European Child & Adolescent Psychiatry (2019) 28:1341–1352
https://doi.org/10.1007/s00787-019-01296-7

ORIGINAL CONTRIBUTION

Mental health problems and school performance in first graders: results of the prospective cohort study ikidS

Christine Gräf[1] · Isabell Hoffmann[1,2] · Christiane Diefenbach[1] · Jochem König[1] · Martina F. Schmidt[1] · Kathleen Schnick-Vollmer[1] · Michael Huss[3] · Michael S. Urschitz[1] · for the ikidS Project Group

Received: 28 March 2018 / Accepted: 12 February 2019 / Published online: 26 February 2019

Abstract

We aimed to estimate unbiased effects of mental health problems (MHPs) on school performance in first graders, with an emphasis on rigorous adjustment for potential confounders. A population-based prospective cohort study was performed in the area of Mainz-Bingen (Germany). In 2015, all preschoolers were approached, and the presence and type of MHP (externalising/internalising) and other physical chronic health conditions were identified by the preschool health examination and study-specific questionnaires. At the end of the first grade, school performance (reading, writing, numeracy, and science) was assessed by the class teacher and rated on a four-item scale ranging from − 8 to + 8. Of 3683 children approached, 2003 (54%) were enrolled. School performance was available for 1462 children (51% boys, mean age 7.3 years). Of these, 41% had signs of at least one MHP. Compared to children without indications of mental and physical chronic health conditions, children with MHPs had lower school performance scores [adjusted mean difference − 0.98, 95% CI (− 1.35; − 0.61); $P < 0.001$]. Regarding the type of MHP, externalising MHPs were associated with poor school performance [adjusted mean difference − 1.44, 95% CI (− 1.83; − 1.05); $P < 0.001$], while internalising MHPs were not. Children with hyperactivity inattention problems were most affected [adjusted mean difference − 1.96, 95% CI (− 2.36; − 1.56); $P < 0.001$]. Externalising MHPs and in particular hyperactivity inattention problems may already affect school performance in early primary school. Identification of children with externalising MHPs prior to school entry may help to prevent impaired academic achievement in affected children.

Keywords Externalising problems · Attention-deficit hyperactivity disorder · Academic achievement · School health · Community paediatrics · Children

Introduction

Mental health problems (MHPs) in children and adolescents are common and of growing concern for education and health policies. In 2003, the WHO recommended a Global Child and Adolescent Mental Health Action Plan [1]. This plan proposed the development and implementation of multi-sectoral strategies for promoting mental health and preventing mental disorders by 2013 and comprised explicitly school-based early detection and intervention programmes for children and adolescents exhibiting emotional and behavioural problems [2].

The prevalence of mental health disorders varies according to definition, age, sampling strategy, and operationalisation. It ranges between 10 and 20% within the paediatric population [3]. A German population-based survey found 14.5% of children and adolescents to have at least one mental health problem with impairments in the areas of home life,

This work is part of the doctoral thesis of Christine Gräf.

Membership of the ikidS Project Group is listed in the Acknowledgements.

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s00787-019-01296-7) contains supplementary material, which is available to authorized users.

Christine Gräf and Isabell Hoffmann contributed equally to the first authorship.

✉ Michael S. Urschitz
urschitz@uni-mainz.de

Extended author information available on the last page of the article

friendships, classroom learning, and leisure time activities [4].

The impact of MHPs on school performance and academic achievement is crucial, because this may contribute to the link between health during childhood, educational attainment, and socio-economic status in adulthood [5]. In 2011, Suhrcke and de Paz Nieves were the first to propose a theoretical framework for the relationship between MHPs and physical chronic health conditions (PCHCs) as well as health-related behaviours and educational outcomes [6]. They reviewed the available evidence and concluded that MHPs such as depression, anxiety disorders, and attention-deficit hyperactivity disorder (ADHD) may have negative effects on school performance, educational attainment, withdrawal from school, and enrolment in college or university.

However, most studies were from the US, thereby introducing some geographical bias, and used cross-sectional study designs, which avoided causal reasoning. Moreover, some of the adverse educational and psychosocial outcomes may be explained by the presence of confounding social, familial, and individual factors; in addition, the quality and level of health care use as well as the extent and effectiveness of special educational support have not been sufficiently investigated in these studies.

To address some of the shortcomings of previous studies, we established the ikidS project (ich komme in die Schule [German]; I am starting school) and aimed at estimating the effects of various chronic health conditions on educational outcomes in a longitudinal study design [7, 8]. The primary objective of the present study was to evaluate the association between MHPs with and without PCHC and early school performance. Furthermore, we aimed to investigate the relationships between subclasses of MHPs (e.g., internalising and externalising MHPs) and early school performance.

Methods

The ikidS cohort

ikidS is an ongoing representative population-based closed cohort study with a prospective design [7]. The sampling strategy, design aspects, and results for representativeness of the cohort have been described elsewhere [8]. Briefly, the cohort was established within the city limits of Mainz (i.e., the capital of the German Federal State of Rhineland-Palatinate) and the surrounding rural district of Mainz-Bingen. All the parents of children who had their mandatory statutory preschool health examination (PHE) between 1st September 2014, and 31st August 2015 were approached ($N = 3683$) and parents of 2003 children (54% of the population) finally agreed to participate. Comparisons with the underlying study population confirmed the representativeness of the cohort [8].

For the present analysis, 541 out of 2003 children were excluded due to the following reasons: (1) parents withdrew their consent after study enrolment ($n = 109$) or (2) migrated out of the study area ($n = 10$), (3) children ultimately did not enter school in September 2015 ($n = 50$), (4) were later assigned to a special needs school ($n = 16$), or (5) had no results for 1st grade school performance ($n = 356$). Reasons for missing performance results were refusal of schools to take part in the performance assessment (eight schools concerning $n = 122$ children) or individual refusal of teachers to fill in the performance questionnaire ($n = 234$).

Data were collected at four time points: at the PHE during the last preschool year [*T*0, mean age 5.89 years, standard deviation (SD) 0.36], 6 weeks before school entry (*T*1, mean age 6.34 years, SD 0.33), 3 months after school entry (*T*2, mean age 6.74 years, SD 0.34), and at the end of 1st grade (*T*3, mean age 7.26 years, SD 0.33). Written informed parental consent was obtained, and the research protocol was approved by the local ethics committee, the regional school authority, and the state representative for data protection. A flow chart of study procedures and participating children is given in the Online Resource (Figure S1).

Definition and assessment of mental health problems

The identification of children with MHPs was based on their PHE data (*T*0) as well as parental and teacher responses to additional study-specific questionnaires administered prior to school entry (*T*1) or during first grade (*T*2–*T*3). The threshold for being classified as having a MHP was set low; a child had to fulfil the criteria below at least at one out of four time points (*T*0–*T*3). We chose this rule so that the children not meeting these criteria were more likely to be truly MHP-free, thereby creating a reliable MHP-free reference group.

The PHE comprised an official parental questionnaire, a thorough medical history, a physical health examination, and several screening tests concerning visual and hearing impairments as well as pre-academic skills. With parental consent, individual PHE data were provided by the regional Public Health Department. The questionnaire as well as the public health physician himself/herself during the examination asked for previous or current doctors' diagnoses of MHPs and parental observations of behavioural or emotional impairments. The following doctors' diagnoses were considered in the PHE: autism spectrum disorder, tic disorder, ADHD, anxiety disorder, major depressive disorder, adjustment disorder, and psychosis. The following parental observations of behavioural/emotional impairments were considered: hyperactive behaviour/restlessness, inattentive behaviour, aggressiveness,

conduct problem, rejectionist attitude, lack of distance, emotional problem, and peer problem. The presence of the above-mentioned diagnoses and impairments was later repeatedly assessed using similar questionnaire items in the additional study-specific questionnaires at *T*1, *T*2, and *T*3 (Table 1).

In addition to these questionnaire items, symptoms, consequences, and treatments for MHPs and other chronic health conditions were assessed by German parent (administered at *T*1, *T*2 and *T*3) and teacher (administered only at *T*3) versions of the Strengths and Difficulties Questionnaire (SDQ) [9–11] and a German parent version (administered at *T*1 and *T*3) of the Children with Special Health Care Needs (CSHCN) Screener [12].

The SDQ is a 25-item 5-scale parent- or teacher-reported instrument covering 4 aspects of behaviour (i.e., conduct problems, hyperactivity inattention (HI), peer problems, and prosocial behaviour) and one aspect of emotional problems. Based on the four problem subscales (i.e., conduct problems, HI, peer problems, and emotional problems), a total difficulties score was calculated, and German reference values were applied to identify abnormal results for the total scale and all subscales [11]. Based on the parent and teacher versions, children with a total difficulties score ≥ 17 or abnormal results for any problem subscale were defined as having an indication of an MHP (Table 1).

The CSHCN Screener is a 14-item parent-reported instrument covering 5 aspects of special health care: (1) a need for

Table 1 Definitions and frequencies of mental health problems within the study sample ($N = 1462$)

Mental health problem	Time of assessment/instrument	Definition/rule	Frequency
Mental health problem, overall	*T*0: PHE questionnaire *T*1, *T*2, *T*3: study-specific questionnaire	Indication of one of the listed doctors' diagnoses or impairments[a]	601 (41.1%)
	*T*1, *T*2, *T*3: SDQ, parent version	Total difficulties score ≥ 17 OR at least one abnormal problem subscale[b]	
	*T*3: SDQ, teacher version	At least one abnormal problem subscale[c]	
	*T*1, *T*3: CSHCN Screener	CSHCN aspect 5 affirmed	
Internalising mental health problem	*T*0: PHE questionnaire *T*1, *T*2, *T*3: study-specific questionnaire	Indication of one of the listed doctors' diagnoses or impairments[d]	359 (24.6%)
	*T*1, *T*2, *T*3: SDQ, parent version	Emotional problems subscale ≥ 5 OR Peer problems subscale ≥ 5	
	*T*3: SDQ, teacher version	Emotional problems subscale ≥ 6 OR Peer problems subscale ≥ 5	
Externalising mental health problem	*T*0: PHE questionnaire *T*1, *T*2, *T*3: study-specific questionnaire	Indication of one of the listed doctors' diagnoses or impairments[e]	391 (26.7%)
	*T*1, *T*2, *T*3: SDQ, parent version	Hyperactivity inattention subscale ≥ 7 Conduct problems subscale ≥ 5	
	*T*3: SDQ, teacher version	Hyperactivity inattention subscale ≥ 7	
Conduct problem	*T*0: PHE questionnaire *T*1, *T*2: study-specific questionnaire	Indication of one of the listed doctors' diagnoses or impairments[f]	126 (8.6%)
	*T*1, *T*3: SDQ, parent version	Conduct problems subscale ≥ 5	
Hyperactivity inattention problem	*T*0: PHE questionnaire	Indication of one of the listed doctors' diagnoses or impairments[g]	326 (22.3%)
	*T*1, *T*2, *T*3: SDQ, parent version	Hyperactivity inattention subscale ≥ 7	
	*T*3: SDQ, teacher version	Hyperactivity inattention subscale ≥ 7	

CSHCN Children with Special Health Care Needs, *PHE* Preschool Health Examination, *SDQ* Strength and Difficulties Questionnaire

[a]Diagnoses: autism spectrum disorder, tic disorder, ADHD, anxiety disorder, major depressive disorder, adjustment disorder, and psychosis; impairments: hyperactive behaviour/restlessness, inattentive behaviour, aggressiveness, conduct problem, rejectionist attitude, lack of distance, emotional problem, and peer problem

[b]Emotional problems/hyperactivity inattention/conduct problems/peer problems

[c]Emotional problems/hyperactivity inattention/peer problems

[d]List of doctors' diagnoses and impairments for internalising mental health condition: anxiety disorder, major depressive disorder, adjustment disorder, psychosis, emotional problem, or peer problem

[e]List of doctors' diagnoses and impairments for externalising mental health condition: ADHD, hyperactive behaviour/restlessness, inattentive behaviour, aggressiveness, conduct disorder, rejectionist attitude, or a lack of distance

[f]List of doctors' diagnoses and impairments for conduct problems: aggressiveness, conduct disorder, rejectionist attitude, and lack of distance

[g]List of doctors' diagnoses and impairments for hyperactivity/inattention problems: ADHD, hyperactive behaviour/restlessness, and inattentive behaviour

prescription medication, (2) a need for social or educational support, (3) functional limitations, (4) a need for physical, occupational, or speech therapy, and (5) the presence of and treatment for an MHP. Each aspect has one key question with one or two additional questions which assess whether the condition is due to a medical or other health condition and whether the duration or expected duration of the condition is 12 months or longer. For the identification of children with an indication of an MHP, only aspect five (the presence of and treatment for an MHP; i.e., CSHCN profile type five) was considered (Table 1).

Based on the above instruments, children were categorised as having (1) at least one indication of an MHP, (2) an internalising MHP (i.e., diagnosis or symptoms of anxiety disorder, major depressive disorder, adjustment disorder, psychosis, emotional problems, or peer problems), or (3) an externalising MHP (i.e., a diagnosis or symptoms of ADHD, hyperactive behaviour/restlessness, inattentive behaviour, aggressiveness, conduct disorder, rejectionist attitude, or a lack of distance). Externalising MHPs were further divided into conduct problems (i.e., diagnosis or symptoms of aggressiveness, conduct disorder, rejectionist attitude, and lack of distance) and HI problems (i.e., diagnosis or symptoms of ADHD, hyperactive behaviour/restlessness, and inattentive behaviour). Children could have both, internalising and externalising MHPs as well as both types of externalising MHPs. A detailed description of how MHP groups were defined is given in Table 1.

Definition and assessment of physical chronic health conditions

A detailed description of how PCHC was defined and operationalised is published elsewhere [8]. In short, PHE data and study-specific questionnaires were evaluated for the presence ("ever", "during the last 12 months" or "currently") of one of the following doctors' diagnoses or health conditions: anaemia, asthma, atopic dermatitis, diabetes mellitus, dwarfism, epilepsy, heart defect, hay fever, hearing impairment, hypothyroidism, low birthweight, overweight/obesity, premature birth, excessive daytime sleepiness, habitual snoring, speech and language disorders, tumour/cancer, underweight, and visual impairment. For these diagnoses and conditions, associations with educational outcomes have been demonstrated in previous studies [6, 13–29]. In addition, we considered the following four aspects of the CSHCN Screener as indicators of a PCHC: (1) a need for prescription medication; (2) a need for social or educational support; (3) functional limitations; and (4) a need for physical, occupational, or speech therapy.

Children were categorised as having a PCHC only, if (1) they were reported to have one of the above diagnoses or conditions, (2) they had one of the four aspects covered by the CSHCN, and (3) at the same time they did not fulfil criteria of an MHP. Hence, children could have either an MHP (with or without a PCHC) or a PCHC only (without an MHP). We chose this rule so that the children not fulfilling these criteria were more likely to be truly PCHC-free and could form a more reliable PCHC-free reference group.

Educational outcome

School performance as the outcome was defined and operationalised in accordance with the German National Educational Panel Study [30]. At the end of the first grade, teachers were asked to rate the child's abilities in reading, writing, numeracy, science, and in social competencies in comparison to their peers of the same age. Responses were given on a 5-point rating scale, ranging from "much lower than average" and "lower than average" to "on average", "higher than average" and "much higher than average". Arbitrary numerical scores were assigned to each response category (i.e., -2, -1, 0, $+1$ and $+2$, respectively).

For the present study, we only considered reading, writing, numeracy, and science, because impaired social competencies may be part of an MHP and including ratings of social competencies into the composite outcome variable would, therefore, introduce bias. Scores of the above four abilities were summed to obtain a combined school performance score ranging from -8 to $+8$, with 0 indicating average performance. A preliminary psychometric validation of the score revealed good to very good internal consistency (Cronbach's $\alpha = 0.88$) and a perfect normal distribution (mean = 0.86, SD = 3.45, median = 0, minimum = -8, maximum = 8, skewness = -0.04). A histogram of the percent distribution is presented in the Online Resource (Figure S2).

Statistical analysis

Demographic and clinical characteristics were described by appropriate statistical parameters (e.g., numbers and frequencies for categorical variables and mean and SD for normally distributed variables). All descriptive statistics were presented for complete cases.

For the primary analysis, the associations between indications of MHP as a health status and the combined school performance score were investigated. For this health status, a categorical variable with three categories was constructed: (1) MHP (with or without PCHC), (2) PCHC only (and no MHP), and (3) none of both. A linear mixed-effects regression analysis with the combined school performance score as the dependent variable, health status as well as potential confounders as independent variables, and a random effect for school class membership was performed. Potential confounders have been identified in previous analyses [8] and included gender, younger than 6 years old at school entry

(yes/no), older than 7 years at school entry (yes/no), socio-economic status, migrant background, single-parent family, multiple births (e.g., twins, triplets, etc.), breastfeeding, household smoking, indoor activities (e.g., painting, tinkering, reading books, etc.), outdoor activities, nutrition, time in last establishment before school entry, early musical education, television in child's bedroom, school location, and a chronic health condition in the family. Results are given as crude and adjusted effect estimates (betas) with 95% confidence intervals and *P* values.

For the secondary analysis, we investigated the relationship between the presence of an externalising MHP (yes/no) or internalising MHP (yes/no; model 2) as well as conduct problems (yes/no) or HI problems (yes/no; model 3), and the combined school performance score. The reference group for the primary and secondary analyses was the group of children with no indications of a chronic health condition, neither a PCHC nor a MHP.

As HI problems turned out to be exceptionally important for school performance and because of the increased use of the SDQ as a screening instrument in the context of PHE or later during primary school [9, 31, 32], we additionally investigated the relationship between the HI subscale of the teacher version of the SDQ and the combined school performance score in a post hoc analysis. For this analysis, the HI subscale score was investigated as a continuous explanatory variable, because the relationship was highly linear.

All regression analyses were based on imputed data sets as outlined previously [8]. First, missing values within the SDQ were imputed as recommended [33]. Second, missing values within the CSHCN Screener and confounding variables were imputed 10 times using chained equations with 100 iterations [34]. For each imputed variable, an individual set of variables was used as predictor variables. Missing values within the combined school performance score were only imputed if one or two items of the score were missing. In this case, the available items were used as predictor variables for the multiple imputation procedure. The statistical analysis was performed using the software packages *R* (version 3.4.1), *nlme* (version 3.1–131), and *mice* (version 2.30) [35].

Results

Of 2003 cohort members, 1462 children fulfilled the inclusion criteria and were enrolled into the present study. Compared to the underlying population and the cohort, the study sample was representative concerning important demographic and clinical parameters [8].

Of 1462 children, 601 children (41%) showed at least one indication of an MHP, 274 children (19%) had indications of a PCHC only, and 384 children (26%) had indications of neither an MHP nor a PCHC (i.e., reference group). The status of MHP/PCHC was partly unknown in 203 children (14%), in most cases due to missing data concerning the CSHCN Screener.

Of 601 children with at least one indication of an MHP, 195 were categorised with only internalising MHPs, 227 with only externalising MHPs, and 164 had both, internalising as well as externalising MHPs. Fifteen children with MHPs could not be assigned to internalising or externalising MHPs. Among the children with externalising MHPs, 265 showed only HI problems, 65 were reported to have only conduct problem, and 61 had indications of both types of externalising MHPs.

On a descriptive basis, children with at least one indication of an MHP differed from the total study sample in terms of gender distribution, socio-economic status, migrant background, family form (single-parent family), household smoking, early musical education, and media use (TV in children's bedroom; Table 2).

In an unadjusted analysis, children with MHPs performed poorer at the end of first grade compared to children of the reference group [crude mean difference − 1.26, 95% CI (− 1.67, − 0.85); $P < 0.001$], while children with PCHC only showed no decrease in school performance [crude mean difference 0.06, 95% CI (− 0.43, 0.54); $P = 0.824$].

In the adjusted analysis, children with MHPs still had lower school performance scores [adjusted mean difference − 0.98, 95% CI (− 1.35, − 0.61); $P < 0.001$] compared to children with neither MHP nor PCHC, while PCHC only was again not related to school performance [adjusted mean difference 0.13, 95% CI (− 0.30, 0.57); $P = 0.543$] (Table 3, model 1). The effect estimates of all the confounders of model 1 are shown in the Online Resource (Table S1).

Regarding both types of MHPs, externalising MHPs were more strongly related to the school performance score [adjusted mean difference − 1.44, 95% CI (− 1.83, − 1.05); $P < 0.001$] than internalising MHPs [adjusted mean difference − 0.12, 95% CI (− 0.50, 0.27); $P = 0.550$; Table 3, model 2].

Regarding externalising MHPs, children with HI problems had the lowest school performance scores (adjusted mean difference − 1.96, 95% CI (− 2.36, − 1.56); $P < 0.001$] while children with conduct problems performed slightly better in comparison to children with neither an MHP nor a PCHC [adjusted mean difference 0.76, 95% CI (0.21, 1.31); $P = 0.007$; Table 3, model 3].

In a post hoc analysis, we found a clear negative and linear relationship between the teacher-reported HI subscale score of the SDQ and the school performance score showing a strong dose–effect gradient [adjusted mean difference per HI subscale score point − 0.48, 95% CI (− 0.54, − 0.42); $P < 0.001$].

Table 2 Characteristics of the study sample and subgroups

Characteristic	Study sample	Children with mental health problems	Children with physical chronic health conditions only	Children without health problems (reference group)
N	1462	601	274	384
Child				
Male, *N* (%)	751 (51.4%)	350 (58.2%)	133 (48.5%)	168 (43.8%)
Age at assessment of school performance, mean (SD)	7.26 (0.3)	7.27 (0.4)	7.24 (0,3)	7.24 (0,3)
Migrant background, *N* (%)	303 (21.8%)	122 (21.7%)	46 (17.6%)	50 (13.3%)
Time in last establishment before school entry				
Up to 1 year, *N* (%)	540 (37.1%)	236 (39.5%)	97 (35.4%)	120 (31.3%)
2–3 years, *N* (%)	598 (41.0%)	247 (41.3%)	104 (38.0%)	171 (44.5%)
4 years and more, *N* (%)	319 (21.9%)	115 (19.2%)	73 (26.6%)	93 (24.2%)
Family				
Single-parent family, *N* (%)	134 (9.4%)	76 (13.0%)	16 (5.9%)	24 (6.3%)
Multiples, *N* (%)	50 (3.4%)	18 (3.0%)	20 (7.3%)	4 (1.0%)
Socio-economic status index, median [Q1; Q3]	14.3 [10.9; 17.2]	13.1 [9.9; 15.2]	14.8 [11.8; 17.3]	15.2 [11.6; 17.7]
Breastfeeding				
Not at all, *N* (%)	231 (16.5%)	102 (17.9%)	36 (13.7%)	48 (12.7%)
Up to 6 months, *N* (%)	574 (41.0%)	238 (41.8%)	104 (39.7%)	152 (40.3%)
More than 6 months, *N* (%)	596 (42.5%)	229 (40.2%)	122 (46.6%)	177 (46.9%)
Nutrition				
Conventional	568 (51.4%)	249 (53.1%)	139 (52.9%)	179 (48.9%)
Mixed	333 (30.1%)	145 (30.9%)	72 (27.4%)	112 (30.6%)
Organic	204 (18.5%)	75 (16.0%)	52 (19.8%)	75 (20.5%)
Smoking in household				
Never, *N* (%)	1293 (91.2%)	509 (87.9%)	260 (96.7%)	364 (96.0%)
Seldom, *N* (%)	94 (6.6%)	50 (8.6%)	6 (2.2%)	14 (3.7%)
Often, *N* (%)	31 (2.2%)	20 (3.5%)	3 (1.1%)	1 (0.3%)
Chronic health condition in the family (yes), *N* (%)	226 (19.3%)	113 (22.5%)	54 (19.7%)	57 (14.8%)
Leisure time activities				
Indoor activities, hours per week, mean (SD)	9.07 (3.7)	8.77 (3.7)	9.22 (3.6)	9.32 (3.6)
Outdoor activities, hours per week, mean (SD)	10.72 (4.9)	10.18 (4.8)	10.64 (4.5)	11.46 (5.1)
Early musical education, *N* (%)	558 (47.7%)	223 (44.3%)	139 (50.9%)	194 (50.5%)
TV in child's bedroom, *N* (%)	122 (10.4%)	55 (11.0%)	35 (13.1%)	26 (6.8%)
School location				
Rural, *N* (%)	783 (53.6%)	349 (58.1%)	143 (52.2%)	205 (53.4%)
Urban, *N* (%)	679 (46.4%)	252 (41.9%)	131 (47.8%)	179 (46.6%)
School performance score (reading, writing, numeracy, science), mean (SD)	0.81 (3.46)	0.04 (3.52)	2.04 (3.33)	1.88 (2.98)

Q quartile, *SD* standard deviation

Discussion

In the present study, indications of at least one MHP at school entry or during first grade with or without indications of a concomitant PCHC were independently associated with lower school performance at the end of first grade. The association remained after carefully adjusting for a series of potential confounders. Moreover, the observed effect was stronger in children who had indications of externalising MHP, which in turn was mainly driven by the group of children with HI problems. To our knowledge, this is the first large European study on this topic in first graders; this study assessed the presence of MHPs via a set of different sources and instruments, used a prospective, longitudinal

Table 3 The effects of health problems on school performance—school performance score ranged from −8 (much lower than average) to 8 (much higher than average)—as assessed by multivariable linear regression analysis ($N = 1462$)

Regression model	Health problem	N^a	Effect estimate β^b (95% confidence interval)	P value
M1: mental health problems, overall	Mental health problems (with or without physical chronic health conditions)	601	−0.98 (−1.35, −0.61)	<0.001
	Physical chronic health conditions only	274	0.13 (−0.30, 0.57)	0.543
	None	384	Reference	
M2: internalising and externalising mental health problems	Internalising mental health problems (yes vs. no)	359	−0.12 (−0.50, 0.27)	0.550
	Externalising mental health problems (yes vs. no)	391	−1.44 (−1.83, −1.05)	<0.001
M3: conduct problems and hyperactivity inattention problems	Conduct problems (yes vs. no)	126	0.76 (0.21, 1.31)	0.007
	Hyperactivity inattention problems (yes vs. no)	326	−1.96 (−2.36, −1.56)	<0.001

[a]Due to missing values in the original dataset, the numbers of health categories do not sum up to 1462. As specified in the statistical methods section, missing values were later imputed by multiple imputation methods, so that even missing values have initially occurred, the results of the regression models base on the whole study sample of 1462 children

[b]Effect estimates were pooled after imputing missing values by chained equations multiple times. Effect estimates are adjusted β-coefficients of linear regression analysis and represent the change in school performance score associated with the respective health problem in comparison to children without chronic health conditions and adjusted for the following confounders: gender, age at school entry, socio-economic status, migrant background, single-parent family, multiple births, breastfeeding, smoking in house hold, indoor activities, outdoor activities, nutrition, time in last establishment before school entry, early musical education, television in child's bedroom, school location, and chronic health condition in the family

study design, investigated school performance very early on in the school career, and adjusted for a series of potential confounders. The results may now be used to further develop school entry procedures and school support services aimed at ameliorating the potentially negative effects of MHPs with or without a concomitant PCHC on future educational outcomes.

Our results are in line with previous studies in children and adolescents using parent reports of symptoms [36] and doctors' diagnoses of MHPs [37], as well as indications of MHPs identified by screening instruments [38–40]. Children using special health care services for behavioural and/or emotional problems (i.e., CSHCN profile type 5) experienced a greater diversity of poor school outcomes and showed the poorest academic achievement results in various school subjects compared to children with other special health care needs [36]. In another study [37], ADHD, autism spectrum disorder and seizure disorder were more strongly related to English language and maths performance compared to asthma, cardiovascular disorders, or diabetes.

We found academic impairments in children with indications of externalising MHPs but not in children with internalising MHPs. In this regard, results of previous studies have been heterogeneous, probably due to the varying operationalisation of conditions and outcomes. However, from a theoretical framework of internalising/externalising behaviour, better academic outcome for internalising behaviour is not unexpected. The psychopathological nature of internalising behaviour such as anxiety is prone to drive pupils investing more time for homework to avoid situations that may boost anxiety in the school setting (i.e., being exposed to critique). In one study [40], internalising and externalising problems at 6–8 years of age reduced the chance for receiving a high school diploma, with a slightly weaker effect of internalising problems. In another study, symptoms of hyperactivity/inattention and conduct disorders were associated with several educational outcomes, whereas symptoms of oppositional defiant disorder and anxiety/depression were not related [41]. According to a systematic review on the reciprocal association between mental disorders and a negative school experience, mood and anxiety disorders seemed to have less effect on school dropout compared to disruptive behaviour disorders [17]. The impact of externalising disorders was even stronger when the disorder occurred early in life. On the other hand, internalising disorders were reported to develop rather as a consequence of school failure and not as a primary cause [17, 42]. In summary of the present results and the body of evidence, externalising MHPs may be more important than other conditions in term of school performance and academic achievement, at least for early school grades.

Within the group of externalising problems, HI problems showed the strongest association with school performance. In our study, the effect of HI problems was much stronger compared to the effect of conduct problems. In fact, children with indications of conduct problems had higher school performance scores compared to children without MHPs, even after adjusting for several confounders. This particular aspect does not fit with our expectations and may be driven by short-term benefits of dominant behaviour in a social context. It should be a topic of long-term follow-up assessments as academic impairments may be expected later in

school career. Except for the last observation, our results are largely in line with the growing body of evidence in this field coming from large longitudinal studies [41, 43] and systematic reviews [15, 44, 45]. Children who are apparently exceptionally inattentive, hyperactive, and/or impulsive, but have not yet been diagnosed as having ADHD, showed lower reading and mathematics achievement scores in the first two school grades [43]. In a meta-analysis of six longitudinal data sets, however, school entry attention skills (together with math and reading skills) but not socio-emotional behaviours including externalising and internalising problems were predictors of later academic performance [46]. Using spline-regression models, the authors were not able to find consistent evidence of effects of problem behaviours on later achievement. As attention may be impaired as a consequence or as a part of the comorbidity of externalising MHPs, controlling for this factor in the analysis may have led to over-adjustment and underestimation of the effect of externalising MHPs on school performance. Nevertheless, all health conditions that aggravate attention skills to a sufficient extend and for a longer period of time will have an impact on school performance and academic achievement, given the extraordinary role of attention skills for learning activities and academic endeavours [46]. This is particularly true for ADHD and HI problems, which explains the strong effect on school performance seen in the present study.

We found indications of at least one MHP in 41% of the study sample, and 22% of the sample presented with HI problems. This is much higher compared to international data (i.e. 16%; [47]) and a current national health survey, which found that 20% of the German paediatric population was affected by psychopathological problems and/or psychosocial impairments [48]. The main reason for this difference relates to the various operationalisations of MHPs. Although the SDQ was used in the national survey and in the present study to identify children with MHPs, a series of additional—mainly PHE-based—indicators were used in ikidS. These indicators partly comprised non-validated items within the parental questionnaire of the statutory PHE. Although it has been used for years by health authorities in Rhineland-Palatinate, the PHE questionnaire has not yet been extensively validated. Despite concerns regarding the validity of these items, we decided to use this information for group classification with the ultimate goal of creating a considerably healthy and disease-free comparison group for regression analysis. This has vice versa led to an enlarged MHP group including children who probably did not suffer from a clinically relevant condition. This approach has potentially diluted the strength of the associations reported. In this regard, the presented effects of MHPs on school performance more likely reflect the lower boundaries of the true effects.

The relative importance of MHPs (with or without PCHC) in comparison to PCHCs alone was also underscored by the present study. MHPs (with or without PCHC) remained a significant predictor of school performance after adjusting for potential confounders, while the presence of PCHC alone (and in absence of an MHP) was not related to school performance in our study. Thus, already in first grade, MHPs (with or without PCHC) may play a crucial role for early educational achievement. However, the effect size of the PCHC only group should be interpreted with caution, as children with both types of health conditions (MHP and PCHC) were assigned to the MHP group (see Strengths and Limitations for a further discussion).

In summary, our results suggest the need to already identify children with relevant MHPs in preschool and treat them appropriately to prevent MHP-related impaired academic achievement. In a post hoc analysis, we found in particular HI problems related to the school performance. This is in accordance with another study showing that MHP screens administered in the first grade were strong predictors of lower achievement test scores 3 years later [39]. Hence, large-scale school-based screening and intervention programmes for MHPs may be helpful to prevent individual long-term negative consequences and reduce the public health burden of MHPs [42]. For example, Skills for Life, one of the largest school-based mental health programmes in the world, was evaluated in 2015 in Chile [47]. In 1637 primary schools, all first- and third-grade students were screened with validated teacher- and parent-completed measures of psychosocial functioning. 16.4% of students were identified as being at risk and were referred to a standardised 10-session preventive intervention in second grade. Relationships were found between the number of sessions attended and improvements in behavioural and academic outcomes; effect sizes of the intervention were small and ranged from 0.08 to 0.16 [47]. These results are in line with a study evaluating a similar school-based intervention, showing small to non-significant effects of the intervention on teacher-reported classroom and learning problems [49]. According to the classic screening criteria by the WHO, there should be a suitable test or examination for screening, an accepted treatment for patients identified, and facilities for diagnosis and treatment available [50]. In the Skills for Life programme, 1007 students were referred to specialists, and 784 (78%) were reported by their parents to have engaged in regular treatment with them [47]. It is crucial for the effectiveness of screening programmes that the majority of those screened positive consequently undergo further diagnostic evaluation and/or immediate effective treatment. Considering the shortage of paediatric psychiatrists

in some countries, the usefulness of such programmes remains questionable to date.

Strengths and limitations

The major strengths and limitations of the ikidS project have been extensively discussed elsewhere [8]. Strengths of the project included (1) a large population-based and representative sample; (2) the application of a causal model for the relationship between chronic health conditions and education [6], which led to a comprehensive adjustment for potential family and leisure time-related confounders; and (3) the usage of state-of-the-art techniques for imputing missing values in longitudinal studies [51]. These strengths enabled us to present largely unbiased estimates of the association between MHPs and school performance in the first graders. Limitations comprised the reliance on PHE data and parent reports instead of psychiatric diagnostic procedures, the use of teacher assessments for school performance instead of objective academic testing, and the lack of a non-responder analysis.

Early school performance was assessed using an instrument proposed by the German National Educational Panel Study [30]. However, extensive validation data are not available and the predictive relevance of the instrument score concerning long-term educational outcomes remains unclear. In general, teacher ratings may be subjective to their occupational experience, their attitude towards a child, and the mean level of competencies within the whole class. Notwithstanding these concerns, the use of teacher ratings is justified by past studies that have found relationships between biological risks and similar teacher ratings [52, 53]. Moreover, teacher ratings are upmost important "real-life" indicators of school success that directly influence the educational career of children in Germany (e.g., the transition to secondary school). To address some of the above limitations we performed a preliminary psychometric evaluation and accounted for the individual subjective rating in the analysis by adding a random intercept for teacher/class in the regression models.

The presence of an MHP was evaluated by reviewing records of the PHE and analysing responses from parents to questionnaires. In the parental PHE questionnaire, the presence of MHPs was partly evaluated with a life-time perspective, i.e., items asked for "ever" having had a specific diagnosis, condition, or problem. Due to this sensitive operationalisation, the group of children with MHP was large and the reference group of healthy children without indications of any health problems comprised only 26% of the study sample. In this regard, the study sample may be not fully representative, as parents of healthy children may have refused study participation more often compared to parents of children with health conditions. The reason for this sensitive operationalisation is to use these data for nationwide health monitoring and individual risk assessment by the public health authorities. Moreover, the ability of these items to predict impaired academic achievement in an individual child has not yet been investigated. Hence, we refrain from recommending these items for individual risk assessment unless comprehensive validation data are available.

At last, one additional limitation should be mentioned. The effects of MHP were not traditionally adjusted for the effects of a concomitant PCHC because this adjustment demands a causal independency between MHP and PCHC. However, MHP can be the causal consequence of a PCHC in some children [54–56], while in other children, MHP occurs independently of the PCHC. In the first case, MHP is a mediator on the causal pathway between PCHC and educational outcomes. In the second case, PCHC is a confounder of the association between MHP and educational outcomes. Based on our study, we cannot disentangle the role of PCHC as either a cause of MHP or a confounder of the association between MHP and educational outcomes. Thus, a simple adjustment for PCHC would lead to over-adjustment and, consequently, underestimation of the MHP effects. In contrast, not adjusting for PCHC would lead to underestimation of MHP effects, too, because children with MHP are compared with a reference group consisting of healthy children and children with PCHC (the latter may decrease the group's mean school performance). In conclusion of this major consideration, we developed the present analysis, where we (1) combined children who only had MHP and children with both PCHC and MHP into a single group and (2) excluded children with PCHC from the reference group. However, the presented results of the MHP group are in effect a mixture of both, MHP-only effects and MHP plus PCHC effects (irrespective of which occurred first). In the latter case, the negative effects on school performance might arise mainly from the PCHC and not from the comorbid MHP. The inability to disentangle the MHP from the PCHC effects is a limitation of the present study; however, we believe that this goal can never be achieved in observational studies, where a causal relationship cannot be reliably distinguished from a statistical association in a single child.

Conclusions

The presence of externalising MHPs (with or without a concomitant PCHC) and especially HI problems at school entry and during the first grade already may have negative effects on school performance at the end of the first grade. Considering the strong impact of HI problems on later academic achievement, early detection (and adequate treatment) may help to prevent school and academic failure. Regarding the WHO Mental Health Action Plan 2013–2020, school-based

detection and intervention programmes with a focus on HI problems should be launched and evaluated, now. Screening with appropriate instruments in preschool or during the first grade may be considered, carefully weighing risks and benefits of mental health screening. Future research activities should address the identification of those children with MHPs who are particularly at risk for performing worse at school and whether these children may benefit from early targeted medical, educational, and/or social support interventions.

Acknowledgements Our thanks go to the documentation specialists and student research aids for conducting the surveys and managing the data. Grateful acknowledgement goes to Katherine Taylor for proofreading as well as Jennifer Schlecht and Anna-Liesa Filbert for additional statistical analyses. Last but not least, we particularly wish to thank all the parents and children for their patience and cooperation; they made this study possible.

Members of the ikidS Project Group are Dietmar Hoffmann (Department of Public Health, County Government Mainz-Bingen), Maria Blettner, Peter Kaatsch (Institute of Medical Biostatistics, Epidemiology, and Informatics; University Medical Centre of the Johannes Gutenberg-University Mainz), Annette Queisser-Wahrendorf, Awi Wiesel, Fred Zepp, Jörg Faber, Stephan Gehring, Eva Mildenberger (Department of Pediatrics; University Medical Centre of the Johannes Gutenberg-University Mainz), Stephan Letzel (Institute of Occupational, Social and Environmental Medicine; University Medical Centre of the Johannes Gutenberg-University Mainz), Heike Elflein, Alexander K. Schuster (Department of Ophthalmology, University Medical Centre of the Johannes Gutenberg-University Mainz), Brita Willershausen, Jens Weusmann (Department of Prosthodontics, University Medical Centre of the Johannes Gutenberg-University Mainz), Christoph Matthias (Department of Communication Disorders; University Medical Centre of the Johannes Gutenberg-University Mainz), Margarete Imhof (Department of Educational Psychology, Johannes Gutenberg-University Mainz), and Perikles Simon (Department of Sports Medicine, Johannes Gutenberg-University Mainz).

Funding This project was supported by a research grant from the German Federal Ministry of Education and Research (grant application number 01ER1302).

Compliance with ethical standards

Conflict of interest On behalf of all the authors, the corresponding author states that there is no conflict of interest.

References

1. WHO (2003) Caring for children and adolescents with mental disorders: setting WHO directions. WHO, Geneva
2. WHO (2013) Mental health action plan 2013–2020. WHO, Geneva
3. Grant R, Brito A (2010) Chronic illness and school performance: a literature review focusing on asthma and mental health conditions. Children's Health Fund, New York
4. Ravens-Sieberer U, Wille N, Erhart M, Bettge S, Wittchen H-U, Rothenberger A, Herpertz-Dahlmann B, Resch F, Hölling H, Bullinger M, Barkmann C, Schulte-Markwort M, Döpfner M (2008) Prevalence of mental health problems among children and adolescents in Germany: results of the BELLA study within the national health interview and examination survey. Eur Child Adolesc Psychiatry 17(1):22–33. https://doi.org/10.1007/s00787-008-1003-2
5. Currie J (2008) Healthy, wealthy and wise: socioeconomic status, poor health in childhood and human capital development. Nat Bur Econ Res, Cambridge **(Working Paper No 1398)**
6. Suhrcke M, de Paz Nieves C (2011) The impact of health and health behaviours on educational outcomes in high income countries: a review of the evidence. WHO Regional Office for Europe, Copenhagen
7. Urschitz MS, Gebhard B, Philippi H, De Bock F (2016) Partizipation und bildung als endpunkte in der pädiatrischen versorgungsforschung [participation and education as outcomes of paediatric health services research]. Kinder- und Jugendmedizin 16(3):206–217
8. Hoffmann I, Diefenbach C, Graf C, Konig J, Schmidt MF, Schnick-Vollmer K, Blettner M, Urschitz MS, ikid SSG (2018) Chronic health conditions and school performance in first graders: a prospective cohort study. PLoS One 13(3):e0194846. https://doi.org/10.1371/journal.pone.0194846
9. Goodman R, Ford T, Simmons H, Gatward R, Meltzer H (2000) Using the strengths and difficulties questionnaire (SDQ) to screen for child psychiatric disorders in a community sample. Br J Psychiatry 177(6):534–539. https://doi.org/10.1192/bjp.177.6.534
10. Woerner W, Becker A, Rothenberger A (2004) Normative data and scale properties of the German parent SDQ. Eur Child Adolesc Psychiatry 13(Suppl 2):Ii3–Ii10. https://doi.org/10.1007/s00787-004-2002-6
11. Woerner W, Becker A, Friedrich C, Klasen H, Goodman R, Rothenberger A (2002) Normierung und evaluation der deutschen elternversion des strengths and difficulties questionnaire (SDQ): ergebnisse einer repräsentativen felderhebung. Z Kinder Jugendpsychiatr Psychother 30(2):105–112
12. Bethell CD, Read D, Stein RE, Blumberg SJ, Wells N, Newacheck PW (2002) Identifying children with special health care needs: development and evaluation of a short screening instrument. Ambul Pediatrics 2(1):38–48
13. Taras H, Potts-Datema W (2005) Childhood asthma and student performance at school. J Sch Health 75(8):296–312. https://doi.org/10.1111/j.1746-1561.2005.00041.x
14. O'Connell EJ (2004) The burden of atopy and asthma in children. Allergy 59(Suppl 78):7–11. https://doi.org/10.1111/j.1398-9995.2004.00563.x
15. Polderman TJC, Boomsma DI, Bartels M, Verhulst FC, Huizink AC (2010) A systematic review of prospective studies on attention problems and academic achievement. Acta Psychiatr Scand 122(4):271–284. https://doi.org/10.1111/j.1600-0447.2010.01568.x
16. Troyb E, Orinstein A, Tyson K, Helt M, Eigsti IM, Stevens M, Fein D (2014) Academic abilities in children and adolescents with a history of autism spectrum disorders who have achieved optimal outcomes. Autism 18(3):233–243. https://doi.org/10.1177/1362361312473519
17. Esch P, Bocquet V, Pull C, Couffignal S, Lehnert T, Graas M, Fond-Harmant L, Ansseau M (2014) The downward spiral of mental disorders and educational attainment: a systematic review on early school leaving. BMC Psychiatry 14(1):237. https://doi.org/10.1186/s12888-014-0237-4
18. Stabler B, Clopper RR, Siegel PT, Stoppani C, Compton PG, Underwood LE (1994) Academic achievement and psychological adjustment in short children. The national cooperative growth study. J Dev Behav Pediatr 15(1):1–6
19. Wright M, Nolan T (1994) Impact of cyanotic heart disease on school performance. Arch Dis Child 71(1):64–70

20. Blaiss MS (2004) Allergic rhinitis and impairment issues in schoolchildren: a consensus report. Curr Med Res Opin 20(12):1937–1952
21. Cohen AK, Rai M, Rehkopf DH, Abrams B (2013) Educational attainment and obesity: a systematic review. Obes Rev 14(12):989–1005. https://doi.org/10.1111/obr.12062
22. Lieu JE, Tye-Murray N, Fu Q (2012) Longitudinal study of children with unilateral hearing loss. Laryngoscope 122(9):2088–2095. https://doi.org/10.1002/lary.23454
23. Leger J, Larroque B, Norton J (2001) Influence of severity of congenital hypothyroidism and adequacy of treatment on school achievement in young adolescents: a population-based cohort study. Acta Paediatr 90(11):1249–1256
24. Bettge S, Oberwohrmann S, Brockstedt M, Buhrer C (2014) Birth weight and special educational needs: results of a population-based study in Berlin. Dtsch Arztebl Int 111(19):337–344. https://doi.org/10.3238/arztebl.2014.0337
25. Moreira RS, Magalhaes LC, Alves CR (2014) Effect of preterm birth on motor development, behavior, and school performance of school-age children: a systematic review. J Pediatria 90(2):119–134. https://doi.org/10.1016/j.jped.2013.05.010
26. Urschitz MS, Eitner S, Guenther A, Eggebrecht E, Wolff J, Urschitz-Duprat PM, Schlaud M, Poets CF (2004) Habitual snoring, intermittent hypoxia, and impaired behavior in primary school children. Pediatrics 114(4):1041–1048
27. Stoeckel RE, Colligan RC, Barbaresi WJ, Weaver AL, Killian JM, Katusic SK (2013) Early speech-language impairment and risk for written language disorder: a population-based study. J Dev Behav Pediatr 34(1):38–44. https://doi.org/10.1097/DBP.0b013e31827ba22a
28. Gurney JG, Krull KR, Kadan-Lottick N, Nicholson HS, Nathan PC, Zebrack B, Tersak JM, Ness KK (2009) Social outcomes in the childhood cancer survivor study cohort. J Clin Oncol 27(14):2390–2395. https://doi.org/10.1200/jco.2008.21.1458
29. Kaestner R, Grossman M (2009) Effects of weight on children's educational achievement. Econ Educ Rev 28(6):651–661
30. Blossfeld H-P, Maurice J, Schneider T (2011) The national educational panel study: need, main features, and research potential. Zeitschrift für Erziehungswissenschaft 14(2):5–17. https://doi.org/10.1007/s11618-011-0178-3
31. Korsch F, Petermann F (2012) Früherkennung von Verhaltensstörungen durch die schulärztliche Eingangsuntersuchung. Prax Kinderpsychol Kinderpsychiatr 61(9):691–705
32. Boman F, Stafstrom M, Lundin N, Moghadassi M, Tornhage CJ, Ostergren PO (2016) Comparing parent and teacher assessments of mental health in elementary school children. Scand J Publ Health 44(2):168–176. https://doi.org/10.1177/1403494815610929
33. Goodman R (2000) Youthinmind Ltd. http://www.sdqinfo.org/py/sdqinfo/c0.py. Accessed 10.12.2017 2017
34. van Buuren S, Groothuis-Oudshoorn K (2011) mice: multivariate imputation by Chained equations in R. J Stat Softw 45(3):1–68
35. R-Core-Team (2017) R: a Language and environment for statistical computing. R foundation for statistical computing, Vienna, Austria. https://www.R-project.org/
36. Forrest CB, Bevans KB, Riley AW, Crespo R, Louis TA (2011) School outcomes of children with special health care needs. Pediatrics 128(2):303–312. https://doi.org/10.1542/peds.2010-3347
37. Crump C, Rivera D, London R, Landau M, Erlendson B, Rodriguez E (2013) Chronic health conditions and school performance among children and youth. Ann Epidemiol 23(4):179–184. https://doi.org/10.1016/j.annepidem.2013.01.001
38. Currie J, Stabile M (2007) Mental health in childhood and human capital. NBER working paper series. National Bureau of Economic Research, Inc, Cambridge
39. Guzman MP, Jellinek M, George M, Hartley M, Squicciarini AM, Canenguez KM, Kuhlthau KA, Yucel R, White GW, Guzman J, Murphy JM (2011) Mental health matters in elementary school: first-grade screening predicts fourth grade achievement test scores. Eur Child Adolesc Psychiatry 20(8):401–411. https://doi.org/10.1007/s00787-011-0191-3
40. McLeod JD, Kaiser K (2004) Childhood emotional and behavioral problems and educational attainment. Am Soc Rev 69(5):636–658. https://doi.org/10.1177/000312240406900502
41. Galéra C, Melchior M, Chastang J-F, Bouvard M-P, Fombonne E (2009) Childhood and adolescent hyperactivity-inattention symptoms and academic achievement 8 years later: the GAZEL Youth study. Psychol Med 39(11):1895–1906. https://doi.org/10.1017/S0033291709005510
42. Schulte-Korne G (2016) Mental health problems in a school setting in children and adolescents. Dtsch Arztebl Int 113(11):183–190. https://doi.org/10.3238/arztebl.2016.0183
43. Merrell C, Tymms PB (2001) Inattention, hyperactivity and impulsiveness: their impact on academic achievement and progress. Br J Educ Psychol 71(1):43–56. https://doi.org/10.1348/000709901158389
44. Frazier TW, Youngstrom EA, Glutting JJ, Watkins MW (2007) ADHD and achievement: meta-analysis of the child, adolescent, and adult literatures and a concomitant study with college students. J Learn Disabil 40(1):49–65. https://doi.org/10.1177/00222194070400010401
45. Erskine HE, Norman RE, Ferrari AJ, Chan GC, Copeland WE, Whiteford HA, Scott JG (2016) Long-term outcomes of attention-deficit/hyperactivity disorder and conduct disorder: a systematic review and meta-analysis. J Am Acad Child Adolesc Psychiatry 55(10):841–850. https://doi.org/10.1016/j.jaac.2016.06.016
46. Duncan GJ, Dowsett CJ, Claessens A, Magnuson K, Huston AC, Klebanov P, Pagani LS, Feinstein L, Engel M, Brooks-Gunn J, Sexton H, Duckworth K, Japel C (2007) School readiness and later achievement. Dev Psychol 43:1428–1446. https://doi.org/10.1037/0012-1649.43.6.1428
47. Guzman J, Kessler RC, Squicciarini AM, George M, Baer L, Canenguez KM, Abel MR, McCarthy A, Jellinek MS, Murphy JM (2015) Evidence for the effectiveness of a national school-based mental health program in Chile. J Am Acad Child Adolesc Psychiatry 54(10):799-807.e791. https://doi.org/10.1016/j.jaac.2015.07.005
48. Holling H, Schlack R, Petermann F, Ravens-Sieberer U, Mauz E, Ki GGSSG (2014) Psychopathological problems and psychosocial impairment in children and adolescents aged 3–17 years in the German population: prevalence and time trends at two measurement points (2003–2006 and 2009–2012): results of the KiGGS study: first follow-up (KiGGS Wave 1). Bundesgesundheitsblatt, Gesundheitsforschung, Gesundheitsschutz 57(7):807–819. https://doi.org/10.1007/s00103-014-1979-3
49. Stein BD, Jaycox LH, Kataoka SH, Wong M, Tu WL, Elliott MN, Fink A (2003) A mental health intervention for schoolchildren exposed to violence—a randomized controlled trial. Jama J Am Med Assoc 290(5):603–611. https://doi.org/10.1001/jama.290.5.603
50. Wilson JMG, Jungner G (1968) Principles and practice of screening for disease. Public Health Papers, vol 34. World Health Organization, Geneva
51. De Silva AP, Moreno-Betancur M, De Livera AM, Lee KJ, Sompson JA (2017) A comparison of multiple imputation methods for handling missing values in longitudinal data in presence of a time-varying covariate with a non-linear association with time: a simulation study. BMC Med Res Methodol 17:114

52. Gozal D (1998) Sleep-disordered breathing and school performance in children. Pediatrics 102(3 Pt 1):616–620
53. Gozal D, Pope DW Jr (2001) Snoring during early childhood and academic performance at ages 13–14 years. Pediatrics 107(6):1394–1399
54. CoCw Disabilities, CoPAo Child, Health F (1993) Psychosocial risks of chronic health conditions in childhood and adolescence. Pediatrics 92(6):876–878
55. Hysing M, Elgen I, Gillberg C, Lie SA, Lundervold AJ (2007) Chronic physical illness and mental health in children. Results from a large-scale population study. J Child Psychol Psychiatry 48(8):785–792. https://doi.org/10.1111/j.1469-7610.2007.01755.x
56. Erhart M, Holling H, Bettge S, Ravens-Sieberer U, Schlack R (2007) The German health interview and examination survey for children and adolescents (KiGGS): risks and resources for the mental development of children and adolescents. Bundesgesundheitsblatt, Gesundheitsforschung, Gesundheitsschutz 50(5–6):800–809. https://doi.org/10.1007/s00103-007-0243-5

Affiliations

Christine Gräf[1] · Isabell Hoffmann[1,2] · Christiane Diefenbach[1] · Jochem König[1] · Martina F. Schmidt[1] · Kathleen Schnick-Vollmer[1] · Michael Huss[3] · Michael S. Urschitz[1] · for the ikidS Project Group

[1] Division of Paediatric Epidemiology, Institute of Medical Biostatistics, Epidemiology, and Informatics, University Medical Centre of the Johannes Gutenberg-University, Obere Zahlbacher Str. 69, 55131 Mainz, Germany

[2] Paul-Ehrlich-Institut, Federal Institute for Vaccines and Biomedicines, Paul-Ehrlich-Str. 51-59, 63225 Langen, Germany

[3] Department of Paediatric and Adolescent Psychiatry and Psychotherapy, University Medical Centre of the Johannes Gutenberg-University, Langenbeckstr. 1, 55131 Mainz, Germany