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# Neuropsychological and Academic Performance in Colombian Children with ADHD: A Comparative Study with a Control Group

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**Abstract: Objective:** This study aimed to determine the effect of ADHD on the neuropsychological and academic performance of a sample of Colombian children in primary and secondary education compared to a control group. **Method:** It was a Quasi-experimental correlational research involving a sample of 194 children from Manizales, comprising 97 children diagnosed with ADHD and 97 controls. The study utilized tasks from the Child Neuropsychological Assessment (ENI) protocol to assess academic and neuropsychological performance. **Results:** Children with ADHD exhibited lower cognitive, linguistic, and attentional performance with greater variability than their neurotypical peers. They showed deficits in IQ, metalinguistic skills, reading, writing, memory, attention, and executive function, with increased errors and heterogeneity across tasks. **Conclusions:** For future research, it is necessary to address ADHD through mixed-methods studies that enrich quantitative findings with the lived experiences of children and families affected by ADHD. Additionally, further exploration is needed regarding functional impairment assessment in the Colombian and broader Ibero-American context, including its correlation with later academic performance in higher education.

**Keywords:** attention-deficit/hyperactivity disorder; neurocognitive performance; executive functioning; metalinguistic skills; memory; attention; language

## 1. Introduction

Attention-deficit/hyperactivity disorder (ADHD) is recognized as one of the most prevalent neurodevelopmental disorders in childhood. It has a significant impact on academic performance, social interactions, and long-term occupational outcomes. Additionally, ADHD is frequently comorbid with affective disorders, personality disorders, and substance use disorders, further complicating its clinical course [1–4]. Recent studies suggest that ADHD persists into adulthood in approximately 6.7% of cases, affecting an estimated 366.33 million adults worldwide [5].

Prevalence estimates for ADHD vary widely, ranging from 5% to 20% depending on the diagnostic criteria, population characteristics, and methodological differences across studies [6–9]. The American Psychiatric Association (2022) categorizes ADHD into three primary presentations:

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predominantly inattentive, predominantly hyperactive-impulsive, and combined. Recent meta-analyses report that the inattentive presentation accounts for 33.2% of cases, the hyperactive-impulsive presentation for 30.3%, and the combined presentation for 31.4% [10–12].

Despite being one of the most extensively researched neurodevelopmental conditions, ADHD remains a topic of debate, particularly concerning discrepancies in prevalence rates. These variations are often attributed to differences in symptom presentation, diagnostic frameworks, and assessment tools, as well as the influence of social, cultural, and educational contexts [6,13–15]. Furthermore, studies indicate that ADHD prevalence and symptom expression vary across ethnic, geographic, economic, and educational settings [16–18]. Recent systematic reviews and meta-analyses encompassing data from diverse regions—including China, India, Africa, the United States, and Ibero-America—estimate a global ADHD prevalence ranging from 3.4% to 14% [19–23]. These findings underscore the need for continued research to refine theoretical models, improve diagnostic accuracy, and develop targeted interventions for ADHD, given its profound impact on mental health, academic success, family relationships, and overall well-being [21,24].

Numerous studies comparing the neuropsychological and academic performance of children with ADHD to that of typically developing peers have consistently reported deficits in working memory, attention, executive functions, and reading comprehension [13,20,25–28]. However, given the disruptions caused by the COVID-19 pandemic, it is essential to reassess these cognitive and academic profiles in the post-pandemic context. Emerging research suggests that children with ADHD now exhibit even greater difficulties in sustaining attention, engaging with academic tasks, and regulating their learning behaviors. The shift toward remote and digital learning environments may have exacerbated these challenges, placing children with ADHD at an even greater disadvantage compared to their peers [29–31].

Additionally, post-pandemic educational reforms have placed increased emphasis on autonomous and independent learning, a requirement that may be particularly challenging for children with ADHD. Given that executive function impairments are a core feature of ADHD, these increased demands may further impact their academic performance and learning outcomes [32,33].

In light of these evolving challenges, it is crucial to update our understanding of the neuropsychological and academic profiles of children with ADHD. Such knowledge will inform the development of tailored psychological and educational interventions aimed at supporting their cognitive and academic growth. Previous research has identified significant variability in ADHD-related cognitive and academic profiles across different sociocultural contexts when compared to control groups. These findings are summarized in Table 1.

**Table 1.** Research Background on the Neuropsychological and Academic Profiles of Children with ADHD.

| Method | Country | Findings | Study |
|---|---|---|---|
| Sample: Children aged from 6 to 13 years diagnosed with ADHD. Aim: analizar los perfiles cognitivos en niños con TDAH y Tempo cognitivo lento (TCL), observando las diferencias entre ellos. | Spain | In the evaluation of the two neuropsychological profiles, no significant differences were found in the indices of verbal comprehension, perceptual reasoning, and total intelligence quotient/general ability index. However, the ADHD group showed lower scores than the control group in working memory. Regarding the processing speed index, the control group exhibited lower performance than the group of children with ADHD. | [34] |
| Sample: Children aged 5 to 15 diagnosed with ADHD. Objective: To identify differences in | Colombia | Differences were found between the case and control groups in the cognitive processes of memory, attention, and language, with lower scores in these | [13] |

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| neuropsychological performance between a group of children diagnosed with combined-type and inattentive-type ADHD and a group of typically developing children. | | areas for the case group compared to the controls. However, no significant differences were observed in the evaluation of executive functions.<br><br>In the memory process, the case group demonstrated significantly lower average performance than the control group in auditory-verbal memory tasks, particularly in encoding and retrieval. Regarding attention, the case group exhibited lower average scores than the control group in auditory attention tasks, such as backward digit span, along with a higher number of errors and omissions. In terms of language, the case group performed worse than the control group in tasks assessing instruction-following and metalinguistic skills. | |
| Sample: Children aged 6 to 16 years diagnosed with ADHD. Objective: To compare the neurobiological functioning of children and adolescents with ASD and ADHD in the city of Manizales. | Colombia | In the comparison of the three subgroups—ADHD, Asperger's, and control—the ADHD group demonstrated lower performance in visuoconstructional and memory tasks, particularly in spontaneous recall and cued recall tests.Regarding executive functions, the ADHD group obtained the lowest average scores in backward and forward digit span tasks, as well as in the number of categories completed. In terms of language performance, the ADHD group showed the lowest scores in verbal fluency and instruction-following tasks. | [35] |
| Sample: 97 children aged 5 to 14 years with ADHD and 97 control subjects. Objective: To examine metalinguistic skills and reading processes in children diagnosed with ADHD, compared to a matched control group. | Colombia | Children with ADHD exhibited significantly lower performance across all metalinguistic and reading tasks compared to the control group, except for spelling and silent reading comprehension tasks. | [20] |
| **Sample:** 85 children aged 8 to 16 years with ADHD. **Objective:** To establish the relationship between two of the main cognitive deficits in ADHD (attention and inhibitory control), symptomatology (inattention and hyperactivity/impulsivity), and functional impact in patients diagnosed with | Spain | The results indicated that greater deficits in cognitive functioning (attention and inhibitory control) predicted higher ADHD symptom severity (inattention and hyperactivity/impulsivity). Regarding the relationship between neuropsychological functioning and functional impact, the data suggested that greater attentional and inhibitory deficits predicted greater functional | [36] |

 doi:10.20944/preprints202504.0114.v1

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| ADHD without comorbid disorders. | | impairment, but only through the mediation of symptom severity. | |
| Sample: 30 children aged 6 to 14 years diagnosed with ADHD. Objective: To compare the neuropsychological performance characteristics of a sample of children with Combined-type ADHD (ADHD-C), Inattentive-type ADHD (ADHD-I), and a control group from the city of Manizales, Colombia. | Colombia | Differences were found in performance on visual attention tasks, with lower mean scores for the ADHD-C group compared to the ADHD-I group. Additionally, the ADHD-I group showed lower mean scores in metalinguistic skills (sound counting) compared to the control group. No significant differences were found in other measures included in the evaluation, such as intellectual capacity, memory, and executive functions. | [37] |
| Sample: 15 children aged 10 to 14 years diagnosed with ADHD. Objective: To analyze the relationship between the neuropsychological profile and the level of emotional intelligence in fifth-grade children with suspected ADHD. | Dominican Republic | In the evaluation of the neuropsychological profile, the assessed group demonstrated a low-average performance in intellectual capacity measures. Additionally, cognitive measures derived from the DNI-Luria battery indicated low performance in tasks related to visual perception, spatial orientation, receptive speech, conceptual activity, immediate memory, logical memory, and attentional control. No association was found between intelligence quotient, neuropsychological profile, and emotional intelligence measures. | [38] |
| Sample: 149 children aged 5 to 6 years, with and without ADHD. Objective: To compare the cognitive profile of preschool children at risk of dyslexia with the cognitive profile of children at risk of both dyslexia and coexisting ADHD. | Belgium | When comparing the group of children at risk for dyslexia with those at risk for both dyslexia and coexisting ADHD, no significant differences were found in most cognitive measures, except for executive functioning, where the dyslexia-only group performed better than the dyslexia-ADHD comorbidity group. The results indicated that the control group generally outperformed both risk groups across all evaluated measures, including phonological processing, executive functioning, receptive vocabulary, and processing speed, except for cognitive flexibility and delay of gratification. | [27] |
| Sample: 24 children with ADHD aged 6 to 15 years and 24 control children aged 7 to 15 years. Objective: To describe the neuropsychological profile of patients with attention-deficit/hyperactivity disorder (ADHD) and its impact on | Spain | Children and adolescents with ADHD showed significantly lower scores than the neurotypical control group in all cognitive measures (motor functions, verbal abilities, abstract reasoning, linguistic, memory, attentional, and executive functions, as well as academic skills), except for perceptual abilities. More than half of the evaluated ADHD | [28] |

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| executive functions and academic performance. | sample had a comorbid learning disorder. |

The body of research analyzed underscores the heterogeneous cognitive and neuropsychological profile of ADHD, reinforcing the notion that this disorder encompasses diverse presentations with distinct functional implications. Across multiple studies conducted in Spain, Colombia, the Netherlands, Belgium, and the Dominican Republic, children with ADHD exhibit significant deficits in executive functioning, working memory, attentional control, and metalinguistic abilities compared to neurotypical peers. Notably, findings consistently differentiate between ADHD presentations, with distinct patterns in inhibitory control, processing speed, and attentional regulation, highlighting the need for tailored diagnostic criteria and intervention strategies.

Beyond core cognitive impairments, evidence suggests that the severity of attentional and inhibitory deficits is a key predictor of both symptom intensity and functional impairment [36]. Additionally, the high prevalence of comorbid learning disorders [28] and overlapping neurodevelopmental profiles—such as those observed in ADHD and dyslexia [27]—reinforce the necessity of comprehensive neuropsychological assessments. These findings collectively advocate for a more nuanced conceptualization of ADHD, emphasizing the importance of individualized intervention frameworks that account for both cognitive variability and functional impact.

This study aimed to determine the effect of ADHD on the neuropsychological and academic performance of a sample of Colombian children in primary and secondary education compared to a control group.

## 2. Materials and Methods

### *2.1. Type of Research*

This was a Quasi-experimental correlational research [39]. The independent variable was the presence or absence of ADHD, while the dependent variable was the performance of the children on various neuropsychological and academic tasks (Table 2). Internal validity was ensured through initial equivalence by matching the two groups: cases and controls.This study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Institutional Scientific Ethical Committee of the Universidad de Manizales, Colombia (ISET-03-22-0012); the date of approval by the ethics committee is 3 February 2022.

**Table 2.** Quantitative Variables.

| Variable Group | Variable | Variable Abbrev. |
|---|---|---|
| **Writing** | Writing Accuracy: Syllable Dictation | WA: SD |
| | Writing Accuracy: Word Dictation | WA: WD |
| | Writing Accuracy: Nonword dictation | WA: NWD |
| | Writing Accuracy: Sentence Dictation | WA: SD |
| | Number of Words with Errors in Copying | NWE:C |
| | Number of Words with Errors in Written Retrieval | NWE: WR |
| | Narrative Composition Analysis: Narrative Coherence | NCA: NC |
| | Narrative Composition Analysis: Written Retrieval Length | NCA: WRL |

 doi:10.20944/preprints202504.0114.v1

| Variable Group | Variable | Variable Abbrev. |
|---|---|---|
| Reading | Copying Speed | CS |
| | Written Retrieval Speed | WRS |
| | Reading Accuracy: Syllables | RA: S |
| | Reading Accuracy: words | RA:W |
| | Reading Accuracy: Non-Words | RA: NW |
| | Reading Accuracy: Sentence Reading | RA: SR |
| | Number of Words with Errors in Oral Reading | NW: EO |
| | Reading Comprehension: Sentence Reading | RC: SR |
| | Reading Comprehension: Oral Reading | RC: OR |
| | Reading Comprehension: Inferential Response in Oral reading (ítem 4) | RC: IROR4 |
| | Reading Comprehension: Silent Reading of a Text | RC: SRT |
| | Reading Speed | RS |
| | Silent Reading Speed | SRS |
| Intelligence Quotient | Verbal Intellectual Quotient Measure – Vocabulary Task | VIQ-Voc |
| | Performance IQ Assessment – Block Design Task | PIQA-BD |
| | Full Scale IQ score | FS: IQS |
| Memory | visual memory: copy score of the complex figure | VM: CSCF |
| | Visual memory: recall score of the complex figure. | VM: RSCF |
| | Coding: Word List | C: WL |
| | Coding/Word List/Working Memory – First Trial | CWL-WM- FT |
| | Coding Spontaneous Recall | CDR |
| | Coding Delayed Recall with Cues | CDRC |
| | Verbal Auditory Recognition | VAR |
| Attention | Visual Attention – Drawing Cancellation Task | VA: DCT |
| | Omission of Drawings | OD |
| | Commission of drawings | CD |
| | Visual Attention: Letter Cancellation Task | VA: LCT |
| | Omissions: Letters | OL |
| | Commissions: Letters | CL |
| | Total Errors: letters | TEL |
| | Auditory Attention: Forward Digit Span Task | AA: FDS |
| | Auditory Attention: Backward Digit Span Task | AA: BDS |
| Executive Functioning | Cognitive Flexibility: Number of Administered Trials | CF: NAT |
| | Cognitive Flexibility: Total Correct Responses | CF: TCR |
| | Cognitive Flexibility: Total Errors | CF: TE |

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| Variable Group | Variable | Variable Abbrev. |
|---|---|---|
| Language | Cognitive Flexibility: Percentage of Errors | CF: PE |
| | Cognitive Flexibility: Number of Categories | CF: NC |
| | Cognitive Flexibility: Inability to Maintain Set | CF: IMS |
| | Cognitive Flexibility: Number of Perseverative Responses | CF: NPR |
| | Cognitive Flexibility: Percentage of Perseverative Responses | CF: PPR |
| | Cognitive Flexibility: Number of Initial Conceptualization Trials | CF: NICT |
| | Semantic Verbal Fluency (Animals) | SVF: A |
| | Phonemic Verbal Fluency (Letter M) | PVF: M |
| | Instruction Following Task | IFT |
| | Metalinguistic skills: synthesis task | MS: ST |
| | Metalinguistic Skills: Sound Counting Task | MS: SC |
| | Metalinguistic Skills: Spelling Task | MS: SPT |
| | Metalinguistic Skills: word counting task | MS: WCT |

*2.2. Sample*

The sample consisted of 194 school-aged children from Manizales. Half of the children had a diagnosis of ADHD. The case and control groups were matched based on sex, age, educational level, socioeconomic status (Table 3). Each group (cases and controls) consisted of 24 girls and 73 boys, with ages ranging from 5 to 14 years (mean: 9.4 years, standard deviation: 2.7 years). Among the children in the case group, 59.8% were diagnosed with combined-type ADHD, while the rest presented predominantly inattentive ADHD.

**Table 3.** Sociodemographic Variables.

| Variable | Descriptive Statistics | Case | Control |
|---|---|---|---|
| Age | Mean | 9,41 | 9,43 |
| | Standard Deviation | 2,7 | 2,67 |
| | Coefficient of Variation | 28,6% | 28,3% |
| Sex | Female % | 24,7 | 24,7 |
| | Male % | 75,3 | 7,53 |
| Socioeconomic status | Strata 1% | 19,6 | 19,6 |
| | Strata 2% | 67,0 | 67,0 |
| | Strata 3% | 13,4 | 13,4 |
| | Strata 6% | 1,0 | 1,0 |
| Education Level | Preschool % | 5,2 | 3,1 |
| | First Grade% | 16,5 | 15,5 |
| | Second Grade % | 14,4 | 12,4 |
| | Third Grade % | 14,4 | 16,5 |

 doi:10.20944/preprints202504.0114.v1

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|---|---|---|
| Fourth Grade % | 6,2 | 9,3 |
| Fifth Grade % | 12,4 | 7,2 |
| Sixth Grade % | 11,3 | 12,4 |
| Seventh Grade % | 12,4 | 10,3 |
| Eight Grade % | 4,1 | 7,2 |
| Ninth Grade % | 3,1 | 5,2 |
| Tenth Grade % | 0,0 | 1,0 |

*2.3. Procedure*

Data on the neuropsychological and academic assessments of children diagnosed with ADHD and control cases were collected over recent years as part of fieldwork conducted in various research projects. These projects were led by a Neuropsychopedagogy Specialization Program at a private university located in a central Colombian city within the Coffee Axis region. The first phase involved contacting school administrators in Manizales and presenting the research objectives. Schools expressing interest in participation were invited to schedule meetings with students' families to extend invitations for study enrollment. Parents who demonstrated willingness to participate provided informed consent. The assessment process was conducted on school premises, where school administrators and parents authorized the participation of children in the study.

For case selection, children who scored a T-score above 65 on both the Conners Parent Rating Scale and the Conners Teacher Rating Scale were included. Conversely, the control group consisted of children with T-scores below 50. Additional eligibility criteria for the control group included adequate academic performance, based on a general school report, and no history of grade repetition or significant academic difficulties.

Children selected through this initial phase underwent a cognitive screening using an abbreviated version of the Wechsler Intelligence Scale for Children (WISC-III, form C6 x2) [40]. Those who obtained an IQ score of 85 or higher proceeded to a structured psychiatric interview using the Mini International Neuropsychiatric Interview for Children and Adolescents (MINI-KID) [41] to confirm the clinical criteria for ADHD diagnosis.

The sample selection process followed a purposive sampling strategy, relying on convenience sampling. An interdisciplinary team was responsible for determining group assignments, including professionals from various fields such as medicine, psychiatry, psychology, and neuropsychology. The final ADHD diagnosis was established based on the results of the MINI-KID screening tool [41].

Ultimately, the study included 97 participants in the ADHD group and 97 in the control group. Both groups underwent neuropsychological and academic assessments using selected subtests from the Child Neuropsychological Assessment Battery (ENI) [42].

*2.4. Inclusion Criteria*

1. A minimum full-scale IQ of 85, based on the score from an abbreviated version of the Wechsler Scale, CX6 form [40].
2. A T-score of 65 or higher for the ADHD group, and a T-score of 50 or lower for the control group on the inattention and hyperactivity/impulsivity dimensions of the Conners questionnaires and checklists completed by parents and teachers [9].
3. Informed consent signed by parents or guardians.

*2.5. Instruments*

1. Screening to Determine Inclusion and Exclusion Criteria
2. Conners' Parent Rating Scale (CPRS) and Teacher Rating Scale (CTRS) [7].
3. WISC III [43], abbreviated form C6 x2: Vocabulary and Block Design subscales [40].

 doi:10.20944/preprints202504.0114.v1

4. Semi-Structured Psychiatric Interview MINI-KID (Mini International Neuropsychiatric Interview for Children and Adolescents) [41].
5. Academic and Neuropsychological performance [42]

*2.6. Data Analysis*

Based on the available data, a data matrix was constructed and subjected to the following statistical analysis using the Jamovi statistical package. This study described the variables using the mean and standard deviation.The Shapiro–Wilk test was used to assess the normality of the variables, while Levene's test was applied to evaluate the homogeneity of variances. The experimental and control groups were compared using Student's *t*-test for normally distributed data with homogeneous variances, Welch's *t*-test for normally distributed data with non-homogeneous variances, or the Mann-Whitney *U* test for non-normally distributed data with non-homogeneous variances. Correlation analyses between variables, distinguishing between case and control groups, were conducted using Pearson's correlation coefficient when the normality assumption was met, or Spearman's correlation coefficient otherwise [44].

## 3. Results

*Description and Comparison Between the Experimental and Control Groups*

Regarding the studied variables (Table 4), the following findings were observed. The mean total intelligence quotient (IQ) was higher in the control group than in the case group, with the latter also exhibiting greater homogeneity in IQ scores. Similarly, across all assessed metalinguistic skills, the control group had higher mean scores and greater homogeneity compared to the case group, suggesting greater variability within the case group in tasks such as synthesis, phoneme counting, spelling, and word counting. In terms of reading, the only measure in which the case group exhibited a higher mean score was number of words with errors in oral reading (NW:EO). For all other reading measures, the case group had lower mean scores than the control group, with a lower coefficient of variation for NW:EO, indicating greater homogeneity in the number of errors within the case group.

In writing, the case group demonstrated higher mean scores in the number of errors in copying (NEW: C), the number of words with errors in written retrieval (NEW: WR), and writing retrieval speed (WRS). However, in all other writing measures, the case group had lower mean scores than the control group (Table 4). Regarding memory, all assessed variables, except for visual memory/recall score of the complex figure (VMRSCF), had higher mean scores in the control group. Notably, for VMRSCF, the case group displayed significant variability in scores (70% dispersion) compared to the control group (30%) (Table 5).

**Table 4.** Statistical for Writing and Reading Variables.

| Variable | Case (Mean ± SD) | Control (Mean ± SD) | p-value | Effect Size (*d*) (R-BC) |
|---|---|---|---|---|
| | | **Writing** | | |
| WA: SD | 6,134 ± 2,519 | 7,0208 ± 1,717 | **0,005** | 0,41140 (*d*) |
| WA: WD | 3,969 ± 1,95 | 5,0833 ± 1,89 | **<0 ,001** | 0,58033 (*d*) |
| WA:NWD | 4,814 ± 2,078 | 5,5104 ± 1,536 | **0,036** | 0,16527 (R-BC) |
| WA: SeD | 9,474 ± 5,803 | 11,5 ± 5,872 | **0,017** | 0,34710 (*d*) |
| NWE: C | 9,329 ± 7,486 | 6,4719 ± 6,01 | **0,006** | 0,42098 (*d*) |
| NWE:WR | 14,783 ± 10,001 | 12,4889 ± 7,581 | 0,284 | 0,09438 (R-BC) |
| NCA: NC | 3,667 ± 1,616 | 4 ± 1,773 | 0,194 | 0,19653 (*d*) |
| NCA: WRL | 70,56 ± 44,453 | 79,0652 ± 45,453 | 0,211 | 0,18920 (*d*) |

 doi:10.20944/preprints202504.0114.v1

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|---|---|---|---|---|
| CS | 11,202 ± 6,182 | 12,4945 ± 6,72 | 0,187 | 0,20012 (*d*) |
| WRS | 14,718 ± 9,154 | 13,5543 ± 7,425 | 0,360 | 0,13963 (*d*) |
| **Reading** | | | | |
| RA: S | 6,505 ± 2,658 | 7,3542 ± 1,735 | **0,017** | 0,16323 (R-BC) |
| RA: W | 9,526 ± 3,028 | 10,4271 ± 1,868 | **0,016** | 0,15174 (R-BC) |
| RA: NW | 6,052 ± 2,252 | 6,8646 ± 1,626 | **0,003** | 0,23647 (R-BC) |
| RA: SR | 7,758 ± 3,231 | 8,9583 ± 2,166 | **0,002** | 0,23673 (R-BC) |
| NW:EO | 4,694 ± 4,952 | 2,4409 ± 3,002 | **<0 ,001** | 0,38558 (R-BC) |
| RC: SR | 6,295 ± 2,82 | 7,0313 ± 2,305 | 0,050 | 0,28593 (*d*) |
| RC: OR | 4,539 ± 2,468 | 5,5789 ± 1,998 | **0,003** | 0,24802 (R-BC) |
| RC: IROR4 | 1,056 ± 0,774 | 1,2935 ± 0,719 | **0,034** | 0,31761 (*d*) |
| RC: SRT | 3,512 ± 2,034 | 4 ± 2,047 | 0,119 | 0,23936 (*d*) |
| RS | 74,141 ± 42,451 | 92,2553 ± 46,433 | **0,007** | 0,40718 (*d*) |
| SRS | 79,988 ± 49,172 | 97,0238 ± 50,899 | **0,030** | 0,34043 (*d*) |

Note: WA: SD = Writing Accuracy: Syllable dictation, WA: WD = Writing Accuracy: Word dictation, WA:NWD = Writing Accuracy: Non-Word dictation, WA: SeD = Writing Accuracy: Sentence Dictation, NWE: C = Number of Words with Errors in Copying, NWE: WR = Number of Words with Errors in Written Retrieval, NCA: NC = Narrative Coherence Accuracy, NCA: WRL = Written Retrieval Length, CS = Copying Speed, WRS = Written Retrieval Speed, RA: S = Reading Accuracy: Syllable, RA: W = Reading Accuracy: Words, RA: NW = Reading Accuracy: Non-Words, RA: SR = Reading Accuracy: Sentence Reading, NW:EO = number of words with errors in oral reading, RC: SR = Reading Comprehension: Sentence Reading, RC: OR = Reading Comprehension: Oral Reading, RC: IROR4 = Reading Comprehension: Inferential response in oral reading, RC: SRT = Reading Comprehension: Silent Reading of a text, RS= Reading Speed, SRS = Silent Reading Speed.

Attention-related measures indicated that the case group had higher mean scores in commission of drawings (CD), omission of letters (OL), and total letter errors (TEL). Furthermore, attention-related variables generally exhibited coefficients of variation of 150% or higher, indicating substantial heterogeneity in both groups (Table 5). Executive function (cognitive flexibility) measures revealed that the case group had higher mean scores in the number of administered trials (CF:NAT), total errors (TE), percentage of errors (PE), number of perseverative responses (NPR), percentage of perseverative responses (PPR), and number of initial conceptualization trials (NICT) (Table 5).

**Table 5.** Statistical for Intelligence Quotient, Memory, Attention, Executive Functioning Variables.

| Variable | Case (Mean ± SD) | Control (Mean ± SD) | p-value | Effect Size (*d*) (R-BC) |
|---|---|---|---|---|
| **Intelligence Quotient** | | | | |
| VIQ: Voc | 25,24 ± 8,142 | 29,6354 ± 9,418 | **<0 ,001** | 0,499 (*d*) |
| PIQA-BD | 28,063 ± 14,633 | 32,1146 ± 14,294 | 0,054 | 0,280 (*d*) |
| FS: IQS | 19,742 ± 4,391 | 23,0313 ± 5,387 | **<0 ,001** | 0,34912 (R-BC) |
| **Memory** | | | | |
| VM: CSCF | 7,835 ± 2,741 | 7,9063 ± 2,726 | 0,857 | 0,026 (*d*) |
| VM: RSCF | 86,557 ± 34,62 | 90,875 ± 42,74 | 0,442 | 0,111 (*d*) |
| C: WL | 26,155 ± 7,742 | 28,25 ± 7,182 | **0,032** | 0,178 (R-BC) |
| CWL-WM- FT | 4,763 ± 1,841 | 5,5313 ± 1,515 | **0,002** | 0,455 (*d*) |
| CSR | 7,237 ± 2,188 | 7,7708 ± 2,382 | 0,107 | 0,233 (*d*) |

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|---|---|---|---|---|
| CDRC | 7,278 ± 2,035 | 7,8333 ± 2,378 | 0,083 | 0,250 (*d*) |
| VAR | 19,443 ± 3,416 | 19,7917 ± 4,203 | 0,528 | 0,090 (*d*) |
| **Attention** | | | | |
| VA: DCT | 19,835 ± 9,077 | 20,3646 ± 9,874 | 0,699 | 0,055 (*d*) |
| OD | 2,454 ± 4,1 | 2,7604 ± 5,761 | 0,671 | 0,061 (*d*) |
| CD | 0,742 ± 1,856 | 0,5 ± 1,306 | 0,295 | 0,151 (*d*) |
| VA: LCT | 22,804 ± 10,429 | 24,8854 ± 11,981 | 0,200 | 0,18531 (*d*) |
| OL | 3,608 ± 7,927 | 1,5625 ± 2,854 | **0,003** | 0,23711 (R-BC) |
| CL | 0,443 ± 0,968 | 0,3854 ± 1,268 | 0,722 | 0,05132 (*d*) |
| TEL | 4,052 ± 7,97 | 1,9479 ± 3,014 | **0,003** | 0,23872 (R-BC) |
| AA: FDS | 4,907 ± 1,001 | 5,0208 ± 1,248 | 0,487 | 0,10044 (*d*) |
| AA-BDST | 3,206 ± 1,04 | 3,5521 ± 1,23 | **0,036** | 0,30366 (*d*) |
| **Executive Functioning** | | | | |
| CF: NAT | 50,25 ± 6,383 | 50,1458 ± 6,066 | 0,908 | 0,01673 (*d*) |
| CF: TCA | 33,667 ± 6,609 | 34,7604 ± 5,783 | 0,224 | 0,17613 (*d*) |
| CF: TE | 16,412 ± 9,273 | 15,3854 ± 8,231 | 0,417 | 0,11713 (*d*) |
| CF: PE | 31,708 ± 16,016 | 29,5313 ± 14,184 | 0,320 | 0,14392 (*d*) |
| CF: NC | 1,927 ± 0,965 | 2,0625 ± 0,938 | 0,326 | 0,14228 (*d*) |
| CF: IMS | 0,615 ± 0,8 | 0,6458 ± 0,821 | 0,790 | 0,03857 (*d*) |
| CF: NPR | 12,063 ± 11,312 | 9,5625 ± 8,257 | 0,273 | 0,09147 (R-BC) |
| CF: PPR | 22,969 ± 20,673 | 18,3958 ± 14,97 | 0,281 | 0,09006 (R-BC) |
| CF: NICT | 16 ± 10,009 | 14,8438 ± 9,476 | 0,412 | 0,11863 (*d*) |
| SVF: A | 14,216 ± 5,134 | 15 ± 5,07 | 0,287 | 0,15356 (*d*) |
| PVF: M | 5,619 ± 3,67 | 6,2708 ± 3,782 | 0,226 | 0,17504 (*d*) |

Note: VIQ: Voc = Verbal Intellectual Quotient: Vocabulary Task, PIQA-BD = Performance Intellectual Quotient Assessment – Block Design, FS: IQS = Full-Scale Intellectual Quotient, VM: CSCF = visual memory: copy score of the complex figure, VM: RSCF = Visual memory: recall score of the complex figure, C: WL = Coding: Word List, CWL-WM- FT = Coding Word List-Working Memory – First Trial, CSR = Coding Spontaneous Recall, CDRC = Coding Delayed Recall with Cues, VAR = Verbal Auditory Recognition, VA: DCT = Visual Attention: Drawing Cancellation Task, OD = Ommission of Drawings, CD = Commission of Drawings, VA: LCT = Visual Attention: Letter Cancellation Task, OL = Omission of Letters, CL = Commission of Letters, TEL = Total of Errors in Letters, AA: FDS = Auditory Attention: Forward Digit Span, AA-BDST = Auditory Attention – Backward Digit Span task, CF: NAT = Cognitive Flexibility: Number of Administered Trials, CF: TCA = Cognitive Flexibility: Total Correct Answers, CF: TE = Cognitive Flexibility: Total Errors, CF: PE = Cognitive Flexibility: Percentage of Errors, CF: NC = Cognitive Flexibility: Number of Categories, CF: IMS = Cognitive Flexibility: Inability to Maintain Set, CF: NPR = Cognitive Flexibility: Number of Perseverative Responses, CF: PPR = Cognitive Flexibility: Percentage of Perseverative Responses, CF: NICT = Cognitive Flexibility: Number of Initial Conceptualization Trials, SVF: A = Semantic Verbal Fluency: Animals, PVF: M = Phonemic Verbal Fluency: Letter M.

In contrast, for all other executive function measures, the case group had either lower or equal mean scores compared to the control group. Additionally, high coefficients of variation (40% or greater) were observed in most executive function measures, suggesting considerable heterogeneity within both groups. Lastly, in language-related assessments, the control group exhibited higher mean scores across all measured variables, while the case group demonstrated greater variability in scores, as indicated by higher coefficients of variation (Table 6). These results highlight significant cognitive, linguistic, and attentional differences between children with ADHD and their neurotypical peers,

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with the case group generally exhibiting lower mean performance and greater variability across most measured domains.

**Table 6.** Statistical for Language Variables.

| Variable | Case (Mean ± SD) | Control (Mean ± SD) | p-value | Effect Size (*d*) (R-BC) |
|---|---|---|---|---|
| | | **Language** | | |
| IFT | 8,546 ± 1,458 | 9,0521 ± 1,251 | **0,009** | 0,20758 (R-BC) |
| MS: ST | 2,557 ± 2,194 | 3,2917 ± 2,161 | **0,020** | 0,33751 (*d*) |
| MS: SC | 4,381 ± 2,687 | 5,3958 ± 2,306 | **0,008** | 0,21886 (R-BC) |
| MS: SPT | 4,144 ± 2,332 | 4,8229 ± 1,908 | 0,081 | 0,14412 (R-BC) |
| MS: WCT | 3,711 ± 2,872 | 4,8646 ± 2,382 | **0,006** | 0,22444 (R-BC) |

Note: IFT = Instruction Following Task, MS: ST = Metalinguistic skills: Synthesis Task, MS: SC = Metalinguistic Skills Sound Counting Task, MS: SPT = Metalinguistic Skills Spelling Task, MS: WCT = Metalinguistic Skills word counting task.

## 4. Discussion

This study corroborates previous research indicating a higher prevalence of attention-deficit/hyperactivity disorder (ADHD) among boys compared to girls. However, the explanation for this difference appears more complex than previously assumed. Traditional research in the field has often attributed these gender disparities solely to neuroanatomical differences or variations in neurotransmitter functioning. For instance, some studies suggest that girls with ADHD exhibit a 10% reduction in gray matter volume compared to boys with ADHD. Additionally, girls are reported to reach peak cortical thickness approximately 3.5 years earlier than boys, suggesting distinct neurological developmental trajectories. Nevertheless, increasing evidence highlights the impact of social context and gender stereotypes on the timely diagnosis of ADHD in girls.

Social norms often encourage girls to conform to expected behaviors such as organization, obedience, dependence, and submission, potentially leading them to suppress disruptive behaviors to align with these societal expectations. As a result, girls may mask ADHD symptoms in the presence of caregivers and educators, complicating diagnosis and delaying intervention [41].

The higher prevalence of ADHD among boys observed in this study aligns with previous reports indicating male-to-female ratios of 4:1 or 3:1 [42–45]. More recent studies, however, suggest a lower ratio of approximately 2:1, where for every two or three diagnosed boys, one girl is identified with the disorder [46,47]. Traditionally, these gender differences were attributed to the greater frequency of ADHD diagnoses in boys [43,48], possibly due to the higher prevalence of the hyperactive-impulsive or combined presentation in boys compared to the predominantly inattentive type observed in girls.

It is essential to consider that parents, teachers, and peers who interact with children diagnosed with ADHD may exhibit greater tolerance toward inattentive behaviors—more common in girls—compared to the overt hyperactive-impulsive symptoms often displayed by boys. This normalization of inattentive symptoms may contribute to underdiagnosis in girls, limiting access to timely interventions. Some researchers suggest that females tend to exhibit symptoms such as distractibility, disorganization, and forgetfulness, which are perceived as less disruptive than hyperactive-impulsive behaviors typically seen in males. Consequently, inattentive symptoms may be overlooked or deemed insufficiently severe to warrant a diagnosis [41].

In general, ADHD tends to be more conspicuous in boys, particularly those with hyperactive-impulsive or combined presentations. Symptoms associated with these presentations include motor restlessness, difficulty remaining seated, excessive talking, trouble waiting for turns, interrupting conversations, and intruding into others' affairs. Additionally, impulsivity in boys with ADHD has

 doi:10.20944/preprints202504.0114.v1

been linked to an increased risk of accidents and early engagement in risky behaviors such as substance use, early sexual activity, and suicidal ideation. Conversely, in girls, the predominantly inattentive presentation may result in delayed diagnosis. Girls with ADHD are more likely to exhibit internalizing disorders, such as anxiety and depression, which can mask ADHD symptoms and further complicate diagnosis. Consequently, difficulties in following instructions, completing tasks, maintaining necessary materials, and frequent distractibility may go unnoticed [49].

Indeed, it has been suggested that for girls to receive an ADHD diagnosis, their symptoms must be sufficiently pronounced or highly disruptive. Research indicates that females may require a higher symptom severity threshold to be diagnosed with ADHD. As a result, girls are often referred for psychiatric consultation only when inattention symptoms significantly impair their academic and social performance or lead to evident functional impairment [49,50]. In the present study, the mean age of the evaluated children was 9 years, which is considered representative for this research. This finding is consistent with the diagnostic age range for children with ADHD as defined by the American Psychiatric Association (2022), which places the diagnosis between the ages of 7 and 12. However, the present findings diverge from those reported in a study conducted by the National Survey of Children's Health (NSCH), which found an average symptom onset age of approximately 6 years. Additionally, the NSCH study reported cases of severe ADHD being diagnosed even earlier, while milder cases were diagnosed approximately one year later [51].

Regarding the socioeconomic status of the cases included in this research, despite the convenience sampling method, a higher percentage of children diagnosed with ADHD came from middle socioeconomic strata, equivalent to strata 3 and 4 in Colombia. Moreover, the majority of diagnosed children attended private schools in the city.

This finding contrasts with previous studies, which indicate a higher prevalence of ADHD in lower socioeconomic strata (strata 1 and 2 in Colombia). Most prior research describes associations between low socioeconomic status and factors such as social vulnerability, limited cultural and economic capital, low parental education (particularly maternal education), and a lack of opportunities—all of which are linked to a higher likelihood of ADHD diagnosis, initiation of medication treatment, and difficulties with classroom concentration and school adaptation [52–54].

Although the present study is limited by its convenience sampling method, the results suggest a trend toward increased awareness, knowledge, and education among middle-class families regarding the clinical and educational implications of ADHD. This awareness appears to facilitate timely diagnosis and intervention, allowing children with ADHD to better adapt to the high academic demands of modern society [55,56].

The fact that most diagnosed children were enrolled in private schools and came from middle-income families suggests a prioritization of educational opportunities despite limited financial resources. This aligns with previous studies emphasizing the role of ADHD awareness in shaping societal norms and attitudes toward mental health issues (e.g., reducing stigma-related fears) and improving access to specialized educational support [49,56].

Among the evaluated sample, the most prevalent ADHD presentation was the combined type (59.8%), followed by the predominantly inattentive type (40.2%). Both figures exceed those reported in other studies, which estimate the prevalence of the combined type at 31.4% and the inattentive type at 32.2% in various global populations [10,11,12].

Classic studies have indicated that ADHD affects up to 1 in 20 children in the United States [57], with more recent prevalence estimates reaching 12.9% among American children [58]. Similarly, research in other countries has confirmed ADHD prevalence rates ranging between 5% and 12% when applying DSM diagnostic criteria [59,60]. Regarding Colombia, previous studies have reported an ADHD prevalence of 11.5%, with higher representation of the combined type (6.4%) and inattentive type (4.8%) compared to the hyperactive-impulsive type (0.3%) [61]. In contrast, more recent reports indicate a prevalence of 10.3% in Africa, with the inattentive type being most common (46.7%), followed by the hyperactive-impulsive type (33.7%) and the combined type (20.6%) [11].

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In the present study, the predominance of the combined and inattentive types suggests increased recognition by families and teachers of the impact of inattention-related symptoms on diagnostic referrals and early ADHD identification. Traditionally, hyperactive-impulsive symptoms prompted more frequent reports from parents and teachers. However, attentional difficulties are now gaining recognition due to their association with long-term academic underachievement, lower overall academic performance, and higher dropout rates [62,63].

Intelligence quotient (IQ) scores were higher among control participants than among those diagnosed with ADHD. This result aligns with previous findings reporting lower general intellectual ability in ADHD cases compared to controls [64].However, this finding contrasts with two recent studies. The first, conducted in China, evaluated 772 children aged 6 to 12 years with ADHD and found that their IQ scores fell within the neurotypical range. Additionally, no significant differences were observed in total IQ (TIQ), verbal IQ (VIQ), or performance IQ (PIQ) across ADHD subtypes [65]. The second study, conducted in Ecuador, assessed 50 children aged 5 to 16 years and reported average intellectual ability scores [66].

Beyond the results regarding the intellectual capacity of children with ADHD, which may be inconclusive and contribute to stigmatizing the difficulties that may arise in their intellectual profile, these findings are relevant insofar as the estimation of intellectual capacity is considered a predictor of academic performance potential [67]. Thus, it is important to assess the performance of children with ADHD in this measure to identify strengths and opportunities for implementing pedagogical, curricular, and didactic adaptations tailored to their intellectual profile. According to a study, this reinterpretation of intelligence scale analysis encourages the triangulation of information from other sources (teacher observations in class, performance tests, classroom innovations, etc.), aiming to enhance the understanding of clinical teams, teachers, and families regarding the student's cognitive functioning [68]. This, in turn, fosters educational adjustments and adaptations that can be implemented both in school and at home [69].

Regarding the academic skills performance by the ADHD cases —specifically in metalinguistic skills, reading, and writing included in this study—it can be observed that, in general, the control group presented higher mean scores across most estimated measures. The only tasks where the ADHD group obtained a higher mean score were those with evident clinical significance. These included reading tasks where the ADHD group exhibited a higher mean score for the number of reading errors in oral reading, and writing tasks where they showed a higher mean number of errors in copying, written recall, and writing speed.

This result aligns with previous studies that have described reading difficulties related to decoding speed and text comprehension, as well as difficulties in expressive vocabulary and word reading among children with ADHD [70–72]. Some research has even indicated that approximately 60% of children with reading disorders (RD) meet the criteria for at least one coexisting disorder. The most common of these is attention-deficit/hyperactivity disorder (ADHD), present in at least 20–40% of cases [73].Similarly, previous studies have described that texts produced by children and adolescents with ADHD, compared to control samples, do not necessarily differ in length but show difficulties in structure, coherence, and ideation related to concept formation. Additionally, spelling difficulties are frequently observed, likely associated with the neuropsychological profile characteristic of children with ADHD. This profile includes challenges particularly in attentional and executive functions, such as working memory, inhibitory control, set shifting, and sustained attention, which are considered predictors of reading and writing processes [74–76].

In this same vein, the neuropsychological profile assessment conducted in the present study considered attention, memory, executive functions, and language as essential cognitive processes in academic learning. Based on the results obtained by the ADHD group in this assessment, it can be stated that the control group showed higher average scores in almost all evaluation tasks, while the ADHD group consistently exhibited lower scores. Specifically, the ADHD group had lower mean scores compared to the control group, except in the visual memory task (complex figure recall score), where the ADHD group performed better. Conversely, the ADHD cases exhibited higher scores—

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indicating greater difficulties—in attentional variables such as commission errors in drawings, omission of letters, and total letter errors.

Regarding executive functions, various difficulties related to cognitive flexibility were evident. The ADHD group showed higher mean scores, relative to controls, in clinically significant variables that indicate challenges in the number of trials administered, total errors, percentage of errors, number of perseverative responses, percentage of perseverative responses, and the number of initial conceptualization trials. In terms of language, the control group exhibited higher mean scores across all evaluated measures compared to the ADHD group.

Overall, the findings of this study support previously described neuropsychological difficulties in children with ADHD, including deficits in selective and sustained attention, working memory, and long-term memory. Executive function challenges were also observed, particularly in cognitive flexibility, the ability to integrate environmental feedback, and behavioral regulation. Additionally, difficulties in verbal fluency—both phonological and semantic—were identified, affecting the production of words that start with a specific letter or phoneme and those belonging to a given semantic category. Finally, the results are consistent with previous studies that have reported difficulties in following instructions and metalinguistic skills.

These findings align with research that has characterized the cognitive profile of children with ADHD as featuring overall lower executive function and academic ability scores, although still within the normal range based on cultural benchmarks. However, these lower scores are significantly below those of control groups and affect academic functionality, learning potential, and life skills [28,77]. These difficulties appear to be exacerbated by the low performance of children with ADHD in certain cognitive functions considered prerequisites for academic skills, such as working memory, processing speed, and attention [78].

An important aspect of this study is the heterogeneity and dispersion of scores within the ADHD group in the evaluation of certain cognitive processes, particularly metalinguistic skills, memory, attention, and executive functions. This result appears to confirm the heterogeneity in the clinical manifestation of ADHD, a topic extensively addressed in recent research identifying novel ADHD profiles [18,26].

Among these studies, one notable investigation involved 854 ethnically diverse adolescents aged 10 to 17 years, in which cognitive profiles were assessed to determine whether they differed based on individual characteristics such as age, gender, race, and level of family adversity. The study identified new ADHD profiles: (1) Simple ADHD (63.7%), characterized by a mix of inattentive and combined ADHD subtypes, moderate levels of impairment, and infrequent comorbidities; (2) ADHD + Internalizing (11.4%), marked by a higher likelihood of comorbid anxiety and/or depression; and (3) Disruptive/Disorganized ADHD (24.9%), characterized by severe problems in organization, time management, and planning (OTP), which was also the combined ADHD subtype frequently exhibiting disruptive behavior at school [18]. Recognizing the intellectual, cognitive, and academic profile characteristics of children with ADHD has become even more crucial in the post-pandemic years. The challenges emerging from the numerous educational changes and curricular adjustments prompted by virtual learning experiences highlight the need for greater intervention efforts. These efforts should address the heterogeneity of the disorder and implement more differentiated and personalized interventions targeting executive functions essential for self-regulated learning. In students with ADHD diagnoses who struggle with working memory and attention, these difficulties may further limit their ability to manage their own learning process.

## 5. Limitations and Future Research Directions

One of the main limitations of this study is the use of a convenience sample. Nevertheless, the results were obtained using well-calibrated protocols, culturally appropriate norms, and strict clinical criteria, which enhance their applicability to similar contexts. For future research, it is necessary to address ADHD through mixed-methods studies that enrich quantitative findings with the lived experiences of children and families affected by ADHD. Additionally, further exploration is needed

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regarding functional impairment assessment in the Colombian and broader Ibero-American context, including its correlation with later academic performance in higher education.

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