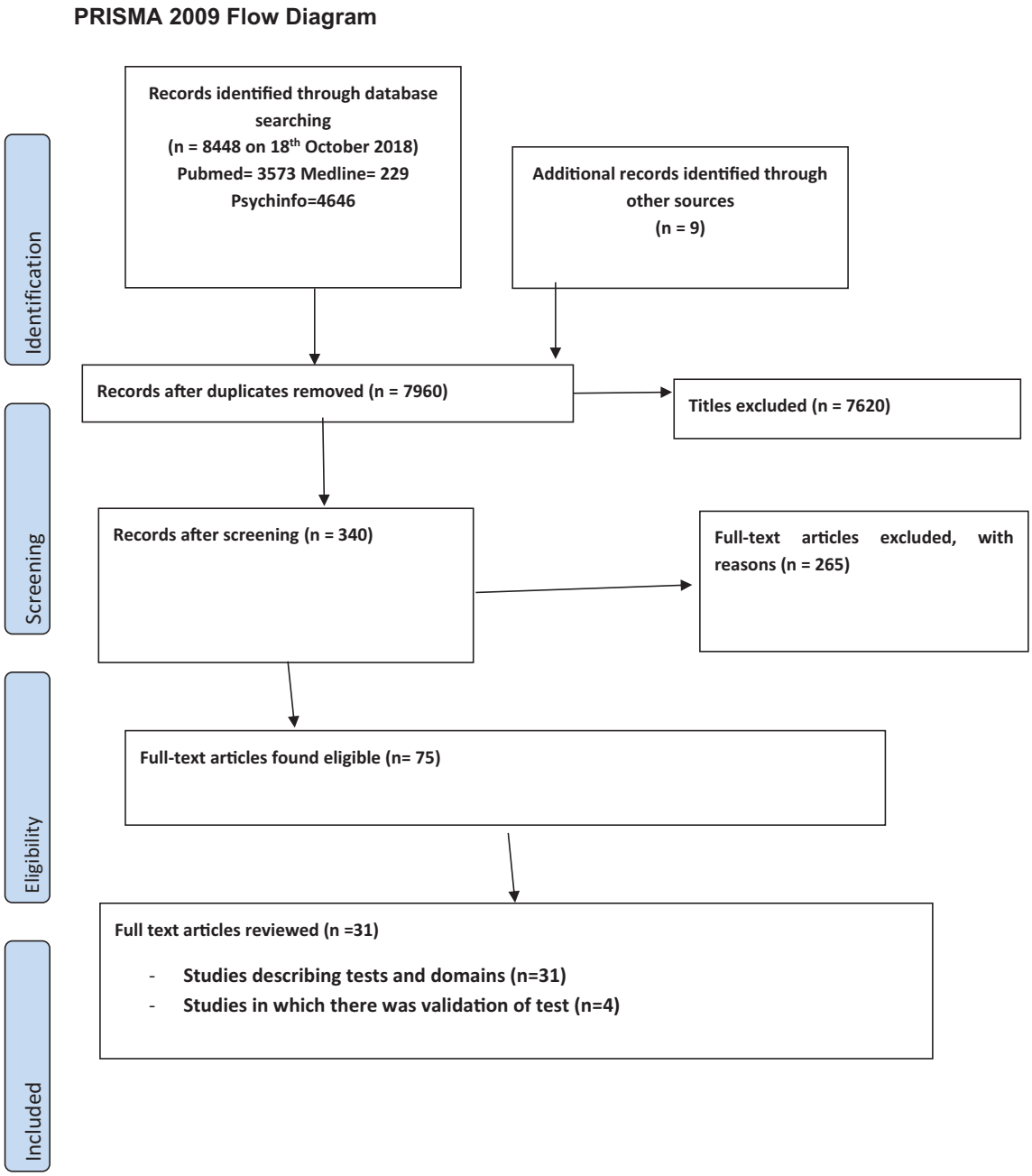


**Fig. 1.** Article selection using PRISMA guidelines.

progress and outcomes was assessed by determining the studies that employed a longitudinal study design as well as those that assessed quality of life in participants.

## 3. Results

### 3.1. Study setting and population

The last search using PubMed was undertaken on April 10th, 2020, while the last search using PsycINFO & Embase, was undertaken on 18th October 2018. After removal of duplicates, eligible titles and abstracts were screened according to the inclusion criteria until a final list was agreed upon. The process is highlighted in Fig. 1. Thirty-one studies were included in the final analysis. The articles were published between 1994 and 2018 with many (15/31) published between the years 2000 and 2010. Seven (7) studies were from Central and South American countries, thirteen (13) 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 31 studies. In total, the final table included 3254 participants with psychosis and 1331 controls.

### 3.2. Early neuropsychological assessment

Only 3 studies were performed early among patients with a first episode of psychosis. The different diagnostic characteristics of the participants are shown in Table 1.

### 3.3. Validation of tests

Only 3 out of 31 studies specifically evaluated a measure against a comprehensive neuropsychological battery. A summary of the publications and associated validation statistics are shown in Table 2.

**Table 1**
Summary of studies included in the review.

| Year | Author | Country | Study design | Population | Population group | Total number of participants | Diagnostic type | Number |
|---|---|---|---|---|---|---|---|---|
| 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 |
| 2002 | Ertugrul | Turkey | Case control | Outpatient | Caucasian | 90 | Schizophrenia | 60 |
| | | | | | | | HC | 30 |
| 2002 | Harvey | South Africa | CS | Outpatient | Caucasian Black | 29 | Schizophrenia English speaking | 5 |
| | | | | | | | Schizophrenia Afrikaans speaking | 24 |
| 2005 | Aleptekin | Turkey | CS | Outpatient | Caucasian | 69 | Schizophrenia | 38 |
| | | | | | | | HC | 31 |
| 2006 | Leppanen | South Africa | CS | Outpatient | Black | 84 | Schizophrenia | 44 |
| | | | | | | | HC | 40 |
| 2007 | Salgado | Brazil | CS | Outpatient Inpatient | Caucasian | 40 | Schizophrenia | 20 |
| | | | | | | | HC | 20 |
| 2007 | Trivedi | India | CS | Outpatient | Oriental | 45 | BPD | 15 |
| | | | | | | | Schizophrenia | 15 |
| | | | | | | | HC | 15 |
| 2007 | Ayres | Brazil | CS | Outpatient | Caucasian | 553 | Schizophrenia | 98 |
| | | | | | | | BPD | 41 |
| | | | | | | | Depression with psychosis | 31 |
| | | | | | | | HC | 383 |
| 2008 | Pradhan | Brazil | CS | Outpatient Inpatient | Caucasian | 103 | BPD | 48 |
| | | | | | | | Schizophrenia | 32 |
| | | | | | | | HC | 23 |
| 2008 | Leppanen | South Africa | CS | Outpatient | African | 81 | Psychosis | 36 |
| | | | | | | | Siblings | 23 |
| | | | | | | | HC | 22 |
| 2008 | Savitz | South Africa | CS | Outpatient | Caucasian | 230 | HC | 65 |
| | | | | | | | BPD I | 49 |
| | | | | | | | BPD II | 19 |
| 2008 | Schneider | Brazil | CS | Outpatient | Caucasian | 94 | BPD | 66 |
| | | | | | | | HC | 28 |
| 2009 | Savitz | South Africa | CS | Outpatient | Caucasian | 110 | BPD with psychosis | 25 |
| | | | | | | | BPD without psychosis | 24 |
| | | | | | | | HC | 61 |
| 2010 | Ayres | Brazil | CS | Outpatient | Caucasian | 160 | Schizophrenia | 56 |
| | | | | | | | Affective psychosis | 34 |
| | | | | | | | HC | 70 |
| 2010 | Ngoma | Democratic Republic of Congo | CS | Inpatient | Black | 341 | HC | 153 |
| | | | | | | | Brief psychotic disorder | 68 |
| | | | | | | | Schizophreniform | 50 |
| | | | | | | | Schizophrenia | 70 |
| 2010 | Cabral-Calderin | Cuba | Longitudinal | Outpatient | Caucasian | 68 | Schizophrenia | 34 |
| | | | | | | | HC | 34 |
| 2011 | Mehta | India | CS | Outpatient | Oriental | 18 | Schizophrenia | 9 |
| | | | | | | | HC | 9 |
| 2011 | Guo | China | Longitudinal | Outpatient | Oriental | 698 | Schizophrenia | 578 |
| | | | | | | | Schizophreniform | 120 |
| 2012 | Nakasujja | Uganda | Longitudinal | Inpatient | Black | 483 | Mania | 312 |
| | | | | | | | Psychosis NOS | 16 |
| | | | | | | | Schizophrenia | 100 |
| | | | | | | | Depression | 55 |
| 2013 | Santosh | India | CS | Outpatient | Oriental | 100 | Schizophrenia | 100 |
| 2014 | Heeramun-Aubeeluck | China | Longitudinal | Outpatient | Oriental | 101 | FEP | 101 |
| 2014 | Okasha | Egypt | CS | Outpatient | Black | 90 | BPD | 60 |
| | | | | | | | HC | 30 |
| 2014 | Mazhari | Iran | CS | Outpatient | Persian | 100 | Schizophrenia | 50 |
| | | | | | | | HC | 50 |
| 2015 | Arau´ jo | Brazil | CS | Outpatient | Caucasian | 174 | Schizophrenia | 116 |
| | | | | | | | HC | 58 |
| 2016 | Hou | China | CS | Outpatient | Oriental | 80 | FEP | 40 |
| | | | | | | | HC | 40 |
| 2016 | Tang | China | CS | Outpatient | Oriental | 148 | Schizophrenia | 94 |
| | | | | | | | HC | 54 |
| 2017 | Charernboon | Thailand | CS | Outpatient | Oriental | 72 | Schizophrenia | 36 |
| | | | | | | | HC | 36 |
| 2017 | Zhou | China | Longitudinal | Inpatient | Oriental | 49 | FES | 32 |
| | | | | | | | HC | 17 |

(*continued on next page*)

**Table 1** (*continued*)

| Year | Author | Country | Study design | Population | Population group | Total number of participants | Diagnostic type | Number |
|---|---|---|---|---|---|---|---|---|
| 2017 | Hendricks | South Africa | CS | Inpatient | Caucasian | 29 | Alcohol induced psychosis | 13 |
| | | | | | | | Alcohol use | 16 |
| 2018 | Sagar | India | Longitudinal | Outpatient | Oriental | 178 | BPD depressed | 36 |
| | | | | | | | BPD manic | 41 |
| | | | | | | | BPD euthymic | 52 |
| | | | | | | | HC | 49 |

FES = first episode schizophrenia, HC = healthy controls, BPD = bipolar affective disorder, FEP = first episode psychosis, NOS = not otherwise specified.

### 3.4. Scope and brevity of tests

The choice of the number of domains assessed differed across the publications with 8 out of 31 publications (25.8%) assessing for impairment in only one domain while 5 out of 31(17%) studies assessed for impairment in six domains. The proportions of domains assessed are shown in the bar graph (Fig. 2) below. Most tests assessed for impairment in the reasoning and problem-solving domain accounting for 24.64% of all tests in the studies. Fig. 3 highlights the proportions of tests that assessed the other domains. In 6 studies, the time taken to perform the assessments was less than hour. Domains assessed and the time taken to perform the tests is highlighted in Table 3.

### 3.5. Setting where tests were performed

Table 1 highlights the clinic setting in which the tests were performed. Twenty-four studies were conducted in an outpatient population, 5 were carried out among inpatients and 2 in both outpatient and inpatient populations.

### 3.6. Administration of tests with support of technology

Four studies (Harvey et al., 2003; Okasha et al., 2014; Savitz et al., 2009; Savitz et al., 2008) used nonspecialised health professionals to perform the tests. Most tests were performed by a neuropsychologist; or by trained research assistant/graduate trainee. Four out of 31 studies used computerized assessments. This is highlighted in Table 3.

### 3.7. Follow up of participants

Only one study (Alptekin et al., 2005) reported on the quality of life of the participants. Only 6/31 studies (19.4%) utilised a longitudinal study design. These longitudinal studies are highlighted in Table 1.

## 4. Risk of bias across studies

There was extensive publication bias ($p \leq 0.005$) as shown in the funnel plot (Fig. 4). Published studies (circles) and unpublished studies (squares) in the funnel plot were estimated from the trim-and-fill method. The solid line corresponds to adjustments for the impact of publication bias summary effect and the dashed line to the unadjusted summary effect.

## 5. Discussion

The research done to date suggests several gaps in the field. Only three studies performed neuropsychological assessments in patients with a first episode of psychosis (Heeramun-Aubeeluck et al., 2015; Hou et al., 2016; Zhou et al., 2017). It is recommended that assessments are performed at the earliest opportunity (American Psychiatric Association, 2013; World Health Organization, 1992; Reichenberg, 2010; Keefe and Fenton, 2007). There is need to validate tools for use among patients with a first episode of psychosis in LMICs (González-Blanch et al., 2011; Moreno-Granados et al., 2014).

The number of studies in which tests were validated against a comprehensive neuropsychological battery was low (Mehta et al., 2011; Mazhari et al., 2014; Araujo et al., 2015). More studies in which the performance of brief tests is compared against comprehensive batteries like the MATRICS consensus cognitive battery (MCCB) are needed. To date most studies have compared the performance of comprehensive batteries like the CogState and the MOCA which have little utility in LMICs with MCCB (Gil-Berrozpe et al., 2020; Lees et al., 2015). However, the results of these studies provide some support for validity.

In 6 out of 31 studies (Salgado et al., 2007; Savitz et al., 2008; Savitz et al., 2009; Mazhari et al., 2014; Araujo et al., 2015; Sagar et al., 2018), the assessment took < 1 h to assess for impairment in five domains, which is attractive for clinical application. Most tests assessed for impairment in the reasoning and problem-solving domain (Gureje et al., 1994; Mattson et al., 1997; Ertuğrul and Uluğ, 2002; Harvey et al., 2003; Alptekin et al., 2005; Ayres et al., 2007; Salgado et al., 2007; Trivedi et al., 2007; Pradhan et al., 2008; Savitz et al., 2008; Savitz et al., 2009; Ngoma et al., 2010; Guo et al., 2011; Nakasujja et al., 2012a; Mazhari et al., 2014; Araujo et al., 2015; Hendricks et al., 2017; Zhou et al., 2017; Sagar et al., 2018). This seems clinically useful given literature from high-income countries that the greatest burden of cognitive impairment is in the cognitive domains of attention/vigilance, memory and reasoning and problem-solving among chronic patients (Rund, 2002).

In this review, only three studies used nonspecialised staff to perform the neuropsychological assessments (Harvey et al., 2003; Savitz et al., 2008; Savitz et al., 2009). This raises concern about the clinical utility of these measures in LMICs, where there are few specialized staff (Evans-Lacko et al., 2019; Mugisha et al., 2017; Semrau et al., 2015). mHealth apps may be more cost-efficient and feasible for delivery by non-specialized staff (Istepanian et al., 2004; Nicholas et al., n.d.; Robbins et al., 2018). Evidence suggests that tests delivered via mHealth applications are more efficient, accurate, accessible and

**Table 2**
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 |
|---|---|---|---|---|---|---|---|---|
| Mehta, 2011 | NR | NR | NR | NR | 84.2 | 81 | 0.71 | NR |
| Mazhari,2014 | YES | HC | 50 | Standard battery | 98.0 | 66.0 | 0.74 | NR |
| Arau´jo, 2015 | YES | HC | 58 | BACS- French | NR | NR | 0.874 | 0.625 |

BACS - Brief Assessment of Cognition in Schizophrenia; MOCA - Montreal Cognitive Assessment.

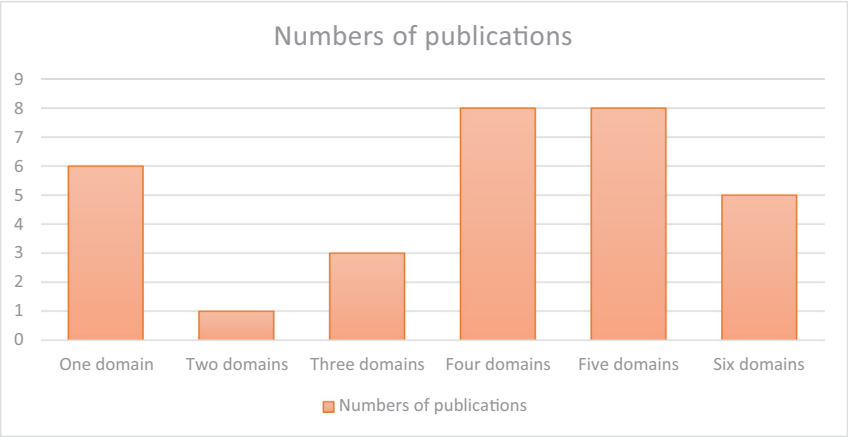


**Fig. 2.** Bar graph showing number of domains assessed in the publications.

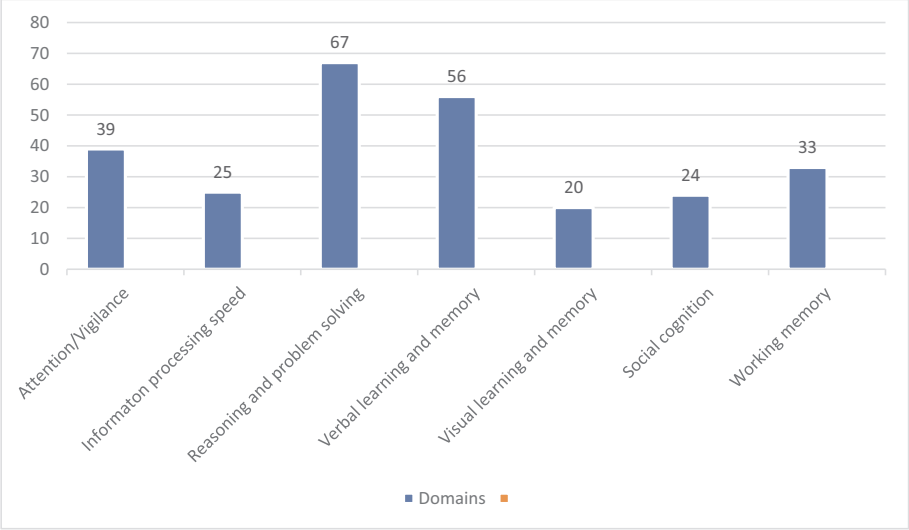


**Fig. 3.** Bar chart showing the proportion of domains assessed.

interactive than assessments delivered via pen and paper (Bakkour et al., 2014).

Most tests were performed using pen and paper tests (Gureje et al., 1994; Mattson et al., 1997; Ertuğrul and Uluğ, 2002; Harvey et al., 2003; Alptekin et al., 2005; Ayres et al., 2007; Salgado et al., 2007; Pradhan et al., 2008; Savitz et al., 2008; Savitz et al., 2009; de Mello Ayres et al., 2010; Ngoma et al., 2010; Guo et al., 2011; Nakasujja et al., 2012a; Mazhari et al., 2014; Okasha et al., 2014; Araujo et al., 2015; Hendricks et al., 2017; Sagar et al., 2018). Limitations of paper based assessments include human error in data collection, the additional time required to score the assessments after they have been administered, costs associated with obtaining copyrighted and proprietary forms, and the burden of transporting and storing hard-copy questionnaires (Robbins et al., 2014a). Further work is warranted on the use of electronic assessments using mobile technology (mHealth applications, or "apps") as is already being done in other populations such as persons living with HIV/AIDS (Brian and Ben-Zeev, n.d.; Robbins et al., 2014b; Robbins et al., 2018).

Few studies were of a longitudinal study design, and so it is unclear whether these tests are useful for monitoring progress and outcomes (Cabral-Calderin et al., 2010; Guo et al., 2011; Nakasujja et al., 2012a; Heeramun-Aubeeluck et al., 2015; Zhou et al., 2017; Sagar et al., 2018). Also, only one study assessed for quality of life as an outcome (Alptekin et al., 2005) highlighting the strong associations between cognitive impairment and quality of life. There is need for further studies on the ability of tests to be used in longitudinal studies.

One limitation of our own work deserves emphasis: we searched for English publications only and so may have missed studies published in other languages. Also, the WGSA criteria are not entirely specific on what characteristics constitute the threshold for meeting a criterion. We welcome scrutiny of our study descriptions into what may constitute meeting the WGSA criteria. A further limitation is that our criteria were based on findings from research on these measures, whereas the criteria are intended to address clinical use of these measures.

In conclusion, measures that have been used in research on psychotic disorders in low- and middle-income countries meet only some WCGA clinical utility criteria. Several candidate assessments are, however, attractive in terms of their scope and duration, and at least one of these, the Brief Assessment of Cognition in Schizophrenia; has been validated in high-income settings (Chianetta et al., 2008; Keefe et al., 2008; Salgado et al., 2007; Mazhari et al., 2014; Araujo et al., 2015). Further work on the administration of measures performed by non-specialized staff using mHealth apps is recommended in low and middle-income contexts.

## List of abbreviations

| | |
|---|---|
| LMIC | low- and middle-income country |
| Apps | application |
| mHealth | mobile health |

**Table 3**
Summary of tests used, domains they assess, duration and who performed test.

| Author | Subtest/scale/battery | Domains assessed | Administration time (hours) | Mode of delivery | Person administering test | Training received |
|---|---|---|---|---|---|---|
| Gureje, 1994 | . Verbal memory<br>. Verbal Fluency<br>. Design fluency<br>. Wechsler Adult Intelligence Scale (WAIS) (Performance subtests)<br>. Wechsler Adult Intelligence Scale (WAIS) (Verbal subtests) | VLM, RP, WM, AV | NR | Pen and paper | Neuropsychologist | NR |
| Mattson, 1997 | . Rey Auditory Verbal Learning Test (RAVLT)<br>. Wisconsin Card Sorting Test (Modified)<br>. Austin Maze<br>. Rey Complex Figure (RCF)<br>. Controlled Oral Word Association Test (COWAT)<br>. Trail making test<br>. Stroop Color and Word Test | VLM, RP, IP, AV | NR | Pen and paper | Clinical psychologist | NR |
| Ertugrul. 2002 | . Wechsler Memory Scale Revised<br>. Wisconsin card sorting test | AV, WM, RP, VSM | 2 | Pen and paper | NR | NR |
| Harvey, 2002 | . Wechsler Memory scale (revised)<br>. Rey Auditory Verbal Learning Test (RAVLT)<br>. Continuous performance test (IP version)<br>. Verbal fluency<br>. Wechsler Adult Intelligence Scale (WAIS)<br>. Wisconsin Card Sorting Test | WM, VLM, AV, IP, RP | NR | Pen and paper | Research assistants | YES |
| Aleptekin, 2005 | . Wechsler Adult Intelligence Scale (WAIS)<br>. Controlled Oral Word Association Test (COWAT) | AV, WM, RP | NR | Pen and paper | NR | NR |
| Leppanen, 2006 | . Facial affect recognition | Social cognition | NR | Computer | NR | NR |
| Salgado, 2007 | . 15 item word list<br>. Digit sequencing task<br>. Token motor task<br>. Category fluency<br>. Symbol coding<br>. Tower of London | VLM, WM, AV. RP, IP | 0.72 | Pen and paper | Psychiatrist | Single |
| Trivedi, 2007 | . Wisconsin Card Sorting Test<br>. Continuous performance test | RP, AV | NR | Computer | NR | NR |
| Ayres, 2007 | . Controlled Oral Word Association Test (COWAT)<br>. Wechsler Adult Intelligence Scale (WAIS) | VSM, AV, WM | NR | Pen and paper | | NR |
| Pradhan, 2008 | . Wisconsin Card Sorting Test<br>. Trail B<br>. Controlled Words Association Test<br>. PGI Memory scale<br>. Bender Visual Motor Gestalt Test<br>. Trail A | RP, VLM, WM, IP, AV | 3.5 | Pen and paper | NR | NR |
| Leppanen, 2008 | . Facial affect recognition | Social cognition | NR | Computer | NR | NR |
| Savitz, 2008 | . Wechsler Adult Intelligence Scale (WAIS)<br>. Controlled Oral Word Association Test (COWAT)<br>. Rey Complex Figure (RCF)<br>. Stroop Color and Word test<br>. Rey Auditory Verbal Learning Test (RAVLT)<br>. Wisconsin Card Sorting Test (64 item) | AV, WM, VLM, VLM, IP, RP | 1 | Pen and paper | Neuropsychologist<br>Psychiatric nurse<br>Graduate students | Yes |
| Schneider, 2008 | . Wechsler Adult Intelligence Scale (WAIS) III | VSM, WM, IP | NR | NR | NR | NR |
| Savitz, 2009 | . Digits span<br>. Controlled Oral Word Association Test (COWAT)<br>. Rey Complex Figure (RCF)<br>. Stroop Color and Word test<br>. Rey Auditory Verbal Learning Test (RAVLT)<br>. Wisconsin Card Sorting Test (64 item) | WM, AV, VLM, RP, IP | 1 | Pen and paper | Neuropsychologist<br>Psychiatric nurse<br>Graduate students | Yes |
| Ayres, 2010 | . Controlled Oral Word Association Test (COWAT) | VSM, AV, WM | NR | Pen and paper | | NR |

(*continued on next page*)

**Table 3** (*continued*)

| Author | Subtest/scale/battery | Domains assessed | Administration time (hours) | Mode of delivery | Person administering test | Training received |
|---|---|---|---|---|---|---|
| | . Wechsler Adult Intelligence Scale (WAIS) | | | | | |
| Ngoma, 2010 | . Rey 15 Item<br>. Rey Complex Figure (RCF)<br>. Letter number sequence task<br>. Test of attention<br>. Trail making test<br>. Motor speed<br>. Controlled Oral Word Association Test (COWAT)<br>. Stroop Color and Word test<br>. Wisconsin Card Sorting Test (256 version)<br>. Trail making test | VLM, VSM, WM, AV, MS, RP | NR | Pen and paper | Clinical psychologist | NR |
| Cabral-Calderin, 2010 | . Emotional Expression Multimorph task | social Cognition | NR | NR | NR | NR |
| Mehta, 2011 | . Social cognition rating scale in Indian Settings | Social cognition | NR | NR | NR | NR |
| Guo, 2011 | . Wechsler Adult Intelligence Scale (WAIS) (Revised)<br>. Wisconsin card sorting test<br>. Wechsler Adult Intelligence Scale (WAIS) (Revised)<br>. Wechsler Memory Scale (Revised) | IP, RP, WM, VSM | NR | Pen and paper | Neuropsychologist | NR |
| Nakasujja, 2012 | . WHO UCLA Auditory verbal learning test<br>. Symbol digit modalities test<br>. Verbal fluency<br>. Wechsler Adult Intelligence Scale version III (WAIS) | VLM, AV, WM, RP, IP | NR | Pen and paper | NR | NR |
| Santosh, 2013 | . Trail making test part B<br>. Trail making test part A<br>. Stroop test<br>. Digit span<br>. Verbal fluency test | RP, IP, AV, WM, VLM | NR | NR | NR | NR |
| Heeramun-Aubeeluck, 2014 | . Paced Auditory Serial<br>. Wechsler Memory Scale<br>. Wechsler Adult Intelligence Scale (WAIS)<br>. Trail making<br>. Hopkins Verbal Learning Test (Revised)<br>. Brief Visuospatial Memory Test (Revised) | WM, IP, VLM, VSM | NR | NR | NR | Yes |
| Okasha, 2014 | . Weschler memory scale<br>. Continuous performance tests<br>. Wisconsin Card Sorting test | WM, VSM, VLM, AV, RP, | 3.5 | pen and paper | Research assistants | NR |
| Mazhari, 2014 | . 15 item word list<br>. Digit sequencing task<br>. Token motor task<br>. COWAT<br>. Symbol coding<br>. Tower of London<br>. Trail making B | VLM, WM, AV. RP, IP | 0.67 | Pen and paper | NR | NR |
| Arau´ jo, 2015 | . Rey Auditory-Verbal Learning Test<br>. Wechsler Adult Intelligence Scale (WAIS) (Version III)<br>. Trail Making test<br>. Controlled Oral Word Association Test (COWAT)<br>. Wisconsin Card Sort Test (128 cards) | VLM, WM, IP, VSM, AV, RP | 0.68 | Pen and paper | NR | NR |
| Hou, 2016 | . Trail making<br>. Stroop color word test<br>. Hopkins Verbal Learning Test-Revised (HVLT-R) | IP, AV, VLM | NR | NR | NR | NR |
| Tang, 2016 | . Facial emotional recognition task | SC | NR | NR | NR | NR |
| Charernboon, 2017 | . Emotion perception<br>. Theory of mind<br>. Social knowledge | SC | NR | NR | NR | NR |
| Zhou, 2017 | . Hopkins Verbal Learning Test-revised<br>. The Verbal Fluency Test, Chinese version<br>. The Color Trails Test<br>. Stroop Color Word Test Chinese version<br>. Cambridge PM Test (C-CAMPROMPT) | WM, VLM, AV, RP | NR | Computer | NR | NR |
| Hendricks, 2017 | | | NR | Pen and paper | Neuropsychologist | NR |

(*continued on next page*)

**Table 3** (*continued*)

| Author | Subtest/scale/battery | Domains assessed | Administration time (hours) | Mode of delivery | Person administering test | Training received |
|---|---|---|---|---|---|---|
| | . Controlled Oral Word Association Test (COWAT)<br>. Trail Making Test<br>. Rey Auditory Verbal Learning Test (RAVLT)<br>. Visual Reproduction Trails<br>. Rey Complex Figure (RCF)<br>. Rey 15 Item<br>. Wechsler Adult Intelligence Scale (WAIS) (South African)<br>. clock drawing test | VLM, AV, IP, WM, VSM, RP | | | | |
| Sagar, 2018 | . Post graduate institute memory scale<br>. National Institute of Mental Health and Neuro-Sciences neuropsychology battery<br>. Verbal working memory | AV, WM,RP, VLM | 1 | Pen and Paper | Neuropsychologist | NR |

WM = working memory, AV = attention/vigilance, VLM = verbal learning and memory, VSM = visual learning and memory, RP = reasoning and problem solving, IP = information processing speed, and SC = social cognition. NR = Not reported.

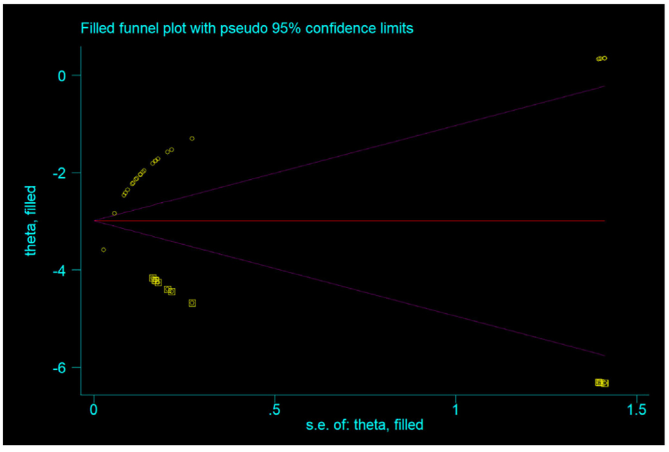


**Fig. 4.** Filled funnel plot with pseudo 95% confidence limits showing publication bias.

## CRediT authorship contribution statement

**Emmanuel K. Mwesiga**:Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Validation, Visualization, Writing - original draft, Writing - review & editing.**Dickens Akena**:Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Resources, Validation, Writing - original draft, Writing - review & editing.**Nastassja Koen**:Conceptualization, Writing - review & editing.**Richard Senono**:Data curation, Software, Writing - review & editing.**Ekwaro A. Obuku**:Conceptualization, Formal analysis, Investigation, Methodology, Software, Validation, Writing - review & editing.**Joy Louise Gumikiriza**:Data curation, Investigation, Validation, Writing - review & editing.**Reuben N. Robbins**:Resources, Writing - original draft, Writing - review & editing.**Noeline Nakasujja**:Conceptualization, Supervision, Writing - review & editing.**Dan J. Stein**:Conceptualization, Funding acquisition, Resources, Writing - original draft, Writing - review & editing.

## Declaration of competing 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.

## Acknowledgements

We are indebted to the Africa Centre for Systematic Reviews and Knowledge Translation, College of Health Sciences, Makerere University that provided trainings in the design and application of systematic reviews.

## Ethics approval and consent to participate

This work is part of the requirements towards an award of a doctoral degree from the University of Cape Town (UCT). The project received ethical clearance from the (HREC) of UCT (# 574/2017), school of medicine research and ethics committee (SOMREC) of Makerere University (#2017-086) and the Uganda National Council of Science and Technology (UNCST) (# HS142ES).

## Availability of data and material

All data generated or analyzed during this study is included in the supplementary information files.

## Funding

This work is supported by the Neuropsychiatric Genetics in African Populations (NeuroGAP) Study (Stevenson et al., 2019). The content of the protocol is solely a responsibility of the authors and the funder had no role in development of the protocol. RNR is supported by the National Institutes of Health (P30 MH043520; PI: Remien).

## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.scog.2020.100187.

## References


Alptekin, K., Akvardar, Y., Akdede, B.B.K., Dumlu, K., Işik, D., Pirinçci, F., Yahssin, S., Kitiş, A., 2005. Is quality of life associated with cognitive impairment in schizophrenia? Prog. Neuro-Psychopharmacol. Biol. Psychiatry 29, 239–244.

American Psychiatric Association, 2013. Diagnostic and Statistical Manual of Mental Disorders, 5th ed. American Psychiatric Association.

American Psychological Association, 2014. Distinguishing between Screening and Assessment for Mental and Behavioral Health Problems.

Araujo, G.E., Resende, C.B., Cardoso, A.C., Teixeira, A.L., Keefe, R.S., Salgado, J.V., 2015. Validity and reliability of the Brazilian Portuguese version of the BACS (Brief Assessment of Cognition in Schizophrenia). Clinics (Sao Paulo) 70, 278–282.

Araújo, G.E., Resende, C.B., Cardoso, A.C., Teixeira, A.L., Keefe, R.S., Salgado, J.V., 2015. Validity and reliability of the Brazilian Portuguese version of the BACS (Brief Assessment of Cognition in Schizophrenia). Clinics 70, 278–282.

Ayres, A.M., Busatto, G.F., Menezes, P.R., Schaufelberger, M.S., Coutinho, L., Murray, R.M., Mcguire, P.K., Rushe, T., Scazufca, M., 2007. Cognitive deficits in first-episode psychosis: a population-based study in Sao Paulo, Brazil. Schizophr. Res. 90, 338–343.

Bakkour, N., Samp, J., Akhras, K., El Hammi, E., Soussi, I., Zahra, F., Duru, G., Kooli, A., Toumi, M., 2014. Systematic review of appropriate cognitive assessment instruments used in clinical trials of schizophrenia, major depressive disorder and bipolar disorder. Psychiatry Res. 216, 291–302.

Brahmi, F.A., Gall, C., 2006. EndNote® and Reference Manager® citation formats compared to "instructions to authors" in top medical journals. Medical Reference Services Quarterly 25, 49–57.

Brian, R. M. & Ben-Zeev, D. Mobile health (mHealth) for mental health in Asia: objectives, strategies, and limitations.

Cabral-Calderin, Y., Mendoza-Quiñones, R., Garcia, A., Caballero, A., Domínguez, M., Reyes, M.M., 2010. Effect of quetiapine treatment on facial emotion recognition deficits in schizophrenia patients. Schizophr. Res. 119, 275–276.

Chianetta, J.M., Lefebvre, M., Leblanc, R., Grignon, S., 2008. Comparative psychometric properties of the BACS and RBANS in patients with schizophrenia and schizoaffective disorder. Schizophr. Res. 105, 86–94.

De Mello Ayres, A., Scazufca, M., Menezes, P.R., Nakano, E.Y., Regina, A.C.B., Schaufelberger, M.S., Murray, R.M., Mcguire, P.K., Rushe, T., Busatto, G.F., 2010. Cognitive functioning in subjects with recent-onset psychosis from a low-middle-income environment: multiple-domain deficits and longitudinal evaluation. Psychiatry Res. 179, 157–164.

Emsley, R., Chiliza, B., Schoeman, R., 2008. Predictors of long-term outcome in schizophrenia. Curr Opin Psychiatry 21, 173–177.

Ertuğrul, A., Uluğ, B., 2002. The influence of neurocognitive deficits and symptoms on disability in schizophrenia. Acta Psychiatr. Scand. 105, 196–201.

Evans-Lacko, S., Hanlon, C., Alem, A., Ayuso-Mateos, J.L., Chisholm, D., Gureje, O., Jordans, M., Kigozi, F., Lempp, H., Lund, C., Petersen, I., Shidhaye, R., Thornicroft, G., Semrau, M., 2019. Evaluation of capacity-building strategies for mental health system strengthening in low- and middle-income countries for service users and caregivers, policymakers and planners, and researchers. BJPsych Open 5, e67.

Fervaha, G., Hill, C., Agid, O., Takeuchi, H., Foussias, G., Siddiqui, I., Kern, R. S. & Remington, G. Examination of the validity of the Brief Neurocognitive Assessment (BNA) for schizophrenia.

Gil-Berrozpe, G.J., Sánchez-Torres, A.M., García De Jalón, E., Moreno-Izco, L., Fañanás, L., Peralta, V., Cuesta, M.J., 2020. Utility of the MoCA for cognitive impairment screening in long-term psychosis patients. Schizophr. Res. 216, 429–434.

González-Blanch, C., Pérez-Iglesias, R., Rodríguez-Sánchez, J.M., Pardo-García, G., Martínez-García, O., Vázquez-Barquero, J.L., Crespo-Facorro, B., 2011. A digit symbol coding task as a screening instrument for cognitive impairment in first-episode psychosis. Arch. Clin. Neuropsychol. 26, 48–58.

Green, M.F., Nuechterlein, K.H., Gold, J.M., Barch, D.M., Cohen, J., Essock, S., Fenton, W.S., Frese, F., Goldberg, T.E., Heaton, R.K., Keefe, R.S., Kern, R.S., Kraemer, H., Stover, E., Weinberger, D.R., Zalcman, S., Marder, S.R., 2004. Approaching a consensus cognitive battery for clinical trials in schizophrenia: the NIMH-MATRICS conference to select cognitive domains and test criteria. Biol. Psychiatry 56, 301–307.

Green, M.F., Horan, W.P., Lee, J., 2019. Nonsocial and social cognition in schizophrenia: current evidence and future directions. World Psychiatry 18, 146–161.

Guo, X., Zhai, J., Wei, Q., Twamley, E.W., Jin, H., Fang, M., Hu, M., Zhao, J., Early-Stage Schizophrenia Outcome Study, I, 2011. Neurocognitive effects of first- and second-generation antipsychotic drugs in early-stage schizophrenia: a naturalistic 12-month follow-up study. Neurosci. Lett. 503, 141–146.

Gureje, O., Olley, O., Acha, R., Osuntokun, B., 1994. Do young schizophrenics with recent onset of illness show evidence of hypofrontality? Behav. Neurol. 7, 59–66.

Harvey, P.D., 2013. Cognitive Impairment in Schizophrenia: Characteristics, Assessment and Treatment. Cambridge University Press.

Harvey, P.D., I Fortuny, L.A., Vester-Blockland, E., De Smedt, G., 2003. Cross-national cognitive assessment in schizophrenia clinical trials: a feasibility study. Schizophr. Res. 59, 243–251.

Heeramun-Aubeeluck, A., Liu, N., Fischer, F., Huang, N., Chen, F., He, L., Yang, C., Luo, Y., Lu, Z., 2015. Effect of time and duration of untreated psychosis on cognitive and social functioning in Chinese patients with first-episode schizophrenia: a 1-year study. Nord J Psychiatry 69, 254–261.

Hendricks, M.L., Emsley, R.A., Nel, D.G., Thornton, H.B., Jordaan, G.P., 2017. Cognitive changes in alcohol-induced psychotic disorder. BMC Res Notes 10, 166.

Hou, C.-L., Xiang, Y.-T., Wang, Z.-L., Everall, I., Tang, Y., Yang, C., Xu, M.-Z., Correll, C.U., Jia, F.-J., 2016. Cognitive functioning in individuals at ultra-high risk for psychosis, first-degree relatives of patients with psychosis and patients with first-episode schizophrenia. Schizophr. Res. 174, 71–76.

Hurford, I.M., Marder, S.R., Keefe, R.S.E., Reise, S.P., Bilder, R.M., 2011. A brief cognitive assessment tool for schizophrenia: construction of a tool for clinicians. Schizophr. Bull. 37, 538–545.

Istepanian R Fau - Jovanov, E., Jovanov E Fau - Zhang, Y. T. & Zhang, Y. T. 2004. Introduction to the special section on M-Health: beyond seamless mobility and global wireless health-care connectivity.

Keefe, R.S., Fenton, W.S., 2007. How should DSM-V criteria for schizophrenia include cognitive impairment? Schizophr. Bull. 33, 912–920.

Keefe, R.S., Harvey, P.D., Goldberg, T.E., Gold, J.M., Walker, T.M., Kennel, C., Hawkins, K., 2008. Norms and standardization of the Brief Assessment of Cognition in Schizophrenia (BACS). Schizophr. Res. 102, 108–115.

Lees, J., Applegate, E., Emsley, R., Lewis, S., Michalopoulou, P., Collier, T., Lopez-Lopez, C., Kapur, S., Pandina, G.J., Drake, R.J., 2015. Calibration and cross-validation of MCCB and CogState in schizophrenia. Psychopharmacology 232, 3873–3882.

Mark, W., Toulopoulou, T., 2016. Cognitive intermediate phenotype and genetic risk for psychosis. Curr. Opin. Neurobiol. 36, 23–30.

Mattson, D.T., Berk, M., Lucas, M.D., 1997. A neuropsychological study of prefrontal lobe function in the positive and negative subtypes of schizophrenia. The Journal of Genetic Psychology: Research and Theory on Human Development 158, 487–494.

Mazhari, S., Parvaresh, N., Eslami Shahrbabaki, M., Sadeghi, M.M., Nakhaee, N., Keefe, R.S., 2014. Validation of the Persian version of the brief assessment of cognition in schizophrenia in patients with schizophrenia and healthy controls. Psychiatry Clin. Neurosci. 68, 160–166.

Mehta, U.M., Thirthalli, J., Naveen Kumar, C., Mahadevaiah, M., Rao, K., Subbakrishna, D.K., Gangadhar, B.N., Keshavan, M.S., 2011. Validation of Social Cognition Rating Tools in Indian Setting (SOCRATIS): a new test-battery to assess social cognition. Asian J. Psychiatr. 4, 203–209.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G., 2009. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. Ann. Intern. Med. 151, 264–269.

Moreno-Granados, J.M., Ferrín, M., Salcedo-Marín, D.M., Ruiz-Veguilla, M., 2014. Neuropsychological assessment of memory in child and adolescent first episode psychosis: cannabis and «the paradox effect». Rev Psiquiatr Salud Ment 7, 13–24.

Mugisha, J., Abdulmalik, J., Hanlon, C., Petersen, I., Lund, C., Upadhaya, N., Ahuja, S., Shidhaye, R., Mntambo, N., Alem, A., Gureje, O., Kigozi, F., 2017. Health systems context(s) for integrating mental health into primary health care in six Emerald countries: a situation analysis.

Nakasujja, N., Allebeck, P., Agren, H., Musisi, S., Katabira, E., 2012a. Cognitive dysfunction among HIV positive and HIV negative patients with psychosis in Uganda. PLoS One 7, e44415.

Nakasujja, N., Allebeck, P., Agren, H., Musisi, S., Katabira, E., 2012b. Cognitive dysfunction among HIV positive and HIV negative patients with psychosis in Uganda. PLoS One 7.

Ngoma, M., Vansteelandt, K., Delespaul, P., Krabbendam, L., Miezi, S.M., Peuskens, J., 2010. Cognitive deficits in nonaffective functional psychoses: a study in the Democratic Republic of Congo. Psychiatry Res. 180, 86–92.

Nicholas, J. A.-O. H. O. O., Larsen ME AUID- ORCID: HTTP://ORCID.ORG/— FAU - Proudfoot, J., PROUDFOOT J AUID- ORCID: HTTP://ORCID.ORG/— FAU - CHRISTENSEN, H. & Christensen, H. A.-O. H. O. O. Mobile apps for bipolar disorder: a systematic review of features and content quality.

Nuechterlein, K. H., Green Mf Fau-Kern, R. S., Kern Rs FAU - Baade, L. E., Baade Le FAU - Barch, D. M., Barch Dm FAU - Cohen, J. D., Cohen Jd FAU - Essock, S., Essock S FAU - Fenton, W. S., Fenton Ws FAU - Frese, F. J. 3rd, Frese FJ 3RD Fau - Gold, J. M., Gold Jm FAU - Goldberg, T., Goldberg T FAU - Heaton, R. K., Heaton Rk FAU - Keefe, R. S. E., Keefe Rs FAU - Kraemer, H., Kraemer H FAU - Mesholam-Gately, R., Mesholam-Gately R FAU - Seidman, L. J., Seidman Lj FAU - Stover, E., Stover E FAU - Weinberger, D. R., Weinberger Dr FAU - Young, A. S., Young As FAU - Zalcman, S., Zalcman S FAU - Marder, S. R. & Marder, S. R. 2008. The MATRICS Consensus Cognitive Battery, part 1: test selection, reliability, and validity.

Okasha, T.A., El Sheikh, M.M., El Missiry, A.A., El Missiry, M.A., El Serafi, D., El Kholy, S., Abdel Aziz, K., 2014. Cognitive functions in euthymic Egyptian patients with bipolar disorder: are they different from healthy controls? J. Affect. Disord. 166, 14–21.

Popay, J., Roberts, H., Sowden, A., Petticrew, M., Arai, L., Rodgers, M., Britten, N., Roen, K., Duffy, S., 2006. Guidance on the Conduct of Narrative Synthesis in Systematic Reviews. *A Product From the ESRC Methods Programme Version*. 1. pp. b92.

Pradhan, B.K., Chakrabarti, S., Nehra, R., Mankotia, A., 2008. Cognitive functions in bipolar affective disorder and schizophrenia: comparison. Psychiatry Clin. Neurosci. 62, 515–525.

Reichenberg, A., 2010. The assessment of neuropsychological functioning in schizophrenia. Dialogues Clin. Neurosci. 12, 383–392.

Robbins, R.N., Brown, H., Ehlers, A., Joska, J.A., Thomas, K.G., Burgess, R., Byrd, D., Morgello, S., 2014a. A smartphone app to screen for HIV-related neurocognitive impairment.

Robbins, R.N., Brown, H., Ehlers, A., Joska, J.A., Thomas, K.G.F., Burgess, R., Byrd, D., Morgello, S., 2014b. A smartphone app to screen for HIV-related neurocognitive impairment. Journal of Mobile Technology in Medicine 3, 23–26.

Robbins, R.N., Gouse, H., Brown, H.G., Ehlers, A., Scott, T.M., Leu, C.S., Remien, R.H., Mellins, C.A., Joska, J.A., 2018. A mobile app to screen for neurocognitive impairment: preliminary validation of NeuroScreen among HIV-infected south African adults. JMIR Mhealth Uhealth 6, e5.

Robinson, K.A., Saldanha, I.J., Mckoy, N.A., 2011. Frameworks for determining research gaps during systematic reviews.

Roebuck-Spencer, T.M., Glen, T., Puente, A.E., Denney, R.L., Ruff, R.M., Hostetter, G., Bianchini, K.J., 2017. Cognitive screening tests versus comprehensive neuropsychological test batteries: a National Academy of Neuropsychology education paper†.

Arch. Clin. Neuropsychol. 32, 491–498.
Rosen, C., Marvin, R., Reilly, J.L., Deleon, O., Harris, M.S., Keedy, S.K., Solari, H., Weiden, P., Sweeney, J.A., 2012. Phenomenology of first-episode psychosis in schizophrenia, bipolar disorder, and unipolar depression: a comparative analysis. Clin Schizophr Relat Psychoses 6, 145–151.
Rund, B.R., 2002. Neurocognitive deficits in schizophrenia. Tidsskrift for den Norske laegeforening: tidsskrift for praktisk medicin, ny raekke 122, 2019–2022.
Sagar, R., Sahu, A., Pattanayak, R.D., Chatterjee, B., 2018. Assessment of cognitive functions in bipolar I disorder: a 1-year naturalistic follow-up study. Bipolar Disord. 20, 248–259.
Salgado, J.V., Carvalhaes, C.F.R., Pires, A.M., Neves, M., Cruz, B.F., Cardoso, C.S., Lauar, H., Teixeira, A.L., Keefe, R.S.E., 2007. Sensitivity and applicability of the Brazilian version of the Brief Assessment of Cognition in Schizophrenia (BACS). Dement Neuropsychol 1, 260–265.
Savitz, J.B., Van Der Merwe, L., Stein, D.J., Solms, M., Ramesar, R.S., 2008. Neuropsychological task performance in bipolar spectrum illness: genetics, alcohol abuse, medication and childhood trauma. Bipolar Disord. 10, 479–494.
Savitz, J., van der Merwe, L., Stein, D. J., Solms, M. & Ramesar, R. 2009. Neuropsychological status of bipolar I disorder: impact of psychosis. Br. J. Psychiatry, 194, 243–251.
Semrau, M., Evans-Lacko, S., Alem, A., Ayuso-Mateos, J.L., Chisholm, D., Gureje, O., Hanlon, C., Jordans, M., Kigozi, F., Lempp, H., Lund, C., Petersen, I., Shidhaye, R., Thornicroft, G., 2015. Strengthening mental health systems in low- and middle-income countries: the Emerald programme. BMC Med. 13, 79.
Stevenson, Anne, Akena, Dickens, Stroud, Rocky E., Atwoli, Lukoye, Campbell, Megan M., Chibnik, Lori B., Kwobah, Edith, Kariuki, Symon M., Martin, Alicia R., De Menil, Victoria, Newton, Charles R.J.C., Sibeko, Goodman, Stein, Dan J., Teferra, Solomon, Zingela, Zukiswa, Koenen, Karestan C., 2019. Neuropsychiatric Genetics of African Populations-Psychosis (NeuroGAPPsychosis): a case-control study protocol and GWAS in Ethiopia, Kenya, South Africa and Uganda. BMJ Open e025469. https://doi.org/10.1136/bmjopen-2018-025469.
Trivedi, J., Goel, D., Sharma, S., Singh, A., Sinha, P., Tandon, R., 2007. Cognitive functions in stable schizophrenia & euthymic state of bipolar disorder. Indian J. Med. Res. 126, 433.
Whiteford, Harvey A., Degenhardt, Louisa, Rehm, Jürgen, Baxter, Amanda J., Ferrari, Alize J., Erskine, Holly E., Charlson, Fiona J., Norman, Rosana E., Flaxman, Abraham D., Johns, Nicole, Burstein, Roy, Murray, Christopher J..L., Vos, T., 2013. Global burden of disease attributable to mental and substance use disorders: fi ndings from the global burden of disease study 2010. Lancet. https://doi.org/10.1016/S0140-6736(13)61611-6.
World Health Organization, 1992. ICD-10: International Statistical Classification of Diseases and Related Health Problems: Tenth Revision. World Health Organization, Geneva.
Zhou, F.C., Wang, C.Y., Ungvari, G.S., Ng, C.H., Zhou, Y., Zhang, L., Zhou, J., Shum, D.H., Man, D., Liu, D.T., Li, J., Xiang, Y.T., 2017. Longitudinal changes in prospective memory and their clinical correlates at 1-year follow-up in first-episode schizophrenia. PLoS One 12, e0172114.