Mental disorders in children and adolescents with type 1 diabetes before and during the COVID-19 pandemic: results from the DPV registry

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Abstract

Objectives: The COVID-19 pandemic affected the mental health of children and adolescents in the general population, yet its impact on those with chronic conditions is relatively unknown. This study aimed to compare the incidences of comorbid mental disorders and substance misuse in children and adolescents with type 1 diabetes before and during the pandemic.

Methods: A total of 42,975 patients aged 6–18 years from the multicentre DPV (Diabetes Prospective Follow-up) registry were included. Multivariable regression models were applied to compare newly diagnosed comorbid mental disorders, adjusted for demographic and clinical variables, among them the number of medical visits, during the pre-pandemic period (09/2017–02/2020) and the COVID-19 pandemic period (03/2020–08/2022).

Results: Analysing both sexes together, there were no differences in the incidence rates of overall mental disorders between the pandemic and the pre-pandemic period. However, girls showed an increased incidence rate (odds ratio 1.2, CI 1.1–1.3) during the pandemic. Adolescent girls also displayed higher incidence rates of depression, eating disorders, and self-harm. Substance misuse declined overall during the pandemic (odds ratio 0.8, CI 0.7–0.9).

Conclusions: During the COVID-19 pandemic, we found higher incidence rates of overall mental disorders in girls, but not in boys and not in the total study population of children and adolescents with type 1 diabetes. Adolescent girls displayed increased incidence rates of depression, eating disorders, and self-harm. Substance misuse declined substantially. Clinicians should be aware of the high-risk group of adolescent girls during times of increased strain.

Keywords: diabetes type 1; children; adolescents; mental disorders; COVID-19 pandemic

Introduction

The COVID-19 pandemic in the years 2020–2022 and the consecutive policy measures to contain the spread of SARS-CoV-2 have affected the wellbeing and psychological health of children and adolescents worldwide. Most reviews reported a higher prevalence of mental health problems during the pandemic, in particular symptoms of depression, anxiety, sleep problems, and post-traumatic stress [1–3], though divergent views have been published as well [4]. In Germany, the population-based longitudinal COVID-19 and
psychological health (COPSY) study reported lower quality of life and elevated numbers of mental health problems during the pandemic, and most mental health outcomes were still worse in autumn 2022 [5–7].

Most studies used self- and parent-proxy-report screening questionnaires, thus including mental health problems on a sub-clinical level. Not every self-reported health problem, however, may lead to a medically confirmed mental disorder diagnosis. With regard to confirmed diagnoses, a Danish and an American nationwide study reported a consistent increase in rates of mental disorder diagnoses during the pandemic [8, 9], and an Italian study covering more than 530,000 children observed an increase in patient admissions to emergency departments for neuropsychological disorders [10].

Children and adolescents with type 1 diabetes (T1D) are a vulnerable group. The complex daily diabetes management, as well as the psychological burden of the condition, may negatively impact the patients’ quality of life and psychological health [11, 12]. Mental health problems are associated with poorer metabolic control and higher rates of diabetes complications and hospital admissions. Children and adolescents with T1D have twice the risk for a comorbid mental disorder, particularly depression, anxiety, and eating disorders [13].

While it is well acknowledged that COVID-19 posed a substantial strain on children and adolescents in the general population, it is unclear whether this burden was equal in vulnerable populations like those with T1D. This study aimed to compare the incidences of comorbid mental disorders in children and adolescents with T1D before and during the COVID-19 pandemic.

**Methods**

**Data source and study population**

Data were collected from the standardised longitudinal DPV database (Diabetes Prospective Follow-up), which records demographic and clinical information on >90% of all children and adolescents with T1D in Germany and Austria and also includes patients from Switzerland and Luxembourg [14]. The participating centres transmit anonymised data twice yearly to the registry administrated at Ulm University, where data are validated and subsequently aggregated for analysis (data set March 2023). Analysis of the anonymised data within the DPV initiative has been approved by the Ethics Committee of the University of Ulm, Germany (approval number: 314/21). The analysis included individuals aged 6–18 years with T1D for at least six months and a new diagnosis of a mental health disorder in the observation periods of 09/2017–02/2020 (pre-pandemic period) and 03/2020–08/2022 (pandemic period). Details on patient selection are presented in a flow-chart.

**Variables**

Demographic variables included sex, age, age at onset of diabetes, and migration biography, defined as a patient or at least one parent not born in Germany/Austria/Switzerland/Luxembourg. Age was categorised as 6–12 years and 13–18 years, and diabetes duration as <2.5 years and ≥2.5 years.

Locally measured HbA1c values were mathematically standardised to the diabetes control and complications trial (DCCT) reference range of 4.05–6.05 mmol/mol by applying the multiple-of-the-mean transformation method [15]. The combined glucose indicator (CGI), incorporating both HbA1c and TIR information, was calculated in addition to include information on metabolic control for individuals receiving telemedicine care only [16]. BMI values were transformed into standard deviation scores (BMI-SDS) based on German reference values [17]. Multiple visits per individual and observation period were aggregated as median.

Information on diabetes therapy comprised the use of continuous subcutaneous insulin infusion (CSII), CGM systems, and automated insulin dosage (AID) systems (documented at least once per observation period). Healthcare utilisation was measured by outpatient visits (including telemedical appointments) per patient-year, calculated under the assumption of a negative binomial distribution.

To identify patients with comorbid mental disorders, free-text information available in the database was searched for terms related to the ICD-10 codes for relevant mental disorders as documented in the DPV registry. Additionally, specific search terms related to pharmacological treatment of mental disorders (medication to treat ADHD (attention-deficit hyperactivity disorders) and anxiety disorders, antidepressant and antipsychotic medication) were applied. The following mental disorders were investigated: any mental disorders, ADHD, depression, anxiety disorders (including obsessive-compulsive disorder), conduct disorders, adjustment disorders, eating disorders, NSSI (non-suicidal self-injury), suicidal attempts, autism spectrum disorders, schizophrenia spectrum disorders, and borderline disorder. Substance misuse was defined as either smoking, (non-medical) cannabis consumption, or alcohol misuse (girls≥10 g, boys≥20 g per day) [18]. The incidence of a mental disorder was defined as new diagnosis in either the pre-pandemic or the pandemic observation period, and allocated to the...
corresponding observation period according to the first documentation in the DPV registry. If a patient had more than one diagnosis of a comorbid mental disorder, all diagnoses were included.

Statistical analysis

Descriptive data were presented for the whole time period and by observation period as unadjusted median with lower and upper quartile (Q1, Q3) for continuous variables and as proportion for categorical variables. Differences between sex and age groups were analysed using chi-square-tests with correction for multiple comparisons (Bonferroni–Holm method).

For comparisons of patient characteristics between pre-pandemic and pandemic cohorts linear and logistic regression models without adjustment were used. Logistic regression models adjusted for age, sex, diabetes duration, migration background, and number of medical visits were estimated to compare the incidences of mental disorders and substance misuse. As individuals may be included in both observation periods, a random effect with Toeplitz covariance structure was included to model multiple measurements per individual. Results were presented as adjusted percentages or odds ratio (OR) with 95% CI pandemic vs. pre-pandemic period for the overall cohort and additionally stratified by sex or age group. A supplementary sensitivity analysis including AID as additional confounder was conducted. Two-sided p-values less than 0.05 were considered statistically significant. All analyses were implemented with SAS (Statistical Analysis Software, SAS Institute Inc., Cary, NC, USA) Version 9.4 (build TS1M7) on a Windows Server mainframe.

Results

Among all patients registered in the DPV database, 42,975 patients were finally included in the analysis, with 31,877 observed during the pre-pandemic and 33,692 observed during the pandemic period. Details on patient selection are presented in Figure 1.

Table 1 presents demographic and clinical variables of the study population for the total time and by observation period.

Table 1.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pre-pandemic</th>
<th>Pandemic</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>12.0</td>
<td>10.5</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Sex</td>
<td>Male: 55%</td>
<td>Male: 52%</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Sex</td>
<td>Female: 45%</td>
<td>Female: 48%</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Diabetes duration</td>
<td>Median: 6.0</td>
<td>Median: 5.0</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Migration biography</td>
<td>Yes: 30%</td>
<td>Yes: 35%</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Mean HbA1c</td>
<td>7.5%</td>
<td>7.0%</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>BMI-SDS</td>
<td>Median: 25.0</td>
<td>Median: 24.5</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Use of diabetes technology</td>
<td>Yes: 50%</td>
<td>Yes: 60%</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Number of outpatient visits</td>
<td>Median: 7.0</td>
<td>Median: 6.0</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Of the 2,820 newly diagnosed mental disorders, 73.6% were allocated to patients documented with one disorder (n=2,074), 19.3% (n=545) to patients with two disorders, and 7.1% (n=201) to patients with three or more disorders. Considerable age- and sex differences between the various mental disorders were present. Incidences of mental disorders were more common in female patients and adolescents. Only newly diagnosed conduct disorders, ADHD, and autism spectrum disorders were more common in boys, and newly diagnosed ADHD was more common in younger children. Substance misuse was more often newly diagnosed in boys and adolescents.

Table 3 presents the incidences of comorbid mental disorders and substance misuse prior to and during the
COVID-19 pandemic adjusted for age group, sex, migration biography, diabetes duration, and number of outpatient visits, and the OR of the total cohort and stratified by sex and age-group. The adjusted analyses displayed no differences in the rates of newly diagnosed mental disorders during the pandemic period compared to the pre-pandemic period in the overall cohort, except for an increase in newly diagnosed NSSI during the pandemic period, which was mainly due to changes in the groups of female patients (p<0.01) and adolescents (p<0.05). Substance misuse decreased overall during the pandemic.

The OR in Table 3 revealed opposite developments between male and female patients during the pandemic. The incidence of overall mental disorders increased significantly in girls (p<0.01), but not in boys. Girls (p<0.01)
and adolescents (p<0.05) displayed increased incidence rates of depression. An increase of newly diagnosed suicidal attempts was also seen among girls (p<0.05) during the pandemic. Adjustment disorders decreased in boys (p<0.05), substance misuse decreased in both sexes (girls p=0.01, boys p=0.001).

An additional sensitivity analysis including AID as confounder did not alter the main results of this primary analysis. All clearly significant or not significant effects were observed with and without adjustment for AID. Only some results that previously bordered on the significance limit of p=0.05 were no longer significant (increased incidences of depression in adolescents, decreased incidences of adjustment disorders in boys during the pandemic), and the significance of the increase of suicidal attempts shifted from girls to the overall cohort.

Additionally, subgroup analyses were conducted for boys<12 years concerning ADHD, girls<12 years concerning depressive disorders, eating disorders, NSSI, and suicidal attempts, and boys<12 years concerning substance misuse. Table 4 displays the results of the subgroup-analyses.

We found no differences in the incidences during the pandemic compared to the pre-pandemic period in male children with regard to ADHD, and female adolescents with regard to suicidal attempts. Adolescent girls showed higher incidence rates of depressive disorders, eating disorders,

| Table 3: Newly diagnosed mental disorders prior to and during the COVID-19 pandemic. |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                                  | Pre-pandemica  | Pandemicb       | Overall cohort  | Girls           | Boys            | Children        | Adolescents     |
|                                  | Mean (95 % CI) | Mean (95 % CI)  | OR (95 % CI)   | OR (95 % CI)    | OR (95 % CI)    | OR (95 % CI)    | OR (95 % CI)    |
| Any mental disorder             | 4.11 (2.71–6.59)| 4.29 (2.87–6.78)| 1.19 (1.05–1.36)| 0.93 (0.81–1.08)| 1.08 (0.95–1.23)| 1.03 (0.90–1.20)| 1.03 (0.90–1.20)|
| Depression                      | 1.57 (0.99–2.36)| 1.72 (1.09–2.53)| 1.24 (1.07–1.46)| 0.93 (0.79–1.11)| 0.87 (0.76–1.02)| 1.15 (1.01–1.30)|
| ADHD                            | 1.18 (0.74–2.03)| 1.14 (0.74–1.73)| 1.03 (0.80–1.34)| 0.94 (0.81–1.11)| 1.05 (0.86–1.27)| 0.91 (0.73–1.14)|
| Anxiety disorders               | 0.68 (0.41–1.14)| 0.77 (0.49–1.19)| 1.14 (0.91–1.44)| 1.14 (0.88–1.48)| 1.03 (0.79–1.31)| 1.26 (0.96–1.51)|
| Eating disorders                | 0.18 (0.03–1.17)| 0.23 (0.14–1.16)| 1.30 (0.98–1.69)| 1.30 (0.97–1.61)| 1.23 (0.86–1.66)| 0.79 (0.54–1.18)|
| Conduct disorders               | 0.24 (0.12–0.48)| 0.22 (0.11–0.44)| 1.02 (0.62–1.66)| 0.85 (0.58–1.29)| 1.11 (0.71–1.74)| 0.79 (0.53–1.18)|
| Adjustment disorders            | 0.29 (0.16–0.54)| 0.23 (0.13–0.41)| 0.92 (0.64–1.34)| 0.66 (0.44–0.88)| 0.76 (0.43–1.35)| 0.79 (0.58–1.07)|
| NSSI                            | 0.06 (0.02–0.29)| 0.10 (0.05–0.19)| 2.15 (1.15–3.94)| 1.69 (1.10–5.18)|
| Suicidal attempt                | 0.09 (0.03–0.32)| 0.13 (0.07–0.3) | 0.08 (0.05–0.28)| 0.14 (0.09–0.22)|
| Autism spectrum disorders       | 0.18 (0.06–0.60)| 0.21 (0.09–0.78)| 0.68 (0.41–1.29)| 0.67 (0.40–1.16)|
| Antipsychotic medication        | 0.21 (0.09–0.84)| 0.28 (0.12–0.90)| 1.42 (0.98–1.89)| 1.44 (0.92–2.23)|
| Substance misuse                | 3.16 (1.81–5.38)| 2.57 (1.74–3.79)| 0.82 (0.71–0.89)| 0.82 (0.71–0.89)|

*p<0.05; †logistic regression models adjusted for age-group, sex, migration biography, diabetes duration, and number of medical visits; ‡OR, odds-ratios in the pandemic period compared to the pre-pandemic period; §Insufficient number of cases for analysis. Bold values indicate statistical significance.

Table 4: Subgroup analyses for adolescent girls, younger boys, and adolescent boys.

<table>
<thead>
<tr>
<th>Comorbid mental disorders %</th>
<th>Pre-pandemic perioda</th>
<th>Pandemic perioda</th>
<th>p-Valuea</th>
<th>Odds-ratio</th>
<th>OR (95 % CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adolescent girls 13–18 years</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depression</td>
<td>3.24 (2.88–3.65)</td>
<td>4.03 (3.63–4.48)</td>
<td>0.006</td>
<td>1.25</td>
<td>(1.07–1.47)</td>
</tr>
<tr>
<td>Eating disorders</td>
<td>0.78 (0.61–0.99)</td>
<td>1.07 (0.88–1.31)</td>
<td>0.042</td>
<td>1.38</td>
<td>(1.01–1.89)</td>
</tr>
<tr>
<td>NSSI</td>
<td>0.32 (0.22–0.45)</td>
<td>0.60 (0.46–0.78)</td>
<td>0.004</td>
<td>1.91</td>
<td>(1.23–2.95)</td>
</tr>
<tr>
<td>Suicidal attempt</td>
<td>0.29 (0.20–0.43)</td>
<td>0.43 (0.31–0.59)</td>
<td>0.122</td>
<td>1.46</td>
<td>(0.90–2.36)</td>
</tr>
<tr>
<td>Younger boys 6–12 years</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AHD</td>
<td>2.92 (2.54–3.36)</td>
<td>2.84 (2.48–3.25)</td>
<td>0.770</td>
<td>0.97</td>
<td>(0.80–1.18)</td>
</tr>
<tr>
<td>Adolescent boys 13–18 years</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Substance misuse</td>
<td>6.89 (6.37–7.44)</td>
<td>5.32 (4.86–5.81)</td>
<td>&lt;0.0001</td>
<td>0.76</td>
<td>(0.67–0.86)</td>
</tr>
</tbody>
</table>

*p<0.05; †from logistic regression models adjusted for migration biography, diabetes duration, and number of medical visits. Bold values indicate statistical significance.
and NSSI in the pandemic compared to the pre-pandemic observation period. The number of newly diagnosed substance misuse decreased substantially in male adolescents during the pandemic.

**Discussion**

In our cohort of children and adolescents with T1D, we found a significant increase of newly diagnosed overall mental disorders in girls, but not in boys and not in the overall study population. This increase was most pronounced in adolescent girls, who also displayed higher rates of newly diagnosed depression, eating disorders, and self-harm. Substance misuse declined substantially in both sexes during the pandemic.

**Comorbid mental disorders**

Population-based surveys on the COVID-19 pandemic and mental disorder diagnoses showed mixed results. Contrary to our study, a population-based registry study on Danish young people reported an increase in the overall incidence rate of psychiatric diagnoses and newly diagnosed anxiety disorders during the COVID-19 pandemic, while, as in our study, the incidence of depression disorders remained unchanged [8]. A survey of a German health insurance company (DAK) based on data from 780,000 children and adolescents also reported an increase in newly diagnosed mental disorders compared to pre-pandemic data [19]. In accordance with both surveys, the use of antipsychotic medication remained unchanged in our cohort. Both surveys and two reviews also reported an increase in newly diagnosed ADHD during the COVID-19 pandemic [8, 19–21]. Contrary to these results, we found no differences between pandemic and pre-pandemic incidence rates regarding ADHD.

There were few studies on the impact of the COVID-19 pandemic on the mental health of children and adolescents with T1D. They focused mainly on depressive and anxiety symptoms and reported mixed results: a higher prevalence of depression and anxiety symptoms during the pandemic [22–24], lower depression scores [25], or no significant change in depression scores during the first year of the pandemic [26]. Recently, first results of the KICK-COVID-Study [27], a prospective multicentre cohort study based on data from the DPV registry, reported a negative impact of the pandemic on the psychological wellbeing of adolescents with T1D, while anxiety- and depression scores were not different from pre-pandemic data [28].

Our findings align with the latter result, though it has to be considered that these studies were questionnaire-driven and did not focus on confirmed mental disorder diagnoses.

**Impact of the pandemic: not always negative**

Although children and adolescents with T1D are a vulnerable group with regard to mental health problems, the COVID-19 pandemic and the related lockdown did not generally increase mental comorbidities in our total cohort.

This could be due to special conditions for diabetes management during the pandemic. Some studies discussed certain possibly positive effects of the pandemic, such as increased time at home with more time for family meals and less time in environments that may impact consistent diabetes management, e.g. school, sports, and social gatherings [11, 12]. Spending more time at home may have made it easier for children to follow diabetes management rules and avoid school-related distress [29]. Positive effects on diabetes management and metabolic control [16, 30] may have compensated potentially harmful effects of reduced social contact during the lockdown. Parental support may have buffered possible adverse effects of the pandemic, and adolescents dealing with diabetes may have developed resilience that may help them cope with the additional stress of a pandemic [31]. Also, for most young patients with T1D, a healthcare system offering interdisciplinary care which was familiar to them remained available during the pandemic. Thus, there may have been easier access to medical and psychological treatment if it deemed necessary compared to children and adolescents without a chronic condition [32].

It is well known that the prevalence of mental disorder diagnoses is strongly dependent on age and sex [33]. Adolescent girls with T1D are a known risk group for reporting mood disorders and self-harm [34]. Our results additionally showed an age- and sex-specific impact of the pandemic: girls, but not boys, displayed a higher overall rate of newly diagnosed mental disorders in the pandemic. The negative impact of the pandemic was most pronounced in adolescent girls, who also showed a significant increase in newly diagnosed depression, eating disorders, and NSSI. Some studies similarly reported girls to be at higher risk for depressive episodes, anxiety disorders, and psychosomatic complaints during the pandemic, and the opposite effects on girls and boys were also described [7, 19, 35]. The increase in the incidence of eating disorders during the pandemic specifically among female adolescents [36–38] has been well documented.

The COVID-19 pandemic may have been particularly challenging for girls. It is possible that girls, especially adolescents, depended to a higher degree on the intimacy and
the emotional support of face-to-face relationships [39]. Thus, they may have been more negatively affected by the social distancing measures and therefore at higher risk for developing mental disorders. Social media and smartphones have been important for children and adolescents to maintain communication during the pandemic. The increased use of social media might, however, have been also a risk factor for girls, as it intensified their comparisons and competition. Girls also were at greater risk of being electronically bullied than boys [39] during the pandemic.

**Substance misuse**

Substance misuse in young people is a significant public health problem. For those with T1D, substance use is especially unfavourable, increasing the probability of acute and long term diabetes complications [18].

An NIH study reported that substance misuse among young adolescents remained overall stable during the COVID-19 pandemic [40]. A systematic review showed an overall reduction in the prevalence of youth alcohol, cannabis, and tobacco use during the pandemic [41]. In accordance with this study, we found a declining incidence rate of substance use in the pandemic observation period in the total cohort as well as in the subgroup of male adolescents – a known high-risk group for substance abuse [42, 43]. The reduced substance use was probably due to limited contact with peers, decreased availability and access to substances, and increased time spent at home with parents [41]. Extensive media consumption, which may be less frequent in children with T1D compared to healthy children during the pandemic [44], could not be investigated based on our data.

**Strengths and limitations**

Besides age- and sex differences between the various mental disorders, some demographic and clinical variables in our study may have worked as confounders, e.g. the number of medical visits, which declined during the pandemic. This problem affects many studies that used routine data rather than a specifically designed study sample to investigate the effect of the pandemic [10, 19]. Adjustments for confounders, especially the number of medical visits, can be considered as strengths of the study, as well as a supplementary sensitivity analysis with AID as additional confounder. A further strength of our study was the large multicentre database of the DPV registry, which covers more than 90% of paediatric patients with T1D in Germany.

The main limitation of the study was the likely underreporting of mental disorders in the DPV database. Mental disorders may remain undiagnosed in routine diabetes care [14]. The documentation of a mental health diagnosis may be made with caution to avoid stigmatisation in young patients, especially if they present with mild symptoms and in times of enhanced strain such as the pandemic. Diabetes centres generally differ in the scope and routine in which mental disorders are documented, and often these depend solely on parental information [45]. Therefore, the analyses were based on a search for specific terms characterising the respective disorder or prescribed medication, as DSM IV or ICD-10 codes were not always available.

It is well known that the consequences of the pandemic did not affect all children and adolescents equally. While we were able to adjust statistically for some demographic and clinical variables, and identify adolescent girls as a particular risk group, other well-known risk factors such as e.g. socioeconomic status or restricted living space, as well as protective factors, could not be considered.

**Conclusions**

We found a significant increase of newly diagnosed overall mental disorders in girls, but not in boys and not in the overall study population of children and adolescents with T1D during the COVID-19 pandemic. Specifically adolescent girls developed depression, eating disorders, and self-harm more often during the pandemic compared to the pre-pandemic period. Substance misuse declined during the pandemic in both sexes. Comprehensive care for children with chronic somatic conditions has to include mental health consequences, especially during times of increased strain, as exemplified by the COVID-19 pandemic.


Research ethics: Analysis of the anonymised data within the DPV initiative has been approved by the Ethics Committee of the University of Ulm, Germany (approval number: 314/21).

Informed consent: Not applicable.

Author contributions: Esther Müller-Godeffroy designed the research analysis, wrote, edited, and reviewed the manuscript. Stefanie Schmid designed the research analysis,
performed the research, contributed to the discussion, and reviewed the manuscript. Christina Reinauer, Angela Galler, Dörte Hilgard, Louise Marshall, Eggert Lilienthal, Thomas Kapellen, Kirsten Mønkemøller, Burkhard Brosig, Christine Prchla contributed to the discussion and reviewed the manuscript, Reinhard W. Holl designed the research, contributed to the discussion, and reviewed the manuscript, he coordinates the DPV initiative. All authors have read and approved the manuscript.

Competing interests: The authors state no conflict of interest.

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Data availability: Not applicable.

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