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## Relationships between teacher-reported ADHD symptom profiles and academic achievement domains in a nonreferred convenience sample of first- to fourth-grade students

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### ABSTRACT

**OBJECTIVES:** Previous studies suggested that inattention was related particularly with reading problems among students. However, most of the former studies had clinically referred samples. A majority of the studies conducted with nonreferred samples have evaluated academic achievement with single or a few parent- or teacher-rated items. Almost none of the studies have investigated reading, writing, and mathematics achievements in a single sample. Data from low- and middle-income countries on the subject are exceedingly scarce. Objectives of the present study were to compare actual measurements of reading fluency, reading comprehension, reading and writing errors, mathematics achievement, and teacher ratings of attention deficit hyperactivity disorder (ADHD) symptoms in a single sample.

**METHODS:** Teachers rated ADHD symptoms in a single, nonreferred, population sample ( $n = 2493$ ) of first- to fourth-grade students with a SNAP-4 rating scale. Actual measurements of reading fluency, reading comprehension, reading and writing errors, and mathematics achievement were also obtained. Fluid IQ was evaluated with Ravens Progressive Matrices. Students were grouped into Predominantly Inattentive (PI), Hyperactive/Impulsive (HI), Combined (C), or control groups. Univariate and multivariate analyses were conducted. Statistical significance was set at  $p < .003$  after correction for multiple comparisons.

**RESULTS:** We showed that after fluid IQ level and gender were controlled, ADHD-PI and ADHD-C groups (but not ADHD-HI) had significantly lower performance in all academic areas. ADHD-PI increased the risk of being in the lowest performing 10th percentile for reading 3 times, for writing more than 3.9 times, and for mathematics more than 6 times.

**CONCLUSIONS:** We investigated the subtype differences in terms of academic achievement between ADHD-PI, ADHD-HI, and ADHD-C, based on teacher reports. Academic achievement data were not based on teacher or parent reports but on the actual performance of the students using standardized tests. Our results suggested that inattention symptoms must be targeted in primary school students in order to help them have academic achievement similar to their peers.

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Attention deficit hyperactivity disorder; subtypes; reading; writing; mathematics

## Introduction

Attention deficit hyperactivity disorder (ADHD) is one of the most common disorders of childhood. ADHD diagnosis is based on two symptom dimensions, hyperactivity/impulsivity (HA/IMP) and inattention (IA). If the subject fulfils the criteria for both dimensions, then he/she is diagnosed as having combined type ADHD. If the subject meets the criteria for only one symptom dimension, then diagnosed as predominantly hyperactive/impulsive (ADHD-HI) or predominantly inattentive (ADHD-PI).

Academic achievement problems are common in children with ADHD. The rate of learning disorder among children with ADHD may be as high as 45% [1]. It has been reported that differences ADHD subtype may also be evident in terms of academic performance. Reading disorder is associated with ADHD-PI

and ADHD-C [2]. Other studies indicated that IA was associated with overall reading problems [3–5]. Another study showed that children with reading disorder and mathematics learning disorder had higher rates of ADHD-PI and ADHD-C [6]. In a clinical sample, authors reported that while inattentive behaviours were associated with reading fluency and comprehension, hyperactivity and impulsivity symptoms were not [7]. Writing impairments in ADHD has been investigated much less frequently [1].

Studies conducted with nonreferred samples provide additional data. In a large sample from three European countries, authors reported significant associations between teacher-reported IA and hyperactivity symptoms and academic difficulties in reading, writing, and mathematics. Academic achievements were evaluated by single items answered by teachers

[8]. Correlations between teachers' behaviour ratings and indicators of academic performance were found in another study [9]. More recently, in another population-based study, significantly higher risks for reading/spelling difficulties and for math difficulties in children with high hyperactivity scores were reported. In that study, researchers evaluated academic difficulties by single parent-rated items [10].

Similarly, results of longitudinal studies suggested that inattentiveness symptoms may be more predictive of academic problems [11,12]. However, most of these studies had referred samples. In a nonreferred sample, Pingault and associates reported that while subjects with a stable high IA trajectory had increased risk of not having a high school diploma after 16 years of follow-up, hyperactivity was not a significant predictor [13].

Overall, these studies suggested that IA was more closely related particularly with reading problems. However, most of the former studies had clinically referred samples. A majority of the studies conducted with nonreferred samples have evaluated academic achievement with single or a few parent- or teacher-rated items. Almost none of the studies have investigated reading, writing, and mathematics achievements in a single sample. Data from low- and middle-income countries on the subject are exceedingly scarce.

The aims of the present study were to provide data to cover some of the limitations of the previous studies. We investigated the subtype differences in terms of academic achievement between ADHD-PI, ADHD-HI, and ADHD-C, based on teacher reports. We collected data on reading fluency, reading comprehension, reading errors, writing errors during dictation, mathematics achievement in a single, nonreferred, population sample of first- to fourth-grade students. Academic achievement data were not based on teacher or parent reports but on the actual performance of the students using standardized tests. To our knowledge, this is one of the largest scale studies comparing ADHD subtype differences in children and adolescents in a middle-income developing country.

Our hypotheses were: (1) there were differences between Inattentive, Hyperactive/Impulsive and Combined types in terms of reading, writing, and mathematics achievements, with ADHD-PI and ADHD-Combined groups having the worst performance; (2) the rate of students at the lowest 10th percentile of achievement was larger in PI and Combined types; (3) the differences between ADHD groups would remain to be significant after gender, school, grade, and fluid IQ score were controlled.

## Methods

### Sample

The sample included 2493 children (boys: 1375, 55.2%; girls: 1118, 44.8%) from first to fourth grades (first

grade: 648, 26.0%; second grade: 656, 26.3%; third grade: 521, 20.9%; fourth grade: 668, 26.8%) from 10 private primary schools in Istanbul, Turkey. All schools are under the same parent organization and have been using the same syllabus for all classes. Despite being private, this school chain follows the state curriculum prepared by the Ministry of Education and all their teachers take part in the in-service teachers education programmes to enable standardisation and unity in the classrooms. In all schools, standard exams have been conducted at the same day and time for each class, ensuring that all students are subject to exactly the same questions.

### Measures

**SNAP-IV.** Swanson, Nolan, and Pelham –IV Questionnaire (SNAP-IV): Items include 18 ADHD symptoms, 9 each in HA/IMP and IA subscales. Items are rated on a 4-point scale from (0) not at all to (3) very much. SNAP-IV is reported to be a reliable and valid instrument [14,15]. In our study, teachers completed the SNAP-IV. Internal consistency was very high in the present sample (Cronbach's alpha: .97).

**Reading achievement.** For each grade, a specific text was read aloud by the students individually in the classroom setting with the teacher and student alone while teachers rated oral reading fluency ( $n = 2098$ ) using the protocol prepared by the researchers. The texts were 98, 115, 138, and 321 words for the first, second, third, and fourth grades, respectively. All texts were selected by the researchers from the standard Turkish textbooks appropriate for each grade. The variables rated were the number of words read correct in one minute, reading errors in terms of omission or insertion of words, letters, phrases or syllables, pronunciation errors, and omitting last parts of sentences. Oral reading errors were calculated by adding all errors together ( $n = 2367$ ). Reading comprehension was evaluated separately by four multiple choice questions answered by the students after reading aloud the provided texts ( $n = 1885$ ).

**Writing achievement.** For each grade, a specific text was dictated by the teachers. Similar to the Reading Achievement, the dictation texts were selected by the researchers from the textbooks written for the respective grades. All dictations were rated by researchers in terms of omission or insertion of letters, words, syllables, spelling errors, and punctuation errors. All errors were added to compute total writing errors ( $n = 2386$ ).

**Mathematics achievement** ( $n = 2339$ ). For the second- to fourth-grade students, mathematics achievement was calculated as the average of points from three mathematics tests given during the whole academic year in three different times. Tests were identical in each school for each grade and were given to students on the same day and time. For the first

grade, there was only one mathematics test which was applied on the same day in all schools. First- and second-grade maths tests included 10 questions, third-grade tests included 8 questions, and fourth-grade tests included 12 questions. Scores were calculated over 100 points.

**Fluid IQ.** Raven Progressive Matrices (RPM): We used Standard Progressive Matrices (SPM). SPM data were collected from all 2493 students. SPM includes 5 sets of a total of 60 diagrammatic puzzles with increasing difficulty. Test has been reported to have acceptable high reliability and validity [16]. Students with SPM scores lower than 85 were excluded from the data analysis ( $n = 131$ ).

### Procedure

Data were collected at several waves. First, mathematics test scores which were given to the students in the second to fourth grades throughout the year were included. Second, a mathematics test was given to the first graders since these students do not routinely take tests at the first grade. Third, reading and writing achievements were evaluated at all schools. Teachers filled the SNAP-IV forms last. All evaluations other than the routine mathematics tests to second to fourth grades were completed in May. Institutional Review Board approval was obtained (20021704-604.01.01-1357). Consent to collect and use data was obtained from all parents.

### ADHD groups

Items rated as “Quite a bit” or “Very much” by the teachers were accepted as “positive”. When the number of positive items was more than six in both IA and HA/IMP items, the students were coded as Combined type. If six items were positive only among IA or HA/IMP items, then the student was coded as IA type or Hyperactive/Impulsive type. If the student did not have more than six positive items in any symptom groups, then s/he was rated Normal. The sample size of the groups was “IA”: 158, 6.3%; “Hyperactivity/Impulsivity”: 112, 4.5%; “Combined”: 168, 6.7%; and “Normal”: 2055, 82.4%.

### Data analysis

In order to test our first hypothesis, we compared the mean mathematics test scores, oral reading fluency, reading comprehension, total reading errors, and total writing errors between ADHD groups and girls and boys by analysis of variance or independent samples t-test, when the variables had normal distribution and non-parametric Kruskal-Wallis or Mann-Whitney- $U$  tests when the variables were not normally distributed. To test our second hypothesis, we

computed chi-square tests to compare rates of students at the lowest 10th percentile of achievement between the aforementioned groups. In order to test our third hypothesis, we used logistic regression analysis with being in the lowest 10th percentile group at oral reading fluency, mathematics tests, oral reading fluency, reading comprehension (lowest 20th percentile), reading errors and writing errors as dependent and ADHD groups (“normal” group as the reference), fluid IQ score, gender (male as the reference), school (the school with the highest number of students as the reference), and grade (first grade as the reference).  $p < .003$  was reported as statistically significant. All  $p$  values were two-tailed.

## Results

### Correlations between ADHD ratings, fluid IQ score and gender

Correlation analysis indicated that SNAP-IV IA and HA/IMP scores were significantly (but modestly) negatively correlated with fluid IQ score. Boys had significantly higher SNAP-IV IA ( $t(1,2492) = 9.4$ ,  $p < .001$ ) and HA/IMP ( $t(1,2492) = 12.1$ ,  $p < .001$ ) scores when compared with girls. All ADHD subtypes were more common among boys ( $\chi^2(df: 3) = 73.2$ ,  $p < .001$ ).

### Comparison of mathematics test scores, oral reading fluency, reading comprehension, total reading errors, and total writing errors between groups

Mean and standard deviations of mathematics tests and reading fluency scores; minimum/maximum and median values of reading comprehension, total reading errors, and total writing errors were provided in Table 1.

**Reading fluency.** Girls had better reading fluency than boys ( $t(1,2096) = 3.0$ ;  $p = .002$ ). ADHD groups had a significant effect on reading fluency ( $F(3,2094) = 20.2$ ;  $p = .007$ ).

**Reading comprehension.** Girls had better reading comprehension than boys ( $z = -3.3$ ;  $p = .001$ ). ADHD groups had a significant effect on reading comprehension ( $\chi^2(3) = 38.8$ ;  $p < .001$ ).

**Reading errors.** Reading errors were more common in boys ( $z = -4.3$ ;  $p < .001$ ). ADHD groups had a significant effect on the number of reading errors ( $\chi^2(3) = 63.8$ ;  $p < .001$ ).

**Writing errors.** Boys had significantly more writing errors than girls ( $z = -7.3$ ;  $p < .001$ ). ADHD groups had a significant effect on the number of writing errors ( $\chi^2(3) = 149.5$ ;  $p < .001$ ).

**Mathematics achievement.** There were no significant differences between boys and girls ( $t(1,2337) = .01$ ;

**Table 1.** Achievement scores of students in terms of gender, ADHD groups (HI: Hyperactivity/Impulsivity, PI: Predominantly Inattentive), and IQ groups.

	Gender		ADHD groups			
	Boys	Girls	Control	HI	PI	Combined
Reading fluency	87.5 ± 30.5	89.6 ± 33.7	89.0 ± 32.1	94.3 ± 33.9	81.4 ± 31.2	84.2 ± 29.2
Reading comprehension	8; 0–9	8; 0–8	8; 0–9	8; 2–8	7; 0–8	7; 0–8
Writing errors	0; 0–27	0; 0–27	0; 0–27	0; 0–27	3; 0–23	2; 0–27
Reading errors	4; 0–35	3; 0–35	3; 0–35	5; 0–26	8; 0–35	8; 0–32
Mathematics scores	80.8 ± 15.8	80.8 ± 15.3	82.0 ± 15.0	83.4 ± 14.3	68.6 ± 17.8	74.7 ± 16.3
Fluid IQ	114.3 ± 13.8	117.2 ± 13.3	116.2 ± 13.6	116.4 ± 13.7	111.7 ± 12.6	111.3 ± 14.0

Significance levels are reported at the text.

$p > .05$ ). ADHD groups had a significant effect on reading fluency ( $F(3,2335) = 45.6$ ;  $p < .001$ ).

Pairwise Mann–Whitney- $U$  analysis which compared the control group with IA and Combined groups indicated that students with IA and Combined groups had more writing errors ( $z = -8.6$ ;  $p < .001$ ;  $z = -8.9$ ;  $p < .001$ , respectively); more reading errors ( $z = -5.7$ ;  $p < .001$ ;  $z = -5.7$ ;  $p < .001$ , respectively); and lower reading comprehension scores ( $z = -4.4$ ;  $p < .001$ ;  $z = -4.6$ ;  $p < .001$ , respectively). HA/IMP group had more writing errors ( $z = -3.5$ ;  $p < .001$ ) and reading errors ( $z = -2.2$ ;  $p = .026$ ) when compared with the control group. The latter comparison was not significant when corrected for multiple comparisons. Post hoc Dunnett T3 analysis indicated that both IA and Combined groups had lower reading fluency and mathematics test scores (all  $p < .001$ ) when compared with the control group.

### Comparison of rates of students at the lowest 10th percentile (20th percentile for reading comprehension) of achievement between groups

As shown in Table 2, chi-square analysis indicated that boys had significantly higher rates of being in the lower achievement group in all areas except mathematics. ADHD group was significantly associated with all academic achievement areas.

### Logistic regression analysis

As summarized in Table 3, boys had significantly higher rates of being in the lower achievement group for regarding and writing errors when compared with girls. Being in the IA and Combined groups were

associated with lower academic achievement in all measured variables. Lower Fluid IQ scores were associated with higher rates of being in the lower achievement groups. The school of the student was significantly associated with mathematics, reading comprehension, reading, and writing errors' scores, suggesting that achievement levels were significantly different among 10 schools which were involved in the study. Grade was significantly associated only with being in the lower reading comprehension group; risk increased in higher grades.

### Discussion

Our results indicated that, in this non-clinical sample of first- to fourth-grade students, after controlling for fluid IQ score, gender, grade, and school, teacher-reported ADHD status was significantly associated with achievement in all academic fields, including mathematics, reading, and writing. Teacher-reported ADHD HA group had significantly lower performance only in terms of writing errors when compared with students in the control group. However, this association was not significant after other variables were controlled. ADHD-PI and ADHD-Combined groups (based on teacher reports) had significantly lower performance in all academic areas. In the multivariate analysis, gender was associated only with writing errors; boys had significantly more errors during dictation. Not surprisingly, students with higher fluid IQ scores had a better academic achievement.

In the present study, the sample included nonreferred children from first to fourth grades who have been educated at a chain of private school, all located in Istanbul. Students were admitted to the school system not based on an entrance exam, but they were

**Table 2.** Rates of students who had performance in the lowest 10th percentile (20th percentile for Reading Comprehension) in terms of gender and ADHD groups (HI: Hyperactivity/Impulsivity, PI: Predominantly Inattentive).

	Gender			ADHD group				$\chi^2$ (df: 3)
	Boys	Girls	$\chi^2$ (df: 1)	Control	HI	PI	Combined	
Reading fluency	12.1%	8.5%	7.6*	8.6%	4.5%	28.5%	21.1%	70.9**
Reading comprehension	21.9%	17.2%	6.7*	17.8%	16.5%	34.5%	33.6%	34.4**
Writing errors	12.9%	7.2%	20.7**	7.7%	10.3%	27.6%	27.5%	112.1**
Reading errors	12.7%	7.9%	13.9**	7.6%	13.9%	27.4%	28.7%	117.9**
Mathematics scores	11.0%	10.7%	0.53	8.6%	7.6%	37.4%	17.4%	118.5**

\* $p < .01$ , \*\* $p < .001$ .



**Table 3.** Logistic regression analysis.

Independent variables	Comprehension			Writing errors			Reading errors			Mathematics			Reading fluency		
	B	Wald	OR (95% CI)	B	Wald	OR (95% CI)	B	Wald	OR (95% CI)	B	Wald	OR (95% CI)	B	Wald	OR (95% CI)
Gender (df: 1, reference: boys)	0.18	2.0	1.2 (0.9–1.5)	0.48	9.9 <sup>a</sup>	1.6 (1.2–2.2)	0.33	4.7	1.4 (1.1–1.9)	–0.29	4.0	0.8 (0.56–0.99)	0.28	3.3	1.3 (0.98–1.7)
School (df: 9)		51.4 <sup>b</sup>			40.6 <sup>b</sup>			58.5 <sup>b</sup>			48.4 <sup>b</sup>			8.4	
Grade (df: 3)		63.0 <sup>b</sup>			7.0			1.8			11.2			3.0	
Fluid IQ		19.5 <sup>b</sup>			23.5 <sup>b</sup>			16.8 <sup>b</sup>			70.6 <sup>b</sup>			16.7 <sup>b</sup>	
ADHD Group (df:3, reference: Control)	–0.02	34.1 <sup>b</sup>	0.98 (0.97–0.99)	–0.03	68.1 <sup>b</sup>	0.97 (0.96–0.98)	–0.02	68.1 <sup>b</sup>	0.98 (0.97–0.99)	–0.05	76.9 <sup>b</sup>	0.95 (0.94–0.96)	–0.24	45.1 <sup>b</sup>	0.98 (0.97–0.99)
HI	–0.12	0.13	0.89 (0.47–1.7)	0.08	0.56	1.1 (0.56–2.1)	0.52	2.9	1.7 (0.93–3.1)	0.17	0.01	1.0 (0.47–2.1)	–0.81	0.12	0.45 (0.16–1.3)
PI	1.1	22.4 <sup>b</sup>	3.0 (1.9–4.7)	1.4	39.1 <sup>b</sup>	3.9 (2.6–6.1)	1.3	36.2 <sup>b</sup>	3.8 (2.4–5.8)	1.8	70.7 <sup>b</sup>	6.3 (4.1–9.6)	1.3	33.5 <sup>b</sup>	3.6 (2.3–5.6)
Combined	0.89	15.3 <sup>b</sup>	2.4 (1.5–3.7)	1.4	41.8 <sup>b</sup>	3.9 (2.6–5.9)	1.4	46.5 <sup>b</sup>	4.2 (2.8–6.4)	0.92	14.7 <sup>b</sup>	2.5 (1.6–4.0)	0.87	13.0 <sup>b</sup>	2.4 (1.5–3.8)

Note: Outcomes were being in the lowest performing 10th percentile (20th percentile for Reading Comprehension). HI: Hyperactivity/Impulsivity; PI: Predominantly Inattentive; CI: Confidence Interval.

<sup>a</sup> $p < .01$ .

<sup>b</sup> $p < .001$ .

usually from middle to high socioeconomic status (SES). This is important since the academic performance of students reported in the present study was relative to their peers in the same grade. Therefore, the academic weaknesses were relative, and we did not diagnose students as having learning disability (LD). Although the students were from a school chain with identical curriculum, the school in which the student was educated was a significant factor for almost all academic areas, suggesting that educational quality might be different among the schools.

In several referred samples, it has been reported that IA symptoms and ADHD-PI may be specifically associated with academic difficulties [2–7]. These results were supported by studies with nonreferred samples. Rodriguez and colleagues reported in a large sample of 13,087 participants from three European countries that there were strong associations between teacher-reported IA and hyperactivity symptoms and academic difficulties in all academic domains. In that study, however, academic achievements were evaluated by single items answered by teachers [8]. In another study with 4148 children, similar associations were reported between teachers' behaviour ratings and indicators of academic performance [9]. A more recent population-based study reported significantly higher risk for reading/spelling difficulties and for math difficulties in children with high hyperactivity scores at Strengths and Difficulties Questionnaire (SDQ), when compared to children with normal SDQ scores. The authors assessed reading/spelling and math difficulties by single parent-rated items [10]. Our study supported and extended the results of these previous studies in important ways. In our sample, academic achievement was evaluated in a large sample of students from first to fourth grade with standard reading, writing, and mathematics tests and evaluations. This makes our study one of the very few studies in a nonreferred sample, which did not rely on teacher reports to rate academic achievements. While parent and teacher-reported academic achievements are more prone to biases, objective tests are more reliable to evaluate objective levels of achievement. In this sense, our study contributes significantly to the existing literature.

It should also be kept in mind that the control group may be better defined as non-ADHD since there were no other measurements for different psychopathologies. Therefore, the presence of other disorders like anxiety disorders or mood disorders, which are not always easily observable by teachers, may also have an effect on academic achievement. In fact, learning problems may stem from various difficulties and disorders, including poverty, lack of resources, lack of adequate schooling, low-quality teaching, perception problems, intellectual disability, specific learning disorders, and several emotional and behavioural disorders. Although poverty, lack of resources, and low-

quality teaching may not be applied to the present sample, and SPM was used to roughly rule out intellectual disability, these are important issues in a comprehensive evaluation of learning.

Interestingly, although not significant at regression analysis, students with teacher-reported ADHD-HI performed more poorly than controls only in terms of writing errors. It has been suggested that methylphenidate treatment may be effective to improve the writing performance of students with ADHD [11]. Since impairments in reading and mathematics do not necessarily respond to medication treatment [12], it has been argued that in some cases, writing symptoms might be related directly to ADHD symptoms [1]. On the other hand, after gender, school, and fluid IQ score were controlled for, the association between HA/IMP symptoms and writing errors was not significant, suggesting that there might be other modifying factors.

Longitudinal studies showed that inattentiveness symptoms may be more predictive of academic problems [11,12]. However, these studies had referred samples. Pingault and associates found in a recent 16-year follow-up study in a nonreferred sample that a stable high IA trajectory from kindergarten to 12 years, when compared with low IA, increased the risk of not having a high school diploma at 22–23 years of age more than 7 times [13]. When IA symptoms were controlled, hyperactivity was not a significant predictor. These results are important since while hyperactivity symptoms decrease with time, IA symptoms tend to persist into adulthood [17]. Overall, results suggested that IA symptoms might be a better target for intervention in order to prevent or ameliorate academic problems.

The similarities and differences between ADHD-C and ADHD-PI have been discussed for a long time. The origins of this can be found in the DSM-III classification of attention deficit disorder with and without hyperactivity. Several differences have been reported between subjects with ADHD-C, and with ADHD-PI. Rates of aggressive behaviours [18,19] and comorbid oppositional defiant and conduct disorders [20–23] are higher in subjects with ADHD-C [24,25]. It has been reported that comorbid LD may also be more common in subjects with ADHD-PI [26]. Other studies have reported a range of differences between the subtypes including a higher level of difficulty in interference inhibition, working memory [27], and motor planning [28] among the ADHD-PI subjects; although these findings have not been consistently supported by other studies [24].

Our results must be interpreted in light of limitations. First, we did not collect behavioural data from parents. This is an important point since it has been shown that data from multiple informants and evidence of impairment are essential for identifying ADHD [15]. Second, we did not make clinical

ADHD diagnosis. Clinical caseness and teacher-reported symptom levels are two different concepts. Therefore, our results may not be valid for clinical cases. Besides, we did not evaluate the students for other possible psychopathologies. It is very reasonable to assume that there were several children with other disorders which may have an effect on academic performance. Third, the students were from middle to high socioeconomical backgrounds only. Fourth, the academic level was evaluated relative to peers in the same grade, and not relative to national norms, which do not exist in Turkey. Fifth, data on all academic fields were not available for the whole sample. Our results might not be generalized to all primary grade students in Istanbul, particularly students from lower SES groups. On the other hand, it can be suggested that comparing students with their peers from similar backgrounds has clear advantages to show their relative strengths and weaknesses in a more realistic sense.

However, there were several strengths. First, the sample was large and nonreferred. Second, we evaluated academic achievement in reading, writing, and mathematics in a single sample, which is very rare among previous studies. Third, we evaluated academic achievement with tests which were tailored for each grade and applied at the same time to the whole sample. Therefore, we did not rely on teacher or parent reports to evaluate academic problems. Fourth, comparing students with their peers from similar socioeconomical backgrounds allowed us to control for an important confounding factor. In fact, relatively worse academic performance to your peers may be even more important than being at the same level with other children who you do not have any relationship. Students get feedback from their parents and teachers on their actual performance relative to peers in their class, not to general population. Fifth, we controlled for IQ level and gender, both important confounders for academic achievement. Sixth, we provide data from a middle-income developing country, which is not very frequent in the literature.

## Conclusions

In summary, our results clearly showed that, after controlling for gender, school, grade, and fluid IQ score, ADHD-PI and ADHD-Combined, but not ADHD-HI were associated with lower reading fluency, reading comprehension, and mathematics ability as well as higher reading and writing errors. ADHD-PI increased the risk of being in the lowest performing 10th percentile for reading 3 times, for writing more than 3.9 times and for mathematics more than 6 times. Our results suggested that IA symptoms must be targeted in primary school students in order to help them catch with their peers in terms of academic achievement.

## Disclosure statement

No potential conflict of interest was reported by the authors.

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