Cognition in Schizophrenia:

A Systematic Review of Wechsler Adult Intelligence Scale Studies

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Abstract

Objective: To critically analyze the evidence regarding changes in verbal and performance intelligence quotient (IQ) in patients with schizophrenia.

Data Sources: An English-language–only search was conducted in the PubMed, Cochrane Library, and LILACS databases for articles with study objectives that included Wechsler Adult Intelligence Scale (WAIS) assessment of cognitive functions in patients with schizophrenia. Descriptors were defined based on Medical Subject Headings, where associations of psychotic disorders related to the schizophrenia spectrum were suggested, as well as the "Wechsler Scales" descriptor. The search was conducted in November 2022 with no restriction on the date of publication to select studies that used any of the WAIS editions.

Study Selection: Articles that met the inclusion criteria were selected after title and summary identification and full-text review.

Results: A total of 28 articles were identified. All studies presented total IQ scores, but only 20 showed results for verbal IQ (n=20) or performance IQ (n=19). Analyzed data indicated patients had average performance on verbal comprehension features but low average performance on perceptual reasoning, working memory, and processing speed indices.

Conclusions: Executive function deficits were found in the analyzed studies, which reflect difficulties in planning and impulse control—characteristics present in the diagnosis of schizophrenia. The identification of this neuropsychological functioning contributes to the understanding of the cognitive dynamics found in schizophrenia and may help in early diagnosis, reinforcing the hypothesis that cognitive performance may be one of the indicators of psychopathologic expression.

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Schizophrenia is a severe mental disorder characterized by positive symptoms (eg, delusions, hallucinations, disorganized thinking, and abnormal behavior) and negative symptoms (eg, blunted affect, reduced speech, and disturbance of volition). These symptoms, according to the *DSM-5*,[1] must be present for at least 6 months, in addition to having a disturbance in level of functioning in ≥ 1 major area of life, such as work, social relations, and self-care. Schizophrenia commonly begins to exhibit its signs and symptoms in late adolescence and early adulthood (around age 30 years), with a slightly higher incidence in men than in women.[1]

Understanding the etiology of schizophrenia begins with a multifactorial model for determining the disease, in which social, environmental, and biological factors are interrelated. The literature also notes the influence of regional and ethnic changes, as well as the experiences of adverse social situations throughout life.[2] A study by Ruby et al[3] found that social experiences and environmental aspects may effect epigenetic change to hereditary genetic features. Neuroscience suggests that environmental influences on gene expression may have important impacts on physiology, behavior, and disease development. Therefore, the severity of symptoms, as well as cognitive changes present in schizophrenia, may be determined by environmental stimuli, hereditary and physiologic aspects, and specific characteristics (eg, culture, age, sex).

Multiple deficits in cognitive functions can be present in people with schizophrenia, leading to significant effects on the individual's functionality and social involvement.[4] A literature review gathered data from 13 studies to identify the main cognitive changes present in schizophrenia.[5] The authors[5] concluded that 7 specific cognitive factors were repeated among these studies and thus represented fundamental dimensions of this population's cognitive deficits: processing speed, attention, working memory, verbal memory, visual memory, logical reasoning, and problem solving. Nevertheless,

Clinical Points

- Although cognition is impaired in schizophrenia, it has a specific pattern.
- Understanding the pattern of impairment is helpful for the diagnosis of schizophrenia.
- The differentiation of cognitive impairments is useful for differential diagnosis and comorbidity assessments in clinical practice.

Callicott et al[6] noted, in functional magnetic resonance imaging and memory tasks, that the alterations in neural circuitry of the prefrontal cortex regions interfered in planning and attention skills in a sample of 9 individuals with schizophrenia, which are reflected primarily as working memory impairment. Yet, the authors[6] argued that impairments in social judgment and decision-making ability produce maladaptive behavior, as they are directly related to the ability to process information and manipulate it to solve problems. The results of these studies are in agreement with Heinrichs,[7] who indicated that cognitive functioning is a more significant marker than psychiatric symptoms and thus can compromise functionality in individuals with schizophrenia.

When compared to healthy individuals (n = 176), the study by Kudo et al[8] showed that those with schizophrenia (n = 87) scored lower on the Wechsler Adult Intelligence Scale (WAIS-III) in total intelligence quotient (IQ) and scored below average in complementary indices (perceptual organization, working memory, and processing speed). In another study, Lin et al[9] assessed 1,200 individuals with schizophrenia and 76 healthy controls regarding sustained attention (continuous performance task), executive function (Wisconsin Card Sorting Test), and the general intelligence scale (WAIS-III). This research showed a statistically significant difference between groups in cognitive functions that involve memory, attention, executive function, and processing speed.

Many studies have found cognitive deficits in patients with schizophrenia, particularly related to frontal functions, executive domains, attention, and visuospatial skills. However, little is known about the relationship between verbal and performance IQ and clinical variables of the disease such as age, intensity of symptoms, and duration of illness. Verbal IQ can be conceptualized as the ability to manipulate abstract symbols, comprehension, and verbal fluency, while the ability to solve problems, integrate perceptual stimuli and motor responses, and evaluate visuospatial information is described as performance IQ.[10]

The main objective of this review is to critically analyze the evidence regarding changes in verbal and performance IQ in patients with schizophrenia. Our hypothesis is that deficits in performance IQ, emphasizing attention, working memory, and perceptual organization, correlate with the difficulty of adapting to the social context, inability to follow important instructions, and impairment in the ability to plan and in impulse control, which are major clinical features of schizophrenia.

Although studies corroborate that there are deficits in cognitive functions of people with schizophrenia and that these functions differ between healthy control groups, sampling characteristics (eg, comorbidities, duration of illness, severity of symptoms, and use of medications that can influence cognitive performance) and the use of different assessment tools complicate efforts at meta-analysis and data comparison of cognitive function measures. Even if the same construct and theories underlie the various instruments with high psychometric quality, there may still be other differences in the results due to the sampling and methodological approaches used in each study.

Although there are various psychological tests for the assessment of cognitive functions, Michel et al[11] noted that the WAIS is considered the gold standard in overall neuropsychological assessment. The WAIS is a broad test of general intellectual capacity, comprised of scales that cover 4 domains of cognitive functioning: verbal comprehension, perceptual organization, working memory, and processing speed.[12] As a methodology, Wechsler[12] adopted the evidence of individual WAIS differences as a starting point for solving different kinds of problems, as diverse mental functions are influenced by global intelligence. Intelligence levels for healthy individuals are classified by the Wechsler scales according to the IQ results obtained.

The objective of this systematic review was to identify characteristics of cognitive functioning in adults with schizophrenia on the WAIS tasks and determine what cognitive functions seem to be impaired in this population compared to scale results from a normative sample.

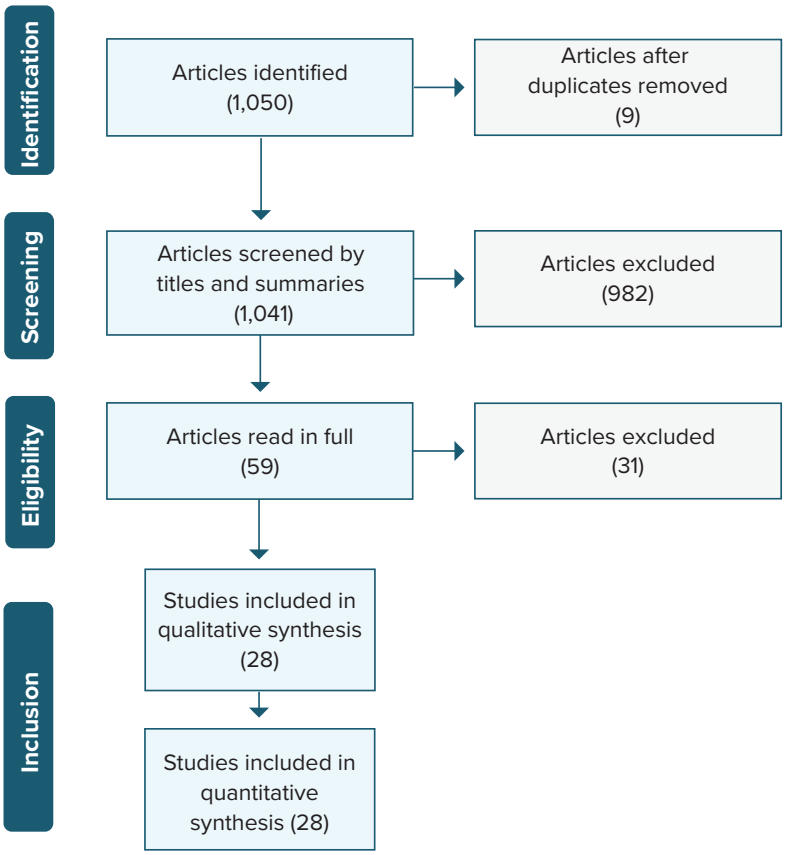
METHODS

An English-language–only search was conducted in the PubMed, Cochrane Library, and LILACS databases for articles with study objectives that included WAIS assessment of cognitive functions in patients with schizophrenia. These databases were chosen because they reflect a large portion of relevant international scientific data, thus meeting the criteria of comprehensiveness and representativeness.

The descriptors used in the search were "Schizophrenia OR Schizophrenia Spectrum and Other Psychotic Disorders OR Schizophrenia, Paranoid OR Schizophrenia, Disorganized OR Schizotypal Personality Disorder OR Schizophrenia, Catatonic NOT Schizophrenia, Childhood NOT DISC2 gene product, human NOT DISC1 protein, human AND Wechsler Intelligence Scales OR Intelligence Scales, Wechsler OR Wechsler Adult Intelligence Scale-Revised OR WAIS-R NOT WMS-IV-NL NOT OR Wechsler

Figure 1.

Preferred Reporting Items for Systematic Reviews and Meta-Analyses Flowchart



Preschool and Primary Scale of Intelligence NOT WPPSI NOT Wechsler Test of Adult Reading NOT National Adult Reading Test NOT Wechsler Intelligence Scale for Children NOT WISC-V OR WISC-IV." Descriptors were defined based on Medical Subject Headings, when application to psychotic disorders in the schizophrenia spectrum are suggested, as well as the "Wechsler Scales" descriptor to sum the latest versions of the WAIS, WAIS-R, WAIS-III, and WAIS-IV. The search was conducted in November 2022 with no restriction on the date of publication to select studies that used any of the WAIS editions. Inclusion criteria for articles were (1) sample comprised of people diagnosed with schizophrenia aged between 16 and 84 years, (2) study aimed at assessing cognitive performance among the participants, (3) use of one of the editions of the WAIS as the main instrument for cognitive assessment, (4) English materials, and (5) correlational, descriptive, or clinical studies. Articles were excluded when the (1) sample was not characterized exclusively by adults with schizophrenia, (2) sample included participants with neurologic comorbidities, (3) authors did not identify the WAIS total IQ score, and (4) studies were described as case studies or bibliographic reviews.

After inserting the descriptors in the selected databases, manual screening of articles that met the study inclusion criteria was conducted. Those that met the inclusion criteria were selected after titles and summaries were identified and articles were read in full.

RESULTS

Twenty-eight articles in which participants were assessed using the WAIS were selected for analysis.[8,9,13–38] The PRISMA flowchart is provided in Figure 1.[39] Table 1 shows sample characteristics, study design, WAIS version used, and mean total IQ score and standard deviation. Studies included in the systematic review were published between 1990 and 2018, with a total sample size of 2,203 assessed subjects. The mean age varied between 22 and 64 years. Regarding study design, cross-sectional studies (19), clinical studies (8), and 1 longitudinal study were identified. As for the scale edition used, 4 studies used the first version (WAIS) of the instrument in their sample, 19 studies used the revised version (WAIS-R), 5 used the third edition (WAIS-III), and no study included in this review used the WAIS-IV, which is the current version of the scale published in 2008 (Table 1).

Table 1.

Summary of Articles Included in the Systematic Review[a,b]

Article	N	Age (mean ± SD, y)	Study Design/Sample Characteristics	Scale	Total IQ Result (mean ± SD)
Gold and Hurt (1990)[13]	19	24.26 ± 6.11	Clinical study with haloperidol treatment for 26 days/inpatients	WAIS	Before haloperidol treatment: 84.89 ± 12.17
Goldman et al (1993)[14]	40	Positive group: 27.8 ± 7.5 Negative group: 31.6 ± 9.9	Cross-sectional study with a full WAIS-R profile positive group and a negative group/inpatients	WAIS-R	Positive: 95.3 ± 13.5 Negative: 89.7 ± 18.0
Condray et al (1995)[15]	15	36.2 ± 8.8	Cross-sectional study with a healthy control group/inpatients admitted voluntarily to a research unit with duration of illness of 13.2 ± 8.9 y	WAIS-R	94.4 ± 6.9
Fujii et al (1997)[16]	10	31.9 ± 6.3	Clinical study with clozapine treatment; retesting with the same battery was conducted in a minimum of 1 year after the initial testing/chronic treatment-resistant inpatients	WAIS-R	Before clozapine treatment: 76.9 ± 9.4
Hawkins et al (1997)[17]	17	29.56 ± 9.29	Cross-sectional study with a schizophrenia spectrum disorders group and a mixed psychiatric group/not available	WAIS-R	87.19 ± 12.05
Mortimer and Bowen (1999)[18]	15	64 ± 17	Cross-sectional study/inpatients with duration of illness of 14 ± 16 y	WAIS-R	78 ± 9
Ilonen et al (2000)[19]	27	33.0 ± 13.6	Cross-sectional study with a healthy control group/first episode with no history of psychiatric inpatient treatment	WAIS-R	89.0 ± 19.4
Egan et al (2001)[20]	120	35.9 ± 8.2	Cross-sectional study with a sibling group and a healthy control group/not available	WAIS-R	92.6 ± 13.5
Baron and Hays (2003)[21]	49	Unclassified	Cross-sectional study/inpatients admitted at least twice within a 6-year period	WAIS-R	77.1 ± 12.6
Zakzanis et al (2003)[22]	32	58	Cross-sectional study with Alzheimer's disease patients as control group/late-onset outpatients diagnosed after age 45 y with an average illness duration of approximately 7 y	WAIS-III	81.84 ± 12.07
Nakano et al (2004)[23]	31	53 ± 10	Cross-sectional study/inpatients with duration of illness of 29 ± 10 y	WAIS-R	77 ± 16
Hori et al (2006)[24]	67	42.7 ± 11.9	Cross-sectional study with a healthy control group/chronic schizophrenia at stable dose for 3 mo	WAIS-R	87.7 ± 17.0
Maeda et al (2006)[25]	16	28.5 ± 4.2	Cross-sectional study/outpatients attending the psychiatric day treatment unit	WAIS-R	89.8 ± 13.1
Mo et al (2008)[26]	29	43.07 ± 8.83	Cross-sectional study with a healthy control group/inpatients in remission and duration of illness of 19.34 ± 7.82 y	WAIS-R	90.38 ± 12.85
Stefanopoulou et al (2009)[27]	36	34.88 ± 9.84	Clinical study without control group/inpatients with mean duration of illness of 12.4 y (range, 28 mo–28 y)	WAIS-III	73.41 ± 11.47
Ozguven, et al (2010)[28]	20	27 ± 4.75	Cross-sectional study with an Asperger's syndrome group and a healthy control group/outpatients	WAIS-R	87.9 ± 14.9
Lu et al (2012)[29]	112	25.2 ± 4.3	Cross-sectional study with a healthy control group/first-episode antipsychotic-naive patients	WAIS-R	87.8 ± 14.7
Rapp et al (2012)[30]	124	Male: 32.3 ± 11.1 Female: 36.6 ± 9.6	Clinical study with control group with schizophrenia plus comorbidities/inpatients with a mean illness duration > 11 y for all groups	WAIS-R	Male: 83.6 ± 12.4 Female: 82.1 ± 13.1
Lin et al (2012)[9]	62	37.96 ± 9.83	Clinical study with control group/not available	WAIS-III	92.52 ± 15.63
Zhu et al (2013)[31]	526	28.150 ± 7.864	Cross-sectional study with a healthy control group/inpatients with mean duration of illness of 5.49 ± 7.21 y	WAIS-RC	Genotype AT+AA: 94.091 ± 15.485 Genotype TT: 97.935 ± 14.511
Kao et al (2013)[32]	39	Male: 40.08 ± 10.4 Female: 39.38 ± 10.89	Clinical study/outpatients in stable clinical condition	WAIS	Male: 88.64 ± 10.54 Female: 89.79 ± 12.56
Fukumoto et al (2014)[33]	63	Remission: 37.3 ± 11.8; No remission: 34.3 ± 13.8	Longitudinal study with 2 groups: a remission group and no remission group/outpatients with duration of illness of 10.4 ± 8.9 y (remission) and 9.8 ± 7.7 y (no remission)	WAIS-III	Remission group: 89.5 ± 16.4 No remission group: 82.7 ± 18.8
Dang et al (2014)[34]	17	Experiment group: 25.4 ± 2.9 Control group: 25.0 ± 2.8	Clinical study with 2 groups: patients with schizophrenia in an experiment group plus patients with schizophrenia in a control group/first episode on an inpatient unit	WAIS-R	Experiment group: 96.1 ± 5.8 Control group: 96.8 ± 5.0

(continued)

Table 1 (continued).

Article	N	Age (mean ± SD, y)	Study Design/Sample Characteristics	Scale	Total IQ Result (mean ± SD)
El-Missiry et al (2015)[35]	109	32.2 ± 9.0	Cross-sectional study with a division of the N: adherent group and nonadherent group/outpatients	Arabic version of the WAIS	Adherent group: 98.73 ± 11.6 Nonadherent group: 81.58 ± 10.4
Nilsson et al (2016)[36]	23	32.0 ± 8.9	Clinical study with control group/inpatients with mean duration of illness of 7.5 ± 8.1 y	WAIS	79.4 ± 19.9
Liang et al (2016)[37]	288	Familial schizophrenia (FS): 23.29 ± 6.79 Sporadic schizophrenia (SS): 22.61 ± 6.15	Cross-sectional study using a group classification: FS plus SS plus control group and FS parents group plus SS parents group plus control group/first-episode patients with duration of illness of 19.83 ± 28.81 mo (FS) and 15.40 ± 22.44 mo (SS)	WAIS-R in China	FS group: 86.69 ± 13.84 SS group: 85.46 ± 15.35
Krukow et al (2017)[38]	47	27.02 ± 5.42	Cross-sectional study with a control group: healthy siblings/inpatients in the remission state with duration of illness of 5.29 ± 4.73 y	WAIS-R	90.33 ± 9.94
Kudo et al (2018)[8]	250	42.5 ± 14	Cross-sectional study with healthy control group/multiple groups including antipsychotic drug–free patients and treatment-resistant patients	WAIS-III	89.5 ± 19.0

[a]WAIS normative sample taken from Wechsler.[12]
[b]Extremely low: IQ ≤ 70, borderline: IQ between 70 and 79, low average: IQ between 80 and 89, average: IQ between 90 and 109, high average: IQ between 110 and 119, superior: IQ between 120 and 129, and very superior: IQ ≥ 130.
Abbreviations: IQ = intelligence quotient, WAIS = Wechsler Adult Intelligence Scale.

In 8 of the total articles selected, cognitive assessment was carried out with 2 sample groups of patients with schizophrenia. Thus, IQ results of 36 samples of individuals with a psychiatric diagnosis of schizophrenia were analyzed in this systematic review. In clinical research with medication administration throughout the study, results of the assessments made initially were analyzed without the interference of treatment on the sample's cognitive performance.

All articles included in this systematic review described the mean and standard deviation of the total IQ result obtained by the sample assessed. Combined verbal and performance scales are transformed into a composite score according to methods defined in the instrument manual and may vary depending on the WAIS edition used.

For most samples (19 samples), the total IQ score was between 80 and 90 (low average), with 9 samples showing average total IQ scores and 6 samples showing extremely low total IQ scores. Considering the total of 36 samples, the calculated average corresponds to a value of 87.39, which is classified as low average in relation to the expected performance for the population studied during standardization and validation of the instrument.

The lowest average total IQ was 73.41 (SD: 11.47) in a sample of 36 subjects.[27] The highest average total IQ was 98.73 (SD: 11.6), wherein 47% of subjects completed college, in addition to having an exclusion criterion for people with a total IQ index < 90.[35]

Comparison Between Verbal IQ and Performance IQ

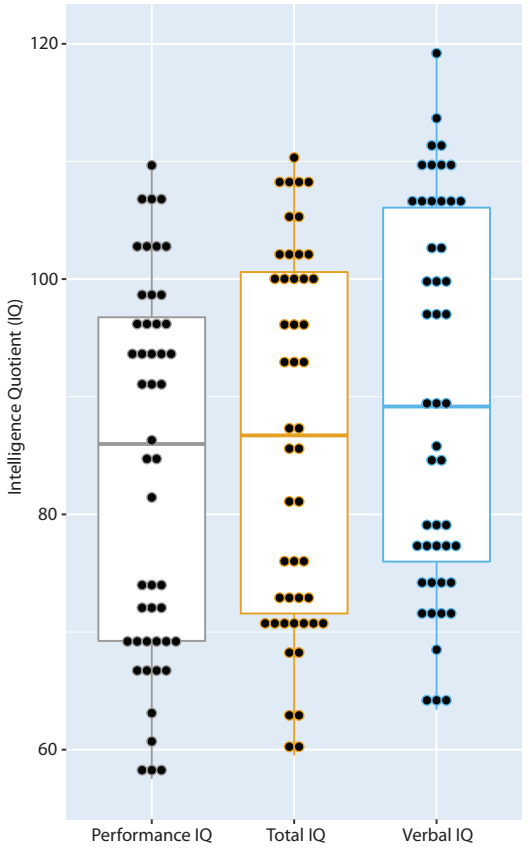
Only 20 studies showed the average verbal IQ performance, while 19 showed the average performance IQ (Table 2). The verbal intelligence quotient (VIQ) is defined based on performance in verbal scale subtests, which change according to the scale version used. Tasks included in this battery assess verbal comprehension, acquired knowledge, quality of formal education, and environmental stimuli. For this step, the ability to deal with abstract symbols is required, where information about language processing, reasoning, attention, verbal learning, memory, and verbal fluency is collected from the subject. Verbal assessment shows auditory and oral intelligence, which aids in expression and verbal conceptualization.[14]

VIQ performance was described in 20 articles, comprising 25 samples assessed, so that most of the samples (15) described the performance as being classified as average in comparison to that expected for the normative sample of healthy individuals. For some samples, performance was classified as low average (8 samples) and borderline (2 samples). VIQ indices had variations in the samples studied; however, the lowest VIQ performance mean (76.23 ± 12.84) is related to a sample of 36 participants,[27] and the highest VIQ mean (104.5 ± 14.7) is from a sample of 6 individuals[14] (Table 2).

Subtests comprising the performance intelligence quotient (PIQ) encompass cognitive domains related to the degree and quality of nonverbal contact, as well as their ability to integrate perceptual stimuli and produce pertinent motor responses, to work in concrete situations, and to assess visuospatial information. The performance aspect of the intelligence scale assesses the quality of sequential reasoning and the ability to establish relationships between events, analyzing the spatial component of perception at a conceptual and executive level, in addition to organizational and psychomotor performance. The performance scale is less influenced by formal education, as above-average results are

Figure 2.

Distribution of IQs in the Analyzed Studies by Percentiles of Mean and Standard Deviation[a]



[a]Samples analyzed according to the IQ measurements, considering variations of standard deviation, indicating maximum and minimum performance in each index.
Abbreviation: IQ = intelligence quotient.

Table 2.

Mean and Standard Deviation of Verbal IQ and Performance IQ Results[a,b]

Study	N	Verbal IQ	Performance IQ
Gold and Hurt (1990)[13]	19	88.05 ± 11.70	83.0 ± 13.64
Goldman et al (1993)[14]	6	104.5 ± 14.7	85.9 ± 11.2
	34	90.2 ± 16.7	90.2 ± 17.3
Condray et al (1995)[15]	15	95.7 ± 9.9	94.9 ± 8.6
Fujii et al (1997)[16]	10	77.0 ± 8.5	79.7 ± 10.8
Hawkins et al (1997)[17]	17	90.06 ± 13.32	85.50 ± 12.22
Zakzanis et al (2003)[22]	32	83.79 ± 13.13	80.14 ± 13.05
Nakano et al (2004)[23]	31	81 ± 16	75 ± 16
Hori et al (2006)[24]	67	90.2 ± 16.7	86.8 ± 16.6
Maeda et al (2006)[25]	16	97.2 ± 13.5	81.5 ± 12.0
Mo et al (2008)[26]	29	90.80 ± 14.27	Unidentified
Stefanopoulou et al (2009)[27]	36	76.23 ± 12.84	74.76 ± 9.01
Lu et al (2012)[29]	112	93.5 ± 16.8	85.9 ± 13.7
Rapp et al (2012)[30]	87	87.1 ± 13.0	81.0 ± 12.6
	37	85.3 ± 14.2	80.1 ± 12.6
Lin et al (2012)[9]	62	94.53 ± 17.08	90.61 ± 16.84
Fukumoto et al (2014)[33]	33	94.2 ± 15.9	85.7 ± 17.5
	30	88.3 ± 17.5	79.3 ± 18.6
El-Missiry et al (2015)[35]	34	101.47 ± 12.2	97.67 ± 12.0
	75	84.89 ± 12.3	81.42 ± 10.2
Nilsson et al (2016)[36]	23	85.8 ± 21.4	76.7 ± 18.9
Liang et al (2016)[37]	98	93.67 ± 13.97	79.19 ± 16.08
	190	93.95 ± 14.75	76.05 ± 18.53
Krukow et al (2017)[38]	47	90.20 ± 11.71	91.75 ± 10.31
Kudo et al (2018)[8]	250	93.0 ± 18.1	86. 9 ± 19.2
Total mean	1,390	90.02	83.73
Total SD		16.22	15.81

[a]WAIS normative sample taken from Wechsler.[12]
[b]Extremely low: IQ ≤ 70, borderline: IQ between 70 and 79, low average: IQ between 80 and 89, average: IQ between 90 and 109, high average: IQ between 110 and 119, superior: IQ between 120 and 129, and very superior: IQ ≥ 130.
Abbreviations: IQ = intelligence quotient, WAIS = Wechsler Adult Intelligence Scale.

usually associated with a high level of organizational skills and ability to work under time pressure.

In this review, performance means of 24 samples with PIQ results were assessed. Most of these samples indicated low average performance (12 studies), and the other samples showed performance classified as borderline (7 studies) and average (5 studies). Samples comprised a total of 1,361 participants assessed for the PIQ, and those with the lowest (74.76 ± 9.01)[27] and highest (97.67 ± 12.0)[35] PIQ score are the same as those with the lowest and highest total IQ score, respectively. Figure 2 shows results from samples assessed for verbal, performance, and total quotients, indicating the distribution by percentiles of mean and standard deviation.

Collected data are provided in Figure 2 by the variation and concentration of results, defining the maximum and minimum values as well as the mean found. The means and standard deviation found in the samples assessed indicated a higher concentration of results classified as average in verbal IQ, as well as the highest number of results classified as low average in performance IQ and total IQ (Figure 2).

Analysis of Sample Performance in the WAIS Subtests

WAIS editions used in this study included 6 subtests for the verbal scale and 5 subtests for the performance scale (Table 3). Eight articles were found that described the sample's average result in each subtest applied, resulting in 300 assessed participants, which allowed performance analysis on cognitive functions in each subtest (Table 3).

The 2 lowest scores are related to the subtests included in the performance scale (picture arrangement and digit symbol coding), which assess attention ability and mental control. The comprehension subtest had the third lowest performance, being considered

Table 3.

Average of Performance Per Subtest Presented in 8 Studies (9 samples) Analyzed in the Systematic Review[a]

	Subtests and Samples Assessed									Average
Verbal Scale	**Information:** investigates the extent of knowledge acquired in contact with reality, through questions of general knowledge.									
	7.04±3.04	8.32±2.81	8.7±3.7	8.75±2.41	9.1±3.4	9.8±4.9	10.07±3.2	12.7±3.4	...	9.31±1.65
	Digit span: memory's ability to immediately hold information, working memory, reversibility; shows a series of numeric sequences for repetition in direct order or reverse order.									
	6.0±1.5	6.63±2.93	7.32±2.66	7.8±3.6	8.2±3.0	8.5±2.8	8.88±2.44	9.76±4.15	9.8±2.9	8.09±1.22
	Vocabulary: learning and language development, thought processes; presentation of a series of word definitions.									
	6.0±1.6	8.1±3.8	8.3±3.3	8.37±2.27	8.4±3.6	8.53±2.29	11.5±2.1	...	...	8.45±1.6
	Arithmetic: computational capacity and speed in mathematical calculation skills, auditory memory, concentration, and abstract reasoning; the individual should mentally solve these arithmetic problems and verbally respond to them.									
	6.32±3.18	6.33±4.0	7.77±2.42	7.95±2.97	8.0±3.2	8.1±3.0	8.22±3.23	8.8±2.1	...	7.68±0.89
	Comprehension: social judgment, verbal comprehension, memory, abstraction, and knowledge of sociocultural norms; consists of a series of questions so the individual can solve everyday problems or understand social rules and concepts.									
	5.6±2.3	6.50±3.66	6.74±2.23	7.2±4.0	7.4±3.3	7.6±3.3	8.11±3.29	10.5±4.4	...	7.45±1.44
	Similarities: symbolization, globalization, and abstraction in 3 levels: concrete, functional, and conceptual; consists of pair of words, orally presented, to explain the similarities of common concepts they represent.									
	6.0±2.6	6.39±3.12	7.8±3.4	8.40±2.73	8.5±3.2	9.05±3.43	9.6±3.3	10.8±2.1	...	8.31±1.59
Performance Scale	**Picture completion:** measures attention to the environment, organizational skills, and reasoning; consists of a set of colored figures of common objects and scenes, each with an important missing part to be identified.									
	6.19±3.40	6.7±3.1	7.37±2.36	7.7±2.3	8.0±3.2	8.5±3.0	10.02±2.4	...	...	7.78±1.25
	Picture arrangement: analysis and understanding of a situation; visual processing, integration capacity, and sequential organization of complex stimuli; consists of colored prints to be ordered in a logical sequence story.									
	6.0±1.7	6.1±2.6	6.33±2.97	7.47±2.34	7.8±3.6	8.0±3.6	8.1±3.3	9.13±2.20	...	7.36±.1.12
	Block design: analysis and synthesis, visual and motor coordination, and speed and perceptual organization; nonverbal subtest for building 2-dimensional designs from a presented model.									
	6.0±3.3	6.87±2.78	8±2.96	8.2±2.1	8.3±2.3	9.0±3.6	9.3±3.5	10.03±6.8	10.04±1.9	8.41±1.36
	Digit symbol-coding: processing speed, mental flexibility, and selective and sustained attention; series of numbers, each paired with a simple symbol; it is required to draw the symbol under its corresponding number.									
	5.25±3.3	6.0±1.3	6.0±1.5	6.29±2.70	6.58±1.22	7.0±2.8	7.2±3.2	9.95±2.63	10.4±12.8	7.19±1.8
	Object assembly: perception of parts for the construction of the whole; measures visual processing, perceptual speed, and ability to integrate visual stimuli; consists of puzzles of common objects, each presented in a standardized configuration.									
	7.2±2.5	7.21±3.19	8.3±3.4	8.46±2.84	8.6±3.4	9.0±1.1	...	...	...	8.12±0.75

[a]Classification: 1 to 4: extremely low; 5: borderline; 6 to 8: low average; 9 to 11: average; 12 and 13: high average; 14 and 15: superior; and 16 to 19: very superior.

Table 4.

Performance and Classification of the WAIS Complementary Indices[a,b]

Study	Verbal Comprehension	Perceptual Organization	Working Memory	Processing Speed
Fukumoto et al (2014)[33]	95.2±14.0 (remission) 93.3±19.0 (nonremission)	90.0±18.1 (remission) 83.7±19.3 (nonremission)	92.7±15.4 (remission) 83.1±16.2 (nonremission)	83.0±13.0 (remission) 73.8±13.0 (nonremission)
Krukow et al (2017)[38]	90.91±11.92	96.35±10.47	Unidentified	Unidentified
Kudo et al (2018)[8]	95.1±17.4	89.7±19.5	89.7±18.0	82.2±17.7
Performance mean	93.62±2.12	89.93±5.16	88.5±4.91	79.6±5.09
Classification	Average	Low average	Low average	Borderline
	Ability to understand instructions, produce answers, and express your thoughts; influenced by educational background and cultural opportunities; measurement of crystallized intelligence.[c]	Ability to organize parts into a whole, visual motor integration, attention to details; ability to perceive spatial relation and sequences; measurement of fluid intelligence.[d]	Temporary storage of information that can, posteriorly, be accessed by other neural circuits.	Cognitive and motor speed, ability to plan and execute activities, motivation to perform, and attention ability.

[a]WAIS normative sample taken from Wechsler.[12]
[b]Extremely low: IQ ≤ 70, borderline: IQ between 70 and 79, low average: IQ between 80 and 89, average: IQ between 90 and 109, high average: IQ of 110 to 119, superior: IQ of 120 to 129, and very superior: IQ ≥ 130.
[c]Depth and scope of the acquired knowledge of a person of a culture and an effective application of this knowledge.
[d]Mental operations that an individual can use when faced with a relatively new task that cannot be rapidly executed.
Abbreviations: IQ = intelligence quotient, WAIS = Wechsler Adult Intelligence Scale.

a measure of social cognition, since it assesses the ability to analyze social context information, predict consequences, and make decisions.

Complementary Indices of the WAIS Results Analysis

Regarding the complementary index results included in the WAIS-III, 3 studies reported results for verbal comprehension and perceptual organization index, while only 2 reported scores corresponding to working memory and processing speed indices (Table 4).

The verbal comprehension index was classified as average, from the mean established between performances shown in the 4 samples assessed, summing a total of 360 participants (see Table 1). The lowest performance found was 90.91 ± 11.92, corresponding to a sample of 47 people.[38] The highest verbal comprehension ability result was 95.2 ± 14.0 in a sample of 33 people.[33]

The perceptual organization index was classified as low average from the mean established for the 4 samples assessed. The lowest result classified in this index was presented by a sample of 30 people (83.7 ± 19.3).[33] The highest performance classified was 96.35 ± 10.47 found in a sample of 47 people.[38]

Working memory index (WMI) and processing speed index (PSI) values were presented in 2 studies, with a total of 3 samples (313 participants). For these 3 studies, the mean was classified as low average for WMI and as borderline for PSI. The lowest WMI and PSI (WMI: 83.1 ± 16.2 and PSI: 73.8 ± 13.0) values were found in a sample of 30 people.[33] Meanwhile, another sample of 33 patients from the same study scored higher in both indices (WMI: 92.7 ± 15.4 and PSI: 83.0 ± 13.0) and showed remission of symptoms during psychiatric treatment.[33]

DISCUSSION

Global Cognitive Functioning in Schizophrenia

This study aimed to identify cognitive functioning characteristics in adults with schizophrenia for WAIS tasks and which cognitive functions are impaired in this population in comparison with the scale's normative sample. Among the 28 studies included in this systematic review, most showed a total IQ performance classified as low average, an average VIQ, and a low average PIQ for individuals with schizophrenia on the WAIS. However, schizophrenia patients showed preserved performance in verbal functions (VIQ), since the mean result of the samples showed a performance compatible with those of the healthy population used in the instrument's validation and standardization process.

Considering the concept of intelligence as a multifactorial trait, which is not always adaptive, and not showing the exclusive need for the effectiveness of abstract reasoning, intelligence corresponds to a global competence that enables the understanding of the world and the reaction to environmental requests. Thus, the IQ considers the level of that intelligence, comparing the performance of a subject of a certain age with results obtained in the assessment of a group with individuals of the same age through verbal and nonverbal tasks.[12]

Comparison Between Verbal and Performance Aspects

Considering the results of the analyzed studies, verbal ability (as assessed by the verbal scale subtests) showed higher scores compared to the average obtained for the performance scale. The lowest scores found in the studies were for performance scale subtests measuring attention ability and processing speed, executive functions concerning visual processing, integration capacity and sequential organization of complex stimuli, and social cognition and social judgment. Impaired social judgment and ability to understand, which are characteristic of schizophrenia, can also be related to short-term memory capacity, given the need to manipulate received information and good contact with reality for the resolution of problems.[15]

In tasks that investigate attentional ability and speed to process information, there is a need for mental control to select main data and establish strategies for problem resolution and speed followed by precision to stay involved throughout the execution of the activity. In schizophrenia, there can be genetically influenced changes in neural circuits of the prefrontal cortex regions, which are related to planning, attention, and memory.[6] These neurofunctional impairments are reflected in impaired ability for mental manipulation and simultaneous information processing. These impairments may in turn affect maladaptive functional and social behavior, as preserved ability for social judgment and decision making are needed to manage social context demands.[6]

Discrepancy between scores obtained in the verbal and working memory scale subtests, which assess working memory, perceptual organization, and processing speed (part of the performance scale), were significant given that these nonverbal abilities were considered below average when compared to the instrument's normative data. Cognitive decline in patients with schizophrenia is related to differences in other cognitive domains assessed, since processing holds a central place in the cognitive structure of this disorder. Cognitive impairment contributes to development of other neuropsychological dysfunctions, such as planning and decision-making impairment.[17]

Performance on verbal tests reflects semantic memory ability, appropriate verbal learning, and interest in the environment, primarily based on educational and cultural opportunities, while having less effect on attention and information manipulation skills. Cognitive impairment in schizophrenia was consistent across the studies in this review, while still independent of psychopathologic

experiences. However, an association between cognition and psychotic symptoms is noted, especially in negative and disorganized dimensions, given that the duration of illness and nonremission of symptoms reflects greater impairment of cognitive functions.[18]

Cognitive Functioning in Schizophrenia as an Endophenotype

Studies included in this review provide an important starting point to reinforce the need to assess neuropsychological functioning. Changes in cognitive functions may occur among individuals with schizophrenia and can be found in unaffected family members. This suggests that evidence of cognitive impairment can be considered an endophenotypic characteristic in schizophrenia.[40] A study by Islam et al[41] reported that positive and negative symptoms of schizophrenia in individuals with moderate and severe cognitive deficits were significantly greater than in groups with mild or no cognitive impairments, emphasizing that psychotic symptoms are associated with cognitive deficits. In addition, that study[41] also found a high family correlation (27%) for cognitive aspects in schizophrenia.

Schizophrenia is a complex neurodevelopmental disorder, in which cognitive deficits are some of the main characteristics and considered as potential endophenotypes.[42,43] In addition to the symptoms described as diagnostic criteria, based on results from the studies included in this review, a hypothesis is raised that cognitive performance is also a significant indicator of schizophrenia, as having a neuropsychological profile with an average VIQ score and low average PIQ was persistent in the assessed samples. Deficits involving performance skills have been noted in studies such as that by Hu et al[43] as an endophenotype candidate for early diagnosis of schizophrenia.

CONCLUSION

This systematic review showed specific cognitive functioning in individuals diagnosed with schizophrenia, highlighting lower than average performance compared to healthy controls regarding executive cognitive functions such as information processing, attention, and working memory capacity. These cognitive functions cover prefrontal cortex function, which is related to problems in planning and impulse control, which are characteristics present in the diagnosis of schizophrenia.

Identification of neuropsychological functioning characteristics described in this study contributes to the understanding of cognitive dynamics found in schizophrenia. This area of research may enhance diagnosis and strengthen the hypothesis that cognitive performance may be a psychopathologic expression of psychosis. In addition, based on neuropsychological function mapping, treatment and rehabilitation programs can be developed to stimulate functions that show a higher level of dysfunction, which promotes an opportunity to create resources and reduce risks of functional and social impairment. Cognitive rehabilitation tends to contribute to relapse prevention in social and executive skills necessary for labor market integration, as well as tools that enable greater functionality and consequently better quality of life. In addition, cognitive function studies of healthy adults with prefrontal cortex genetic changes may help inform future understanding of the relationship between psychosis and cognitive changes.

Limitations of this study include the presence of few articles describing subtests, as well as complementary indices, as such information would more accurately indicate aspects of the neuropsychological profile within the diagnosis of schizophrenia, offering more robust data on the existing deficits and preserved cognitive functions. Other limiting aspects of this study correspond to the extreme values of IQ performance, since the samples assessed had different profiles and varying aspects such as age, education, and duration of illness.

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