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Can prosocial behavior buffer symptom severity and impairment in children and adolescents with ADHD symptoms in a clinical setting?

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Abstract

Background Most research in children with ADHD has focused on risk factors and their outcomes, such as symptom severity as a risk factor for functional impairment. Yet, a small group of studies show that some children function well despite their symptom severity. Preliminary evidence suggests that social protective factors may protect children with ADHD against its negative impact across different domains. The purpose of this study was to evaluate whether prosocial behavior, as a protective factor, buffers the effects of symptoms on impairment in children and adolescents with ADHD symptoms.

Methods In this cross-sectional study, we used routinely collected data from the Development and Well-Being Assessment (DAWBA). Reports were included from 822 mothers, 581 fathers, and 1109 teachers, who provided information on the children's symptoms, impairment and prosocial behavior (aged 5–18). To examine the effects of prosocial behavior on the relationship between symptoms and functional impairment, multiple regression analyses were conducted using data from these three perspectives.

Results Although we did not find buffering effects, regression analyses revealed that parent- and teacher-reported prosocial behavior demonstrated promotive effects on functional impairment, indicating that prosocial behavior may be beneficial in reducing impairment on daily life of children with ADHD. These results were consistent across raters and age-groups, except the mother-rated model for adolescents. Additionally, when investigating these effects by gender, we found that higher prosocial behavior, as observed by fathers, was related to lower impairment for girls.

Conclusion Our results suggest that prosocial behavior should be considered in clinical practice when evaluating impairment scores for ADHD. Finally, our findings plead for more in-depth measures of social protective factors and across different levels, including individual, family, and community levels. This approach will help identify factors that, independently of risks, may positively impact the functioning of these children.

Keywords ADHD symptoms, Prosocial behavior, Functional impairment, Resilience, Clinical setting

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Introduction

Most studies in children with ADHD have predominantly focused on risk factors, such as symptom severity, as a risk factor for functional impairment. Impairment is defined as a disability in everyday functioning due to symptoms [1] and it is most commonly observed in family life, friendships, classroom learning, and leisure activities [2, 3]. Children and adolescents with ADHD are likely impaired in all these areas. Yet, a small group of studies show that some children with ADHD function well despite their symptom severity [4–6]. Currently, there is a lack of understanding of what makes these children resilient. Preliminary evidence suggests that social protective factors, such as those related to a close family environment and a child's social competencies, may protect children against the negative impact across different domains [7]. Studying these factors is crucial, as they may explain why children with similar ADHD symptoms vary in their everyday functioning. In our study, we focus on the protective role of prosocial behavior as an aspect of social competence in children with ADHD symptoms in a clinical setting.

By focusing on protective factors, this study adopts the developmental psychopathology perspective of resilience, which emphasizes the role of protective factors in explaining differences in functional impairment among children and adolescents [4, 7]. Resilience is defined as the process of adapting well despite adversity. Two types of protective factors are commonly used to describe this resilient process [8, 9]. The term “promotive” refers to a protective factor that is directly associated with the outcome of interest and works in the opposite direction of the risk factor whereas the term “buffers” and “protective effects” are used synonymously to indicate when a protective factor mitigates the negative effects of the risk factor on the outcome variable [10]. This means that a child with severe ADHD symptoms and low levels of protective factors will experience greater functional impairment than a child with comparable ADHD severity but higher levels of protective factors. In this study, we will specifically examine the promotive and buffering effects of prosocial behavior.

To date, only a few studies have explored the protective effects of social factors in ADHD [7]. These factors include, among others, friendship quality, positive parenting, and social skills [4, 7, 12–14]. Generally, social skills, encompassing prosocial behavior, have been found to protect against risk factors and adversity [11]. Therefore, prosocial behavior may also have beneficial effects for children with ADHD. However, there is limited knowledge about its specific protective effects within this group of children and adolescents [7].

Prosocial behavior has been associated with positive effects on children's mental health, as well as successful

peer relationships and academic achievement [15]. Moreover, its effect tends to increase with age [17], appears to be more pronounced in girls [18], and may vary across different settings (e.g. home versus school) [19]. While compelling evidence indicates that ADHD symptoms can limit the development of high social skills compared to children without ADHD, recent studies suggest that social skills may have promotive effects in children with ADHD symptoms, particularly in younger populations [7, 20, 21]. Currently, there is only one study that investigated the buffering effect of social skills in children diagnosed with ADHD [4]. The authors studied the relationship between ADHD symptoms and academic functioning and found no promotive or protective effect of social skills. These findings highlight the need for further research to determine whether higher levels of prosocial behavior in children with ADHD contribute to reduced functional impairment.

Currently, it is unclear to what extent higher prosocial behavior buffers the effect of symptoms on functional impairment in children with ADHD symptoms in a clinical setting. Furthermore, as children's behavior is often context-dependent (e.g., home versus school), our study includes ratings from both parents and teachers. As they observe children in different settings, their evaluation of prosocial behavior and functional impairment may differ, providing unique insights into the child's overall functioning [19]. Literature reports show a small to moderate agreement between parents and teachers in social competence and children's functioning [22]. Moreover, as children enter different developmental stages (e.g., young childhood versus adolescence), the protective effects of these factors on outcomes are likely to vary with age [17, 23]. Similarly, the impact of prosocial behavior may differ by gender, as research has found that girls with ADHD are often rated as more prosocial compared to boys [18]. This study builds on prior work by exploring both the promotive and buffering effects, examining these effects separately for different ages and raters, and assessing gender differences in the relationship between prosocial behavior and impairment. Specifically, we hypothesize that children with high levels of prosocial behavior will experience less impairment from their ADHD symptoms. Additionally, we expect that children with similar symptoms, but higher prosocial behavior will exhibit less functional impairment compared to those with lower prosocial behavior. By investigating these protective effects from multiple perspectives (mothers, fathers, and teachers) across various age groups and gender, we aim to better understand how prosocial behavior influences functional impairment in children with ADHD. If our findings support our hypotheses, they could provide valuable insights for clinical practice, helping to identify factors that improve the functioning of these children

despite ADHD symptoms and using these indicators to refine the current interventions.

Method

Participants and procedure

This study includes parental and teacher reports from children and adolescents aged 5 to 18 who were admitted to the Center for Child and Adolescent Psychiatry (LUMC Curium). It falls under the LUMC Curium program focused on research using patient files. The Medical Ethics Review Board of the Leiden University Medical Center (LUMC) reviewed the overall study and determined that the research is not subject to the Medical Research Involving Human Subjects Act (non-WMO approval number: G21.174). Additionally, the study has been approved by the scientific committee of LUMC Curium.

To examine the relationship between symptoms and functional impairment, we used data from the Development and Wellbeing Assessment (DAWBA), which is routinely administered to all children referred to LUMC Curium. For this study, we could only utilize data from parents and teachers at the time of referral, data of children was not available. The DAWBA does not include children's reports for ADHD based on literature, showing that parents and teachers provide more reliable information regarding ADHD symptoms and impairment than children [24]. Further, we included DAWBA's that were administered between 2016 until 2022 and for which, next to the teacher-rating, at least one parent-rating of the child was present, resulting in 1678 DAWBA's. Finally, only data with a parental or teacher-rated functional impairment score for ADHD symptoms were included; that is, children who, according to their parents

or teacher, exhibited at least two ADHD symptoms. In total, 822 mothers, 581 fathers, and 1109¹ teachers reported impairments scores. Among these, 364 mothers, fathers, and teachers completed both symptoms and impairment scores for the same children. The sample was further divided into two age groups: children aged 5–11 and those aged 12–18, resulting in 6 subsamples in total (for details, see Table 1).

Measures

Risk factor

DAWBA and DSM IV ADHD

The DAWBA is a widely used computerized diagnostic interview that contains both open and structured questions about symptoms and functional impairment for various disorders in children aged 2–17 [1, 25]. The questions are closely related to the DSM-IV diagnostic criteria on current problems. In the DAWBA, data on symptoms and impairment from different informants are combined into an algorithm that assesses the likelihood of whether the reported symptoms and impairments in the structured sections meet DSM-IV and ICD-10 criteria. DAWBA has shown good predictive validity for ADHD in clinical populations, with the predictive value of a positive or negative DAWBA diagnosis being greater than 0.80 [26]. Additionally, there is a high level of agreement, with an inter-rater reliability of 0.70, between the DAWBA computer-generated diagnoses and the clinical diagnostic ratings performed by experienced clinicians in clinical samples [25–27].

According to DSM IV, to qualify for an ADHD diagnosis, six or more symptoms of either inattention or hyperactivity-impulsivity need to be present [28]. When assessing ADHD via the DAWBA, a participant must first

Table 1 Means and standard deviations of our study variables, split by age group (5–11 and 12–18 years) and raters (teachers, mothers, and fathers)

	5–11 years			12–18 years			
	Teacher (N=704)	Mother (N=393)	Father (N=515)	Teacher (N=307)	Mother (N=371)	Father (N=210)	
Gender	Fem %	27.7%	30.3%	29.6%	53.1%	53.4%	53.8%
Age	M	8.14	8.00	8.08	14.12	14.10	13.99
	SD	1.81	1.79	1.81	1.49	1.57	1.43
SES	M	0.37	0.39	0.37	0.48	0.53	0.58
	SD	0.74	0.72	0.68	0.81	0.73	0.75
ODD	M	3.35	3.44	3.40	2.50	2.60	2.65
	SD	1.50	1.42	1.42	1.64	1.62	1.60
ADHD ^a	M	19.50	23.01	21.28	14.19	19.68	18.26
	SD	8.88	7.20	6.96	6.98	7.15	6.69
Prosocial ^b	M	5.07	6.34	6.27	5.58	6.37	6.08
	SD	2.59	2.21	2.23	2.44	2.32	2.41
Impairment ^c	M	6.13	8.94	8.73	4.95	9.41	9.51
	SD	3.38	3.61	3.55	3.31	3.91	3.61

^a DAWBA ADHD scale range: 0–36, ^b SDQ prosocial scale range: 0–10, ^c DAWBA impairment scale range: 0–18 (Mother and Father) or 0–12 (Teacher), Average SES score [Netherlands] = 0.17.

answer “yes” to at least two symptoms to continue with questions on impairment in daily life.

The parent and teacher-rated DAWBA contains 18 ADHD questions about symptoms (9 questions about hyperactivity and 9 about inattention). An example of a question about **hyperactivity** asked to parents is: “Over the **last 6 months**, and compared with other children of his/her age, did [name of the child] often fidget?” Each question is assessed on a three-point scale, with possible answers of 0 “no more than others”, 1 “a little more than others”, and 2 “a lot more than others”. An example of a question about **inattention** asked to parents is: “Over the **last 6 months**, and compared with other children his/her age, does [name of the child] often make careless mistakes or fail to pay attention to what s/he is supposed to be doing?” The scores can range from 2 to 36 if all items are completed, with higher scores corresponding to a higher number and more severe symptoms.

Protective factor

Prosocial behavior scale

Parents and teachers reported on children’s prosocial behavior using the Strength and Difficulties Questionnaire (SDQ) [29, 30]. The SDQ is a brief screening instrument for mental health problems for children aged 2–18 and contains, next to difficulties (emotional or behavioral), also strength items (prosocial behavior). The prosocial subscale has shown good internal consistency for both parent and teacher reports. For adolescent clinical outpatients, the internal consistency was $\alpha=0.75$ [31]. For younger children aged 4–12, $\alpha=0.67$ for parent reports and $\alpha=0.80$ for teacher reports [32]. In a clinical setting for children aged 5–17, the internal consistency was $\alpha=0.72$ for parent reports and $\alpha=0.83$ for teacher reports [12]. Prosocial behavior is manifested when persons help, share, and/or cooperate with others. This scale consists of 5 items rated on a three-point scale, with answer categories: 0 “Not true”, to 2 “Certainly true”. An example of such an item from the parents’ perspective is: [Name of the child] is kind to younger children. The total scores can range from 0 to 10, with higher scores corresponding to more prosocial behavior.

Outcome

Functional impairment

We used parent and teacher-rated DAWBA impairment scores to indicate the level of distress and functional impairment that the child experiences from ADHD symptoms [1, 25]. The parent version contains six questions: two about distress and burden caused by the symptoms, and four about functional impairment in (a) getting along with family, (b) making and keeping friends, (c) engaging in play, hobbies, sports and other leisure activities, and (d) learning and classwork. The teacher version

contains only three questions about (a) distress, (b) peer relations, and (c) classroom learning. An example of an item from the parent’s perspective is: “Have his/her difficulties with activity or concentration interfered with how well s/he gets on with you and the rest of the family?” Each question is rated on a four-point scale (not at all, a little, a moderate amount, a great deal), with scores ranging from 0 to 18 for the parent report and from 0 to 9 for the teacher-report. Importantly, impairment questions are not related to specific ADHD symptoms; rather, they concern the overall impairment from ADHD symptoms on daily functioning.

Control variables

Social economic status

Social Economic Status (SES) was assessed using the neighborhood status scores, which combined the average income with the level of education, and the proportion of unemployed individuals in a neighborhood [33]. The average SES score in the Netherlands in 2010 was 0.17 [range: -7.25–3.19].

Oppositional defiant disorder (ODD)

Oppositional Defiant Disorder (ODD) was included as a control variable due to its high prevalence in youth with ADHD (co-occurring up to 60% of cases) and its association with a worse prognosis and increased functional impairment [34]. ODD is characterized by a frequent and persistent pattern of irritable and angry mood, as well as disobedient behavior. In our study, it was assessed using the DAWBA probability bands score. This probability score indicates the likelihood of a clinical diagnosis based on an algorithm that integrates the information from both parents and the teacher about symptoms and functional impairment. The score is divided into six probability bands, ranging from a probability of less than 0.1% to over 70% of having ODD. These percentages are then recoded into numbers with values ranging from 0 (“0.01%”) to 5 (“≥ 70%”). Scores of 50% or higher have shown to predict the diagnosis well [26].

Analytical approach

To assess the associations between functional impairment and ADHD symptoms, prosocial behavior, and covariates (age, gender, SES, and ODD), bivariate correlation analyses and 95% confidence intervals were calculated. Next, to test our main hypothesis, we conducted six multiple regression analyses with ADHD symptoms, prosocial behavior, the moderating (interaction) effect of prosocial behavior as predictors, and functional impairment from ADHD symptoms as the outcome variable. To test the interaction effects, we first mean-centered the main predictors and then created the interaction terms by multiplying ADHD symptoms with prosocial

Table 2 Frequencies of ADHD subtypes based on symptoms, split by age group (5–11 and 12–18 years) and raters (teachers, mothers, and fathers)

ADHD Subtype	5–11 years			12–18 years		
	Teacher (N=704)	Mother (N=393)	Father (N=515)	Teacher (N=307)	Mother (N=371)	Father (N=210)
^a Inattention	76%	75.5%	70.4%	78.6%	39.1%	30.0%
^b Hyperactivity	58.7%	83.9%	80.9%	21.7%	89.9%	87.6%
^c Combined	51.1%	65.4%	57.7%	20.4%	37.8%	27.1%

^aDAWBA ADHD Inattention Scale (0–9), ^bADHD Hyperactivity Scale (0–9), ^cADHD Combined Subgroup Scale (0–18).

Table 3 Univariate effects with 95% confidence intervals of our study variables with functional impairment across age groups and raters

		5–12 years			12–18 years		
		Teacher (N=704)	Mother (N=393)	Father (N=515)	Teacher (N=307)	Mother (N=371)	Father (N=210)
Gender	<i>B</i>	-0.18**	-0.09*	0.04	0.07	-0.02	-0.04
(F=0, M=1)	<i>CI</i>	[0.81, 1.91]	[-1.38–0.03]	[-0.46–1.12]	[-0.21–1.10]	[-1.04–0.72]	[-1.28–0.69]
Age	<i>B</i>	-0.12**	0.03	0.06	-0.07	-0.08	-0.09
	<i>CI</i>	[-0.36–0.09]	[-0.12–0.23]	[-0.08–0.32]	[-0.38–0.06]	[-0.48–0.08]	[-0.56–0.13]
SES	<i>B</i>	0.00	0.04	0.06	-0.04	-0.08	0.04
	<i>CI</i>	[-0.30–0.38]	[-0.24–0.64]	[-0.21–0.86]	[-0.56–0.26]	[-1.01–0.20]	[-0.46–0.85]
ODD	<i>B</i>	0.46**	0.30**	0.24**	0.26**	0.33**	0.25**
	<i>CI</i>	[0.88–1.12]	[0.55–0.97]	[0.36–0.86]	[0.33–0.72]	[0.53–1.04]	[0.26–0.86]
ADHD	<i>B</i>	0.66**	0.46**	0.42**	0.56**	0.33**	0.27**
	<i>CI</i>	[0.23–0.27]	[0.19–0.27]	[0.16–0.26]	[0.21–0.29]	[0.12–0.24]	[0.07–0.22]
Prosocial	<i>B</i>	-0.29**	-0.17**	-0.17**	-0.22**	-0.18**	-0.21**
	<i>CI</i>	[-0.47–0.29]	[-0.42–0.14]	[-0.43–0.11]	[-0.43–0.17]	[-0.48–0.11]	[-0.52–0.12]
ADHD*Prosocial	<i>B</i>	-0.00	-0.05	-0.06	-0.03	-0.00	-0.01
	<i>CI</i>	[-0.01–0.01]	[-0.03–0.01]	[-0.04–0.01]	[-0.02–0.01]	[-0.03–0.02]	[-0.03–0.02]

B = unstandardized regression weight, CI = confidence interval of B, P = probability value, *P < 0.05, **P < 0.01.

behavior. Furthermore, to examine gender differences in the impact of prosocial behavior on impairment, we created and assessed the interaction between gender and prosocial behavior. We controlled for the influence of age, gender, SES, and ODD and built separate models for ratings by mothers, fathers, and teachers, as well as for different age categories (5–11 and 12–18 years old). We used two-tailed tests in all analyses, with a p-value of < 0.05 indicating statistical significance. All the analyses were conducted in SPSS version 29.

Results

Participants' characteristics

The average age of participants was 8 for the younger group and 14 for adolescents. In the younger group, slightly less than 30% were girls, while in the older group, just over 50% were girls. Detailed information on the means and standard deviations for these variables can be found in Table 1.

Subtypes of ADHD

To provide an overview of the children included in the study, we calculated the frequencies of ADHD subtypes based on their symptoms (Table 2). As outlined in the

DSM-IV, a child meets the criteria for one of the following subgroups - Inattention, Hyperactivity, or Combined Inattention and Hyperactivity - if, over the past six months, six or more symptoms of inattention or hyperactivity have persisted, or at least six symptoms from each subgroup are present. Overall, we found a similar pattern between mothers and fathers in the frequencies across all subgroups and age groups. For the older group, both mothers and fathers reported lower frequencies of inattention and higher frequencies of hyperactivity. Remarkably, a reversed pattern was observed among teachers, with higher frequencies of inattention and lower frequencies of hyperactivity. In this teacher sample, the inattention subgroup appeared to be more prevalent.

Univariate effects of our study variables with functional impairment

As shown in Table 3, symptoms, prosocial behavior, and ODD were significantly correlated with functional impairment. These effects were consistent across raters and age groups. However, we observed only a direct effect of prosocial behavior with functional impairment but no interaction effects, regardless of the rater.

Table 4 Multi trait multi method matrix (children 5–11 years)

Method	(a) Mother			(b) Father			(c) Teacher		
	1	2	3	1	2	3	1	2	3
(a) Mother									
1. ADHD		−0.10**	0.46**	0.46**	−0.06	0.18**	0.34**	−0.05	0.17**
2. Prosocial			−0.17**	−0.10*	0.60**	−0.14*	−0.04	0.26**	−0.02
3. Impact				0.31**	−0.17**	0.40**	0.24**	−0.17**	0.24**
(b) Father									
1. ADHD					−0.12**	0.42**	0.19**	0.02	0.11*
2. Prosocial						−0.17**	0.02	0.21**	−0.03
3. Impact							0.11*	−0.06	0.13*
(c) Teacher									
1. ADHD								−0.31**	0.66**
2. Prosocial									−0.29**
3. Impact									

** $P < 0.01$ level, * $P < 0.05$ level (2-tailed); Symptoms $N_{M-F} = 389$, Symptoms $N_{M-T} = 579$, Symptoms $N_{F-T} = 456$, Prosocial $N_{M-F} = 525$, Prosocial $N_{M-T} = 680$, Prosocial $N_{F-T} = 582$, Impact $N_{M-F} = 284$, Impact $N_{M-T} = 440$, Impact $N_{F-T} = 313$; M-F = Mother-Father, M-T = Mother-Teacher, F-T = Father-Teacher, Impact = Impairment.

Table 5 Multi trait multi method matrix (adolescents 12–18 years)

Rater	Mother			Father			Teacher		
	1	2	3	1	2	3	1	2	3
(a) Mother									
1. ADHD		−.27**	.33**	.46**	−.11	.08	.32**	−.02	.11
2. Prosocial			−.18**	−.16*	.51**	−.21**	−.01	.30**	−.03
3. Impact				.25**	−.04	.18*	.13*	−.06	.03
(b) Father									
1. ADHD					−.17**	.27**	.20**	−.04	.04
2. Prosocial						−.22**	−.08	.33**	−.06
3. Impact							.09	−.03	−.01
(c) Teacher									
1. ADHD								−.18**	.52**
2. Prosocial									−.22**
3. Impact									

** $P < 0.01$ level, * $P < 0.05$ level (2-tailed); Symptoms $N_{M-F} = 201$, Symptoms $N_{M-T} = 337$, Symptoms $N_{F-T} = 255$, Prosocial $N_{M-F} = 320$, Prosocial $N_{M-T} = 429$, Prosocial $N_{F-T} = 359$, Impact $N_{M-F} = 149$, Impact $N_{M-T} = 218$, Impact $N_{F-T} = 153$; M-F = Mother-Father, M-T = Mother-Teacher, F-T = Father-Teacher. Impact = Impairment.

Inter-rater agreement

Since our measures were rated by the same informants, we considered the possibility of a rater bias in our sample. Therefore, we tested whether (1) there were consistencies between different raters for the same variables, and (2) whether the pattern of associations between symptoms, prosocial behavior, and impact was similar across raters. If we observed these consistencies, it would indicate some degree of inter-rater agreement. If different raters agreed on a certain measure and showed the same pattern of associations, it would suggest that the role of rater bias is rather limited.

We conducted an inter-rater agreement analysis on the main variables using the Multi-Trait Multi-Method matrix (see Tables 4 and 5), which represents the convergent correlation of the same variables between the three raters. When inspecting the correlations between raters and across age groups, we found a significant, positive, and relatively high association between mothers and

fathers for symptoms ($r = 0.46$, in both age groups) and prosocial behavior ($r = 0.51$ to 0.60). The association was somewhat lower for teachers, with correlations for symptoms ($r = 0.19$ to 0.34) and prosocial behavior ($r = 0.21$ to 0.33). For the impairment variable, we observed lower correlations for parents ($r = 0.18$ to 0.40) and even lower between parents and teachers ($r = -0.01$ to 0.24). An explanation for the differences in agreement between parents and teachers may be that they observe the child in different contexts. Additionally, the teacher impairment scale includes only three of the six items used for parents. Despite the lower correlation for impairment, we observed the same patterns of associations between variables within each rater across both groups, indicating that overall, there is a fair inter-rater agreement, although it is not as high as we would have hoped.

Table 6 Promotive effects of prosocial behavior with functional impairment split by age group (5–11 and 12–18 years) and raters (teachers, mothers, and fathers)

		5–11 years			12–18 years		
		Teacher	Mother	Father	Teacher	Mother	Father
		(N = 704)	(N = 393)	(N = 515)	(N = 307)	(N = 371)	(N = 210)
Gender (F = 0, M = 1)	<i>B</i>	−.24	−.24	−.21	.33	.57	.95
	<i>SE</i>	.21	.31	.37	.30	.43	.49
Age	<i>B</i>	.01	.11	.19*	.00	.00	−.07
	<i>SE</i>	.05	.08	.09	.10	.14	.17
SES	<i>B</i>	−.20	.16	.11	−.00	−.23	.28
	<i>SE</i>	.13	.19	.25	.18	.29	.32
ODD	<i>B</i>	.45**	.40**	.27	.05	.52**	.37*
	<i>SE</i>	.07	.11	.13	.10	.15	.16
ADHD	<i>B</i>	.21**	.21**	.19**	.24**	.13**	.12**
	<i>SE</i>	.012	.02	.03	.02	.03	.04
Prosocial	<i>B</i>	−.10*	−.17*	−.20*	−.21**	−.10	−.24*
	<i>SE</i>	.04	.07	.08	.06	.10	.10
Prosocial* ADHD	<i>B</i>	−.00	−.013	−.017	−.00	−.00	−.00
	<i>SE</i>	.00	0.001	.01	.01	.01	.01
R²		0.49	0.28	0.22	0.30	0.18	0.17

B = unstandardized regression weight, SE B = standard error of B, P = probability value, *P < 0.05, **P < 0.01, R² = explained variance of the model.

Main analysis

Effects of prosocial behavior

After adjusting for ADHD symptoms and covariates, we found promotive effects of prosocial behavior on functional impairment in all models rated by teachers, mothers, and fathers, except for the mother-rated model of adolescents. These consistent results indicated that higher levels of prosocial behavior were associated with less symptom-related impairment, regardless of the rater's perception. There were no significant buffering effects between symptoms and prosocial behavior in predicting impairment, meaning that the relationship between ADHD symptoms and impairment was not attenuated for children and adolescents with high levels of prosocial behavior. These results were consistent across the three raters. Furthermore, only in the father-rated model for adolescents, did we find a significant interactive effect between gender and prosocial behavior in predicting impairment ($B = 0.49$, $p = 0.01$). When examining this effect separately for boys and girls, the results showed that fathers perceived girls who scored high in prosocial behavior as being less burdened by their symptoms in daily life ($B = -0.29$, $p = 0.00$), while the effect was not significant for boys ($B = 0.08$, $p = 0.46$). Detailed information on the models can be found in Table 6.

Discussion

The purpose of this study was to evaluate the buffering effect of prosocial behavior on the relationship between symptoms and functional impairment in children with ADHD symptoms in a clinical setting, using the developmental psychopathology framework of resilience [7]. Although we did not find support for the buffering effect,

we did observe promotive effects of prosocial behavior, suggesting that it may help reduce symptom-related impairment. These results were consistent across raters (mothers, fathers, teachers) and age groups, except for the mother-rated model for adolescents. Mothers did not perceive high prosocial behavior of adolescents as being associated with improved daily functioning. Interestingly, when examining these effects by gender, we found that only fathers perceived high prosocial behavior in girls as significantly related to improved functioning.

Effects of prosocial behavior

Our study revealed no buffering effect of prosocial behavior on the relationship between ADHD symptoms and functional impairment across both age groups and raters. This finding suggests that, among children with similar severity of ADHD symptoms, higher scores of prosocial behaviors did not translate into buffering effects for functional impairment, as reported by both parents and teachers. These results are consistent with a previous study that similarly found no buffering effect of social skills on academic functioning of adolescents with ADHD symptoms [4]. It has been argued that while prosocial behavior and social skills are important for development of social relationships and overall adjustment, interventions that focus solely on improving social skills have shown limited success for youth with ADHD because they have failed to impact other aspects of social functioning, such as friendships and peer relationships [4, 7]. As research on protective factors and resilience in ADHD is still in its infancy, we know very little about the buffering processes in these children [7]. In our study, ADHD, and perhaps also ODD symptoms, were found to

be more important in predicting impairment. This may not be surprising, as a higher number of ADHD symptoms could lead to greater disruption in the daily life of these children.

Furthermore, mother-, father-, and teacher-rated prosocial behavior demonstrated a promotive effect on impairment in the younger children. This effect was observed even after controlling for gender, age, SES, and ODD symptoms. It is likely that parents and teachers view high levels of prosocial behavior in a child positively, leading them to perceive the child's symptoms as less burdensome and the child as less impaired by these symptoms. Moreover, since the children in this group are younger and may experience less persistent and chronic symptoms, parents and teachers may be more likely to notice and appreciate the child's strengths. A previous study that demonstrated promotive effects of prosocial behavior on the daily functioning of young children with ADHD symptoms [21] found that prosocial behavior was positively related to academic achievement. The authors suggested that prosocial behavior may be important in maintaining positive relationships with teachers, even amidst the frustration caused by attention difficulties associated with ADHD. In additional analyses, we examined the association between prosocial behavior and the single learning item in our impairment scale. Overall, we did not find a significant relationship between prosocial behavior and learning. However, we should be cautious in drawing conclusions from these findings, as they are based on a single item. Moreover, learning is not the same as academic achievement. Future studies are needed to further investigate this relationship using validated scales.

Promotive effects of prosocial behavior on functional impairment were observed for fathers and teachers in the adolescent sample. Although we had no specific hypotheses regarding gender differences, we did check for possible gender \times prosocial behavior interactions in predicting ADHD symptoms. Of the six possible interactions, the only significant one was found in the older group as judged by fathers. When examining this effect for boys and girls separately, we found that the association was gender-related for fathers. Specifically, we observed no association between prosocial behavior and impairment for boys, but a negative association for girls: higher levels of prosocial behavior were linked to lower levels of impairment. Previous research has shown that girls with ADHD are often perceived as more prosocial than boys [18]. However, the finding that prosocial behavior may reduce impairment only for girls is novel. One possible explanation, based on these studies, is that fathers may be more likely to view girls through traditional gender roles, which emphasize cultural beliefs that girls are naturally kind and caring. When girls conform to

these roles, fathers may perceive them as more prosocial, which could lead to the perception that they are less burdened by symptoms [17, 18]. Additionally, no promotive effect of prosocial behavior was found in the model with the mother ratings. Although mothers' ratings of their child were similar to those in the younger group, higher prosocial behavior did not result in less impairment. To examine these discrepancies between mother and father ratings, we reviewed the literature on cross-informant agreement. To the best of our knowledge, no study has assessed the agreement between mother and father ratings of prosocial behavior in adolescents with ADHD. A meta-analysis focusing on the social competence of children and adolescents found moderate agreement between mother-father and parent-teacher ratings [35]. Furthermore, in their meta-analysis, Achenbach et al., (1987) [36] found a higher correlation between mother and father ratings of externalizing behavior for children between 6 and 11 years old compared to adolescents. It has been suggested that younger children may be more limited in the contexts in which they display mental health problems [37]. Based on our results and the literature, we argue that when children are younger and raters observe the child in similar contexts, it may be easier for parents to agree on the child's behavior and its effect on impairment [37]. As children enter adolescence, peer relations become more important; adolescents spend less time with parents, more time with peers and become more sensitive to social evaluation from their peers [38]. During this phase, the relationship with the parents changes, which may lead parents to perceive the influence of prosocial behavior on impairment differently. Studies have shown that mothers tend to have more insight into their adolescents' peer relations than fathers [39] and are more likely to gather information from adolescents through active supervision [40, 41]. Consequently, mothers may be more aware of the impairments that adolescents experience and may perceive that prosocial behavior no longer plays a significant role.

Strengths and limitations

Our study has several strengths. The use of data from a real clinical setting with validated instruments, representative samples, three raters, and including both children and adolescents, increases the confidence in our findings. Furthermore, by focusing on strengths rather than risks and assessing these effects from multiple perspectives, we obtained a more comprehensive picture of these children's functioning. However, there are also several limitations that require attention. Since we used routinely collected data, we could only include the protective factor available in our data set. As a result, we were unable to fully disentangle the impact of potential social buffering. Moreover, the cross-sectional design did not allow us to

draw conclusions about its causal effects in a clinical setting. Additionally, we used neighborhood SES as a proxy for the environment in which the child resides due to the lack of individual family SES data. However, we did not find a significant influence of neighborhood SES in our models, which raises the question of whether individual family SES scores might have significantly impacted the relationship between prosocial behavior and impairment. Furthermore, it would have been valuable to include children's perspectives, especially those of adolescents. For adolescents, relationships outside the home become more important, leading to distinct perspectives between parents and adolescents regarding impairment and prosocial behavior [4, 36]. Finally, as our variables were rated by the same informant, there may be a rater bias in our results. Despite this, we consistently found a significant main effect of prosocial behavior on impairment and no interaction effects, regardless of the rater. Therefore, we believe that rater bias did not significantly affect our results. Moreover, we addressed this issue by conducting extra analyses on inter-rater agreement for our main variables, where we found a fair level of agreement.

Clinical implications and future directions

Although we did not find buffering effects, our results suggest that prosocial behavior may be associated with lower impairment in children and adolescents with ADHD (and comorbid ODD symptoms). Thus, it should be considered in clinical practice when evaluating impairment scores. Furthermore, including information from mothers, fathers, and teachers may provide valuable insights into the effect of prosocial behavior on impairment across different developmental stages. Taken together, our results plead for more research on the influence of children's social competencies and other social protective factors, as they, independently from risks, may positively impact the functioning of these children. Therefore, future studies should include more in-depth measures of these factors and across different levels, such as quality of parental attachment, parental monitoring (family), quality of peer relationships, school connectedness, participation in sports and social activities, and social cohesion in the neighborhood (community). This approach will contribute to a better understanding of the influence of social buffers on the daily functioning of children with ADHD and the potential for strengthening these buffers in intervention development. Additionally, examining individual aspects of impairment, alongside overall impairment, may provide more specific insights into how protective factors affect impairment. Conducting a network analysis to explore the interrelations among these variables across layers may offer a better representation of how social environment positively impacts the functioning of children with ADHD.

Abbreviations

ADHD	Attention deficit hyperactive disorder
ODD	Oppositional Defiant Disorder
DAWBA	The Development and Well-Being Assessment
SDQ	Strength and Difficulties Questionnaire
SES	Social Economic Status
DSM-IV	The diagnostic and statistical manual of mental disorders, 4th edition
ICD-10	International Statistical Classification of Diseases and related health problems, 10th revision
Non-WMO	Research that is not subject to the Medical Research Involving Human Subject Act Medical Research Involving Human Subject Act
LUMC	Leiden University Medical Center

Supplementary Information

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Supplementary Material 1

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Author contributions

All authors designed the study. Analyses were performed by MH. The first draft of the manuscript was written by MH under supervision of MC and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Data availability

The data supporting the findings of this study are available from the LUMC, but restrictions apply to their availability as they were used under the licence for this study and are not publicly available. However, data can be obtained from the authors upon reasonable request and with permission from the LUMC. Interested parties should contact the corresponding author to request the data.

Declarations

Ethical approval and consent to participate

Our study is part of the LUMC Curium application, which involves research using existing data from patient files. This application was reviewed by the Medical Ethical Committee Leiden, Den Haag, Delft (METC LDD, approval number: G21.174). Given the observational nature of the study, the METC LDD confirmed that no ethical approval was required. Additionally, the METC LDD waived the need for informed consent due to the observational, non-interventional, and unidentifiable nature of the data used in this study.

Consent for publication

Not applicable.

Conflict of interest

The authors declare that they have no conflict of interest.

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