Received: 28 August 2023 | Revised: 15 January 2024 | Accepted: 17 January 2024

DOI: 10.1111/apa.17125

ACTA PÆDIATRICA NURTURING THE CHILD WILEY

ORIGINAL ARTICLE

Teachers reported that children with special health care needs displayed more attention problems

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Funding information
Bundesministerium für Bildung und Forschung, Grant/Award Number: 01ER1302 and 01ER1702

Abstract

Aim: Children with special health care needs (SHCN) perform more poorly at school compared to their classmates. Specific causal pathways have not yet been extensively studied. Therefore, we investigated teacher-rated global attention, an important prerequisite for educational attainment, in children with SHCN.

Methods: Data of a population-based prospective cohort study, which recruited preschool children from the Mainz-Bingen area, Germany, were analysed. Children with SHCN were identified by the Children with Special Health Care Needs screening tool. In 2016, global attention was reported by teachers at the end of first grade (mean age: 7.3 years) on a 5-point rating scale ranging from −2 through +2. Associations between SHCN consequences and teacher-rated attention were estimated by linear mixed models, adjusted for confounding variables.

Results: We included 1921 children (51% males); of these, 14% had SHCN. Compared to their classmates, children with SHCN had poorer teacher-rated attention scores (adjusted mean difference: −0.35, 95% CI: −0.52 to −0.17). The effect was strongest among children with treatment or counselling for mental health problems or functional limitations. The effect remained after excluding children with attention deficit hyperactivity disorder from the analysis.

Conclusion: Children with SHCN showed more teacher-rated attention problems, which could explain their lower educational attainment.

KEYWORDS
attention problems, child health, chronic disease, educational status, special health care needs

1 | INTRODUCTION

Over the past three decades, the proportion of children who suffer from chronic health conditions has increased.[1] Within this group, those with an increased need for or use of special health care services are a particularly vulnerable group. In a population-based study in Germany, around 17% of children of primary school age had special health care needs (SHCN) due to any physical, developmental, or mental chronic health condition.[2] It has been shown that children with SHCN perform more poorly in school than their healthy

Abbreviations: ADHD, attention deficit hyperactivity disorder; CI, confidence interval; ikidS, ich komme in die Schule (I will start school); SD, standard deviation; SHCN, special health care needs; SMD, standardised mean difference.

This work is part of the doctoral thesis of Jennifer Schlecht.

peers.[3] This may have long-lasting effects on later educational attainment, socioeconomic status, and general health in adulthood.[4] The causal pathways from poor health to educational outcomes are not well known, but learning skills have been suggested as a potential mediator in this association.[4] Specifically, impaired attention at school might play a crucial role as it limits the time and intensity children are engaged in learning.[5,6] In a systematic review on attention problems and academic achievement,[7] inattentiveness rather than hyperactivity was associated with academic problems. In an analysis of six longitudinal studies,[5] attention skills were related to academic achievement in math and reading. This relationship was independent of school-entry achievements, socioemotional behaviours, and social skills.

The relationship between attention deficit hyperactivity disorder (ADHD) and educational outcomes has been well researched. However, only few studies have investigated whether other chronic health conditions affect attention capacity in general and attention at school in particular. A study of 1457 fourth to sixth graders aged 9–11 years in the United States[8] found that SHCN adversely affected students' self-reported attention. Studies on attention at school in children with SHCN in European countries are lacking.

To investigate the influence of health problems on academic achievement, we conducted the 'ich komme in die Schule' (ikidS) study, which translates as I will start school. We found that children with SHCN due to a physical, developmental, or mental chronic health condition had lower overall school performance ratings at the end of first grade.[9] More specifically, they performed poorest in numeracy and writing compared to their classmates without SHCN.[10]

The present study aimed to investigate the association between SHCN and teacher-rated global attention as a marker of learning skills and a potential mediator between health problems and academic achievement.

Key Notes

- The causal relationships, why children with special health care needs perform more poorly at school and have lower academic achievements, are not fully understood.
- We found teacher-rated global attention capacity to be lower in children with special health care needs, independent of the presence of attention deficit hyperactivity disorder.
- Addressing global attention capacity by effective interventions in children with special health care needs could mitigate negative long-term effects on their educational outcomes.

2 | METHODS

2.1 | Study cohort

The present study used data from the German population-based prospective cohort study ikidS. Details on the ikidS cohort have been published elsewhere.[9,11] In brief, we recruited kindergarten children who started school in 2015 in the city of Mainz and the surrounding district of Mainz-Bingen at their preschool health examination. The parents or guardians of 2003 of the 3683 eligible children agreed to participate. Data were collected at six time points from the preschool health examination at age 5–6 years through to the end of the sixth grade at age 11–12 years.

We obtained the preschool health examination data from the public health authority of the Mainz-Bingen district in two formats: first, in a de-identified form for the entire population, which did not include identifiers such as names and addresses, and second, in the original identified form for participants.

Only children who attended an elementary school in the study region in 2015 were included in the study. Children with a physician diagnosis of a mental disability or cerebral palsy during first grade or with a recommendation for a special needs school were excluded.

2.2 | Assessment of variables

We identified children with SHCN based on their needs and use of special health care or functional limitations using the German version of the Children with Special Health Care Needs screening tool[12] prior to school entry and at the end of first grade at age 6–7 years. The instrument consists of 14 items that assess five consequences of physical, developmental, or mental chronic health conditions. Consequences covered by the instrument are the use or need of prescription medication; the use or need of medical, mental health, or educational services; the presence of functional limitations compared with others of the same age; the use or need of specialised therapies; or the treatment or counselling for emotional, behavioural, or developmental problems. A physical, developmental, mental, or other chronic health condition is defined as having lasted or being expected to last for at least 12 months. A SHCN is present if at least one of five consequences due to any chronic health condition is confirmed either prior to school entry or at the end of first grade. Of note, the screening tool does not restrict the identified children to those with a specific diagnosis. Instead, it identifies children with any physical, developmental, mental, or other chronic health condition who need or use special health care services. Children were further categorised based on the number of SHCN consequences they experienced to study the different levels of need complexity.[13] Due to the low number of children who experienced more than two consequences, children were grouped into three groups of 0, 1, or >1 consequences experienced.

Global attention of each participating child was evaluated by classroom teachers at the end of first grade using an item from the German National Educational Panel Study.[14] Teachers were asked

to assess a child's persistence and the ability to concentrate, defined as remaining occupied with something for a longer period of time, on a 5-point Likert scale. The scale ranged from much worse than (−2) and slightly worse than (−1) to just as good as (0), slightly better than (+1), and much better than (+2) other children of the same age.

2.3 | Statistical methods

Descriptive statistics were based on complete cases only. Distributions of continuous variables are presented as mean and standard deviation (SD); results of categorical variables are reported as absolute and relative frequencies. We report pairwise correlations between the five binary SHCN consequences as phi correlation coefficients.

The effect of SHCN on teacher-rated attention at the end of first grade was estimated from a linear mixed-effects regression model adjusted for the confounding variables described below. For the primary analysis, the presence of SHCN was the independent variable. For the secondary analysis, each of the five individual SHCN consequences and the cumulative number of SHCN consequences (0, 1, >1), respectively, were the independent variables. For each effect estimate, we computed a standardised mean difference (SMD). Effects are presented as adjusted mean differences with 95% confidence intervals (CIs) and SMD between children with SHCN compared to children without SHCN.

The analysis was based on the theoretical framework conceptualised by Suhrcke and de Paz Nieves in 2011.[4] They listed potential health problems, specific educational outcomes, and mediating, moderating, and confounding factors and proposed causal structures for these factors. The framework was later extended by Dadaczynski[15] and our working group by proposing additional potential mediators, moderators, and potentially relevant school-related outcomes.[11,16] Based on this framework, we constructed a directed acyclic graph for the relationship between SHCN and teacher-rated attention to identify a minimally sufficient adjustment set.[17] This set included gender, immigration status,[18,19] socioeconomic status,[20] multiple at birth, breastfeeding, chronic health condition in the family, completion of recommended well-child visits, and school location. Definitions and operationalisations of these variables are given elsewhere.[9] The directed acyclic graph is provided in Figure S1.

In addition to the overall effect, we were also interested in the independent effects of each of the five SHCN consequences on teacher-rated attention. We therefore constructed a second directed acyclic graph (Figure S2) that included all five SHCN consequences as independent variables and teacher-rated attention as the dependent variable. Based on this directed acyclic graph, we identified a minimally sufficient adjustment set for each of the five SHCN consequences. The effect of each SHCN consequence was then adjusted for the above confounding variables and the respective confounding SHCN consequences (Table S1).

In a sensitivity analysis, we repeated the analysis after excluding all children with ADHD, since the effect of SHCN on teacher-rated attention may be mainly driven by this group of children. Children with ADHD were identified using parental questionnaires. ADHD was present if a child met any of two conditions: first, a lifetime ADHD diagnosis made by a physician or psychologist, and second, at least two abnormal ratings on the German version of the Strengths and Difficulties Questionnaire[21] either before school entry, after school entry, or at the end of first grade.

Missing values were frequent for SHCN status (25%), confounding variables (up to 45%), and teacher-rated attention at the end of first grade (24%). Therefore, we imputed missing values 10 times using multivariate imputation by chained equations and 100 iterations. Only pooled results are reported.[22]

Analyses were carried out with the packages nlme and mice[23] of the statistical software R[24] (version 4.2.2., R Foundation for Statistical Computing, Vienna, Austria).

2.4 | Ethics

This study was performed in line with the principles of the Declaration of Helsinki.[25] The study was approved by the Ethics Review Board of the Medical Association of Rhineland-Palatinate (reference number: 837.544.13, 9229-F), the regional supervisory school authority of Rhineland-Palatinate, and the state representative for data protection in Rhineland-Palatinate. Written informed consent was obtained from legal guardians of all children included in the study. Due to the young age of 5–6 years at study recruitment and in accordance with recommendations of the ethics board, no written informed consent was obtained from participating children.

3 | RESULTS

Of the 2003 participants of the ikidS cohort study, 1921 were included in the present analysis. We excluded 51 children due to deferral from school entry, 27 due to a recommendation for a special needs school, and 4 due to mental disability or cerebral palsy. Diagnoses among children excluded from the analysis can be found in Table S2. The characteristics of children included in the current study were similar to the overall study population except that they were less likely to come from immigrant families (Table S3).

3.1 | Children with SHCN

We identified 202 children (14%) who had SHCN either prior to school entry or at the end of first grade; of these, 43% had SHCN at both time points. While the majority of children with SHCN experienced one consequence (52%), 48% experienced more than one consequence (two, 21%; three, 12%; four, 10%; and five, 4%). We observed 171 children with SHCN (85%) who had at least one medical,

developmental, or mental diagnosis that may adversely affect school performance. The most frequent diagnoses were asthma (22%), global developmental delay (19%), and ADHD (17%) (Table S2). Children without a definitive diagnosis had health impairments such as language and speech problems, enuresis or encopresis, agitation, or anxiousness. Compared to all children in the sample, children with SHCN were more likely to be male and came from non-immigrant families. They were more often formula-fed and had mothers with and fathers without high school diploma. Regarding their location, more children with SHCN attended school in the rural district of Mainz-Bingen (Table 1).

Above-average use or need of medical, mental health, or educational services and use or need of prescription medication were the most frequent SHCN consequences (46% each). Compared to this, treatment or counselling for emotional, behavioural, or developmental problems (41%) and the use or need of specialised therapies (40%) were slightly rarer. Functional limitations compared with others of the same age were the rarest consequence (19%). The highest pairwise correlations (phi coefficient) were between above-average use or need of medical, mental health, or educational services and the other consequences (range: 0.45–0.53). We also observed high pairwise correlations between use or need of specialised therapies and treatment or counselling for emotional, behavioural, or developmental problems (0.51) (Table S4).

3.2 | SHCN and teacher-rated global attention

Children with SHCN had poorer teacher ratings on the global attention scale than children without SHCN (mean ± SD: −0.2 ± 1.2 vs. 0.2 ± 1.1). This translates to a higher percentage of children who performed below average among children with SHCN compared to those without SHCN (41% vs. 23%) (Figure 1). In the adjusted analysis, children with SHCN performed on average 0.35 points lower on the teacher-rated attention scale compared to children without SHCN (95% CI: −0.52 to −0.17; SMD: −0.33) (Table 2). In the sensitivity analysis excluding children with ADHD, children with SHCN scored 0.27 points lower than children without SHCN (95% CI: −0.46 to −0.08; SMD: −0.26) (Table S5).

The strongest association between individual SHCN consequences and teacher-rated attention was found for treatment or counselling for emotional, behavioural, or developmental problems (adjusted mean difference: −0.58; 95% CI: −0.82 to −0.33; SMD: −0.55) and functional limitations compared with others of the same age (−0.34; 95% CI: −0.72 to 0.05; SMD: −0.32) (Table 2). The overall effect of SHCN on teacher-rated attention was primarily driven by children who experienced more than one SHCN consequence (−0.55; 95% CI: −0.81 to −0.30; SMD: −0.52) and less by children who experienced only one consequence (−0.14; 95% CI: −0.37 to 0.09; SMD: −0.13; Table 2). In the sensitivity analysis excluding children with ADHD, the effects of treatment or counselling for emotional, behavioural, or developmental problems and experiencing more than one consequence decreased considerably (Table S5).

TABLE 1 Characteristics of children included in the study sample and children with special health care needs.[a]

	Study sample	Children with special health care needs
	(*n* = 1921)	(*n* = 202)
Child		
Gender		
Male	988 (51.4)	118 (58.4)
Female	933 (48.6)	84 (41.6)
Missing, *n*	0	0
Age at preschool health examination (y), mean (SD)	5.9 (0.4)	5.9 (0.4)
Missing, *n*	0	0
Immigration status		
Yes	428 (23.5)	19 (9.9)
No	1396 (76.5)	172 (90.1)
Missing, *n*	97	11
Multiple at birth		
Yes	57 (3.0)	7 (3.6)
No	1842 (97.0)	189 (96.4)
Missing, *n*	22	6
Breastfeeding		
Not at all	304 (16.5)	42 (22.0)
Up to 6 months	741 (40.2)	70 (36.6)
More than 6 months	796 (43.2)	79 (41.4)
Missing, *n*	80	11
Family		
Abitur (A-level examinations)[b] Mother		
Yes	1095 (61.9)	123 (65.1)
No	673 (38.1)	66 (34.9)
Missing, *n*	153	13
Abitur (A-level examinations)[b] Father		
Yes	1017 (60.0)	102 (55.7)
No	677 (40.0)	81 (44.3)
Missing, *n*	227	19
School location		
District of Mainz-Bingen (rural)	996 (51.8)	125 (61.9)
City of Mainz	925 (48.2)	77 (38.1)
School-related attention compared to children of the same age at the end of first grade[c], mean (SD)	0.1 (1.1)	−0.2 (1.2)
Missing, *n*	460	32

Abbreviation: SD, standard deviation.

[a]Unless otherwise stated, values are expressed as *n* (%). % relates to non-missing values.

[b]Including advanced technical college entrance qualification.

[c]Teachers rated the students' concentration abilities on a rating scale ranging from −2 (much worse) through +2 (much better than other children of the same age).

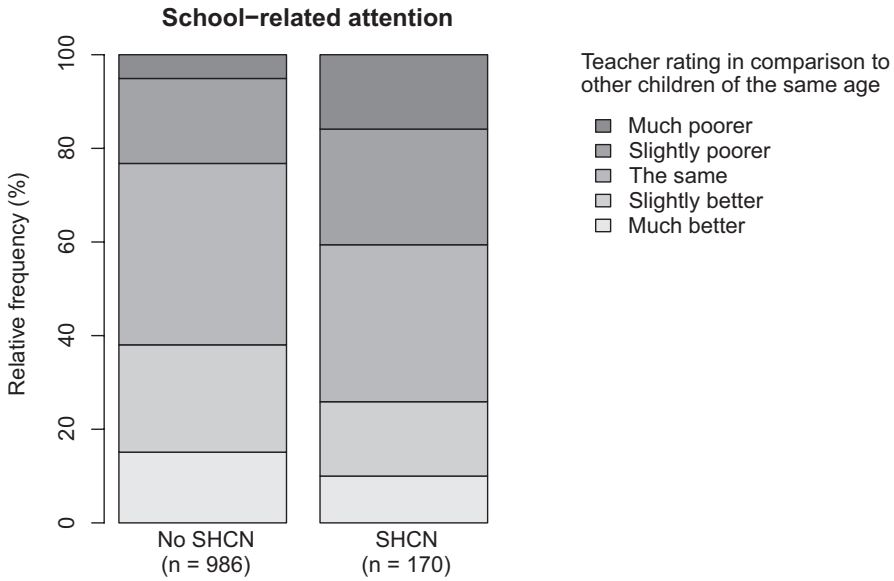

FIGURE 1 Distribution of teacher-rated global attention scores at the end of first grade between children with and children without special health care needs.

TABLE 2 Associations between special health care needs and school-related attention teacher rating at the end of first grade ($n = 1921$).

			Mean difference, adjusted[a]	[95% CI]	SMD
Overall SHCN					
No SHCN			(ref)		
SHCN			−0.35	[−0.52; −0.17]	−0.33
Individual SHCN consequences					
1	Use or need of prescription medication	No	(ref)		
		Yes	−0.14	[−0.39; 0.11]	−0.14
2	Above-average use or need of medical, mental health, or educational services	No	(ref)		
		Yes	−0.28	[−0.60; 0.05]	−0.26
3	Functional limitations compared with others of the same age	No	(ref)		
		Yes	−0.34	[−0.72; 0.05]	−0.32
4	Use or need of specialised therapies	No	(ref)		
		Yes	−0.12	[−0.42; 0.19]	−0.11
5	Treatment or counselling for emotional, behavioural, or developmental problems	No	(ref)		
		Yes	−0.58	[−0.82; −0.33]	−0.55
Number of SHCN consequences experienced					
0 consequences			(ref)		
1 SHCN consequence			−0.14	[−0.37; 0.09]	−0.13
>1 SHCN consequences			−0.55	[−0.81; −0.30]	−0.52

Abbreviations: CI, confidence interval; SHCN, special health care needs; SMD, standardised mean difference.

[a]Mean difference between children with and children without special health care needs (reference group). Teachers rated the students' attention abilities on a rating scale ranging from −2 (much worse) through +2 (much better than other children of the same age). Adjusted for gender, immigration status, socioeconomic status, multiple at birth, breastfeeding, chronic health condition in the family, health care utilisation, and school location. Individual SHCN consequences were further adjusted for consequence 1, consequences 2 and 5; consequence 2, consequences 3–5; consequence 4, consequences 3 and 5; consequence 5, and consequence 3.

4 | DISCUSSION

Our study showed that children with SHCN had lower teacher ratings of global attention than children without SHCN. The lowest attention ratings were found among children with treatment or counselling for emotional, behavioural, or developmental problems, functional limitations, and those who experienced two or more SHCN consequences. The observed effects decreased but generally remained after the exclusion of children with ADHD. Our results largely concur with the findings from a US study that found effects of SHCN, in particular functional impairments and use of or need for special mental health care services, on students' self-reported

attention.[8] The results of the present study also support the hypothesis that attention problems at school are one of the causal pathways that link health problems to educational attainment.

Attention at school may be affected in children with SHCN in different ways. For example, impaired attention may be an inherent component of a specific mental health condition such as ADHD. However, our analysis showed that the negative effect of SHCN on teacher-rated attention remained even after excluding children with ADHD. First, this finding demonstrates that attention problems can also occur with conditions other than ADHD, for example pervasive disorders such as autism or specific developmental disorders such as learning disorders. Second, attention problems may occur as a psychosocial consequence of a specific chronic health condition. For instance, sleep disorder may result in daytime sleepiness. Third, attention problems could also emerge as a side effect of medication. For instance, antihistamines may lead to daytime sleepiness. The specific diagnoses among children with special health care needs due to treatment or counselling for mental health problems can be found in Table S2.

Irrespective of the individual cause, our findings suggest that attention could be a promising target for condition-specific interventions in children with SHCN. First, the underlying health condition that negatively affects attention could be treated. This would be the case for conditions such as ADHD. Second, conditions that indirectly affect attention could be diagnosed and treated in a way to minimise the negative effects on attention. Third, generic interventions to improve attention such as physical activity or working memory training may be offered to children with SHCN. In a meta-analysis, de Greeff et al.[26] reported that short-term physical activity (adjusted Hedge's g: 0.43, $n=6$ studies) and long-term physical activity (adjusted Hedge's g: 0.90, $n=1$ study with two comparisons) improved selective attention in children aged 6–12 years. However, the effect of physical activity on academic performance was much lower (short-term activity: 0.09, $n=4$; long-term activity: 0.26, $n=3$) and was mainly driven by improvements in spelling and less by improvements in reading or math. Besides physical activity, interventions that target the working memory directly to improve attention have been shown to be effective in children and adults as well as individuals with and without ADHD.[27]

Our study also suggests that treatment or counselling for emotional, behavioural, or developmental problems, and functional limitations could be more strongly related to attention capacity at school than others. This finding could be used to identify children at risk during the preschool health examination and refer them to specialised outpatient clinics for children with SHCN. Based on the findings from the ikidS study, the Children with Special Health Care Needs Screener was recommended to be introduced as part of the preschool health examination in Rhineland-Palatine.

4.1 | Strengths and limitations

Our study had several strengths. Most research on the influence of child health on educational outcomes has been conducted in the United States. This is the first population-based, longitudinal study from Germany and one of the first in continental Europe. The study sample was largely representative of the underlying population and covered rural and urban areas. This makes our findings largely generalisable to other areas in Germany with a similar population structure. We identified confounding variables by using a theoretical framework and directed acyclic graphs to minimise bias in the effect estimates.

The study also had a number of limitations. A comprehensive consequence-based concept of chronic health conditions and the actual needs for special health care were used for the identification of affected children. This approach defines the presence of a chronic health condition through the parent-reported actual need for and use of these services. Thus, children with chronic health conditions but *without* current SHCN were not identified and remained in the comparison group for analysis. Any remaining misclassification of the exposure is, however, likely negligible. In a previous analysis, we found chronic health conditions *without* actual SHCN were not associated with poorer school performance.[9]

The group of children with SHCN was very heterogeneous. It included children with physical, developmental, or mental health conditions, or a combination of these conditions. The group also comprised children, who were medically evaluated at that time point and had no definitive diagnosis, yet. In our group of children with SHCN, the majority had asthma, global developmental delay, or ADHD. Due to this heterogeneity, the estimated effect on global attention should be interpreted with caution. It can be seen as a pooled effect of various single effects of the underlying health conditions.

Global attention at school was rated by the classroom teacher using an instrument by the German National Educational Panel Study. This instrument, however, did not allow to differentiate between different types of attention such as selective or sustained attention. The ratings were also likely influenced by the teachers' experience, attitude towards the child, or the average performance level of the class. To correct for this potential bias by clustered data, we used hierarchical regression models.

5 | CONCLUSIONS

Children with SHCN may have lower global attention at school compared to children without SHCN. The effect decreased but generally remained after excluding children with ADHD. Children experiencing several SHCN consequences are particularly at higher risk for attention problems at school. Screening for SHCN and attention problems at or before school should be implemented in school health policies. The Children with Special Health Care Needs screening tool is convenient and could be integrated into the preschool health examination. This could help to identify a relevant subgroup of children at risk for attention problems and related subsequent educational problems at school. If feasible and accurate, the screening would help to identify children who would benefit from early interventions to improve attention in affected children.

AUTHOR CONTRIBUTIONS

Jennifer Schlecht: Conceptualization; methodology; formal analysis; writing – original draft; writing – review and editing. **Florian Hammerle:** Writing – review and editing. **Jochem König:** Methodology; formal analysis; writing – review and editing. **Stefan Kuhle:** Writing – review and editing; methodology. **Michael S. Urschitz:** Conceptualization; methodology; writing – review and editing; supervision; funding acquisition.

ACKNOWLEDGEMENTS

We wish to thank all participating parents, children, and teachers for their patience and cooperation; they made this study possible. Open Access funding enabled and organized by Projekt DEAL.

FUNDING INFORMATION

This study received funding from the Federal Ministry of Education and Research of Germany (numbers: 01ER1302 and 01ER1702).

CONFLICT OF INTEREST STATEMENT

The authors have no conflicts of interest to declare.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Schlecht J, Hammerle F, König J, Kuhle S, Urschitz MS. Teachers reported that children with special health care needs displayed more attention problems. Acta Paediatr. 2024;113:1051-1058. https://doi.org/10.1111/apa.17125