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PSYCHOLOGICAL ASPECTS OF DIABETES

Psychological care in children and adolescents with type 1 diabetes in a real-world setting and associations with metabolic control

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Abstract

Background: International guidelines recommend psychosocial care for children and adolescents with type 1 diabetes.

Objective: To assess psychological care in children and adolescents with type 1 diabetes in a real-world setting and to evaluate associations with metabolic outcome.

Methods: Delivery of psychological care, HbA1c, and rates of severe hypoglycemia and diabetic ketoacidosis (DKA) in children and adolescents with type 1 diabetes from 199 diabetes care centers participating in the German diabetes survey (DPV) were analyzed.

Results: Overall, 12 326 out of 31 861 children with type 1 diabetes were supported by short-term or continued psychological care (CPC). Children with psychological care had higher HbA1c (8.0% vs 7.7%, $P<.001$) and higher rates of DKA (0.032 vs 0.021 per patient-year, $P<.001$) compared with children without psychological care. In age-, sex-, diabetes duration-, and migratory background-matched children, HbA1c stayed stable in children supported by CPC during follow-up (HbA1c 8.5% one year before psychological care started vs 8.4% after two years, $P = 1.0$), whereas HbA1c was lower but increased significantly by 0.3% in children without psychological care

(HbA1c 7.5% vs 7.8% after two years, P <.001). Additional HbA1c-matching showed that the change in HbA1c during follow-up was not different between the groups, but the percentage of children with severe hypoglycemia decreased from 16.3% to 10.7% in children receiving CPC compared with children without psychological care (5.5% to 5.8%, P =.009).

Conclusions: In this real-world setting, psychological care was provided to children with higher HbA1c levels. CPC was associated with stable glycemic control and less frequent severe hypoglycemia during follow-up.

KEYWORDS

adolescent, child, clinical, diabetes mellitus, type 1, HbA1c, psychology

1 | INTRODUCTION

Children and adolescents with type 1 diabetes appear to have more psychological distress and a higher risk of emotional problems and psychiatric disorders compared with children and adolescents without diabetes.[1-4] In particular, prevalence rates of depression, anxiety, and eating disorders are elevated in youth with type 1 diabetes.[1-4] Psychosocial problems and psychiatric disorders can interfere with treatment performance and adherence in type 1 diabetes and are often associated with poor glycemic control and an increased rate of diabetic ketoacidosis (DKA).[5-15] More diabetes-related hospital admissions are reported in children and adolescents with psychosocial problems or psychiatric disorders.[5,11,13] Therefore, the international consensus guidelines recommend easy accessibility of psychosocial care for children and adolescents with type 1 diabetes and their families.[4]

Psycho-educational and behavioral intervention studies show positive effects of psychological care on well-being and metabolic parameters.[16-21] Psychological or psychiatric interventions are either single interventions or part of a combined psycho-social-educational intervention.[4,15] Many psychosocial and behavioral interventions studied in pediatric and adolescent type 1 diabetes are family-centered and involve caregivers and the family.[4] In 2006, Winkley et al published a meta-analysis including 10 studies with children and adolescents[19]: The authors conclude that psychological interventions result in improved glycemic control.[19] Furthermore, some intervention studies illustrate reduced frequency of acute adverse events; for example, DKA and hospital admissions in children and adolescents with type 1 diabetes after psychological interventions.[17,22]

However, not all intervention studies demonstrate consistent results, and several studies fail to show improvement of glycemic control.[23,24] In 2015, in their meta-analysis, Pillay et al concluded that behavioral interventions result only in a short-term benefit in respect to glycemic control.[23] The authors emphasize that all studies had medium or high risk of bias and that there are few data for other outcomes.[23] The recent meta-analysis by Charalamopoulos et al from 2017, comprising nine UK-based trials for children and young people with type 1 diabetes, reveals that psycho-educational interventions result in a non-significant reduction of HbA1c levels.[24]

Considering the inconclusive data about psycho-educational interventions and the presumed positive effect of psychological care on glycemic control, rate of DKA, and hospital admissions, we see a need to examine the outcome of psychological care in a real-world-setting. A survey, assessing the implementation of psychosocial and behavioral intervention in diabetes care centers in clinical practice in different countries, shows that more than 70% of teams have "easy access" to a mental health specialist.[25] Almost 80% of teams offer psychosocial behavioral interventions to children and adolescents with type 1 diabetes.[25] However, at present and to our knowledge, characteristics and outcome of psychological care for children and adolescents with type 1 diabetes in a real-world setting have not yet been published. Therefore, our aim was to investigate and describe both provision of psychological care and associations between psychological care and outcome parameters in routine clinical care. We set out to analyze clinical and metabolic data, glycemic control, and rates of acute diabetic complications like DKA and severe hypoglycemia during follow-up of children and adolescents with type 1 diabetes receiving psychological or psychiatric care in a real-world setting.

2 | METHODS

Demographic, clinical, and laboratory diabetes-related data of children and adolescents with type 1 diabetes were recorded in 416 diabetes care centers in Germany within the prospective diabetes survey (DPV). Data were derived from physicians, health care professionals, and medical charts, and recorded electronically. Each diabetes care center recorded diabetes-related data on all individuals across all age ranges at their center and transferred the anonymous data records electronically to Ulm University annually or biannually. At Ulm University, the data underwent plausibility check, and revision of the electronic records was done by each center. The Ethics Committee of Ulm University approved data collection and anonymous analysis. Overall, 41 229 children and adolescents with type 1 diabetes up to the age of

18 years with diabetes duration of more than one year were registered in the survey from 2009 to 2017.

Participation of the diabetes care center in the present analysis exploring psychological care was voluntary. Of the 416 diabetes care centers, 199 centers participated and provided data about psychological care within the survey. The characteristics of the population from the participating diabetes care centers (study population, n = 31 861) and from the non-participating centers (n = 9 368) are depicted in Appendix. Delivery of psychological treatment, given to the child, adolescent or the parents, was assessed differentiating two types of psychological care: Short-term psychological care (SPC), that is, psychodiagnostic assessment and short-term or single-session psychological counseling, and continued psychological care (CPC), that is, psychotherapy or other ongoing psychological or psychiatric care. Biannual quality circle meetings took place with the objective to assure quality criteria standards with respect to the type of psychological care and psychiatric diagnosis according to ICD-10 GM classification.

Parameters age, sex, migratory background, diabetes duration, body mass index SD score (BMI SDS), treatment strategy (multiple daily injections or insulin pump treatment), insulin dose, HbA1c, rates of severe hypoglycemia and DKA, and frequencies of microalbuminuria, retinopathy, and hospital admission were analyzed. Migratory background was defined as the place of birth of the patient or one or both parents in a country other than Germany. BMI SDS was calculated using the national KIGGS (German Health Interview and Examination Survey for Children and Adolescents) reference data in Germany.[26] HbA1c values were measured in local diabetes care centers. HbA1c levels were mathematically standardized to the Diabetes Control and Complications Trial (DCCT) reference range of 4.05% to 6.05% (21-43 mmol/mol) using the multiple of the mean method.[27] Median HbA1c during one year for each subject was calculated. Screening for retinopathy and microalbuminuria was done according to guidelines of the International Society for Pediatric and Adolescent Diabetes (ISPAD).[28] Number of severe hypoglycemia (hypoglycemia with loss of consciousness or seizure or requiring assistance from another person to actively administer carbohydrates, glucagon, or intravenous glucose according to the guidelines of ISPAD[29]), episodes of DKA (with pH < 7.30, as defined according to the guidelines of ISPAD[30]), and the number of hospital admissions were recorded. Rates of severe hypoglycemia, DKA, and hospital admission were estimated over the time period of one year and presented as per patient-year.

2.1 | Statistical analysis

We used SAS 9.4 statistic software for data evaluation and statistical analysis (SAS Institute, Cary, North Carolina). Data are presented as median, lower and upper quartiles or as mean and SD. Rates of severe hypoglycemia, DKA, and hospital admission are presented as event rates per patient-year. Wilcoxon test was performed to compare age, diabetes duration, BMI SDS, insulin dose, and HbA1c in subjects with or without psychological care. χ^2 test was used to compare sex, migratory background, use of insulin pump treatment, and the percentage of children with HbA1c ≥ 9.0% between groups. Negative binomial regression and Poisson model were applied to compare rates of severe hypoglycemia, DKA, and hospital admission. Holm-Bonferroni method was applied to approach the problem of multiple testing. The most recent available data during the time period 2009 until 2017 was used for presenting the characteristics of all children and adolescents with and without psychological care.

For longitudinal and comparative analysis of children with CPC and without psychological care, propensity-score matching was used to ensure that both groups had similar baseline characteristics.[31,32] A 1:5 case:control (case = CPC, control = without psychological care) propensity-score matching (greedy-matching algorithm) with the parameters age, sex, diabetes duration, and migratory background was conducted. The matched groups consisted of 335 children with CPC (cases) and 1675 children without psychological care (control). Clinical parameters and outcome of matched children with CPC and without psychological care were compared at baseline (ie, before CPC started) and after follow-up time of two years. Figure 1 depicts the time points baseline and follow-up with respect to the start of CPC within the timeline. In case children had CPC several times during the 8-year time period (ie, with breaks in between), we used the first CPC for analysis. Paired *t* test was used for continuous parameters, McNemar test for parameters with the binomial distribution. Holm-Bonferroni method was applied for multiple testing. Wilcoxon test was applied for comparison of change of HbA1c and percentages of severe hypoglycemia and DKA during follow-up. Additional propensity-score matching was conducted, by adding HbA1c as a covariate into the matching in order to compare children with similar HbA1c levels: The 1:5 case:control (case = CPC, control = without psychological care) propensity-score matching (greedy-matching algorithm) with the parameters age, sex, diabetes duration, migratory background, and HbA1c encountered 270 children with CPC (cases) and 1350 children without psychological care (control). Parameters of matched children with CPC and without psychological care were compared likewise as

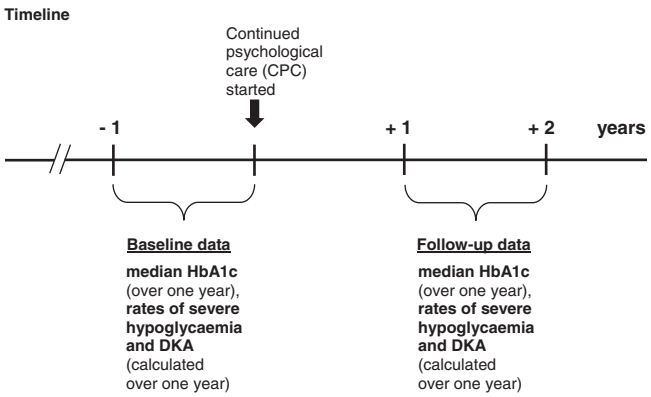

FIGURE 1 Baseline and follow-up time points with data collection (median HbA1c, rates of severe hypoglycemia and diabetic ketoacidosis [DKA]) are depicted with respect to the start of continued psychological care (CPC) within the timeline

described at baseline (ie, before CPC started) and after follow-up-time of two years. Statistical two-sided significance was assumed at *P* values of <.05.

3 | RESULTS

Overall, out of 31 861 children and adolescents with type 1 diabetes, 12 326 (39%) children and adolescents received psychological care. Characteristics of children and adolescents with type 1 diabetes with and without psychological care are given in Table 1: Comparing children and adolescents with and without psychological care showed, among others, that children supported by psychological care had significantly worse metabolic control and the rate of DKA was significantly higher compared to children without psychological care. Rates of severe hypoglycemia did not differ. Furthermore, children with psychological care were younger and the percentage of females was slightly higher in the group of children with psychological care (see Table 1). In 2 125 children and adolescents with psychological care, information about psychiatric diagnoses was available. The most frequently reported diagnoses were attention deficit hyperactivity disorder (40%), depression (30%), anxiety disorders (16%), and eating disorders (10%).

Details about the type of psychological care were available in 3 260 children and adolescents with type 1 diabetes and are shown in Figure 2: 65% of children and adolescents received only SPC, 11% of children were supported by CPC, and 24% had both, SPC and CPC, over the period of one year. Out of all children with CPC, either alone or combined with SPC, 85% had psychotherapy and 15% had other ongoing psychological or psychiatric care (see Figure 2).

In order to analyze associations between psychological care and outcome parameters, matching based on age, sex, diabetes duration, and migratory background was conducted. Results, comparing matched children and adolescents with type 1 diabetes with CPC and without psychological care at baseline, that is, before CPC started, and after follow-up time of two years, are given in Table 2. HbA1c levels increased significantly by 0.3% in children and adolescents not receiving psychological care during follow-up (median HbA1c 7.5% vs 7.8% after two years, *P* <.001, see Table 2). In contrast, in children supported by CPC, HbA1c levels were higher at baseline, that is, before CPC started, but stayed stable during follow-up time (median HbA1c 8.5% before psychological care started vs 8.4% after two years, *P* = 1.0, see Table 2). In the group of children with CPC, the percentage of children with severe hypoglycemia fell by 5.3% during follow-up (from 14.9% at baseline to 9.6% after two years), which was significantly different from the change in the group of children without psychological care (percentage of severe hypoglycemia 5.8% at baseline vs 6.1% after two years, (see Table 2).

Because the group of children with CPC had significantly higher HbA1c levels before psychological care was started, additional

TABLE 1 Characteristics of the children and adolescents with type 1 diabetes with and without psychological care

	Total	Without psychological care	With psychological care	*P*-value
Number	31 861 (100%)	19 535 (61%)	12 326 (39%)	—
Age (y)[a]	15.3 (11.8; 17.5)	**15.7 (12.0; 17.6)**	**14.8 (11.5; 17.1)**	**<.001**[b]
Sex ratio (male/female)	52%/48%	**54%/46%**	**50%/50%**	**<.001**[c]
Migratory background	20%	**19%**	**22%**	**<.001**[c]
Age at diabetes onset (y)[a]	8.0 (4.6; 11.4)	8.0 (4.5; 11.4)	8.0 (4.8; 11.3)	.88[b]
Diabetes duration (y)[a]	5.4 (2.9; 8.8)	**5.7 (3.0; 9.1)**	**5.1 (2.8; 8.2)**	**<.001**[b]
BMI SDS[d]	+0.32 ± 0.90	**+0.31 ± 0.89**	**+0.34 ± 0.92**	**.02**[b]
Insulin dose (IU/kg)[a]	0.86 (0.69; 1.07)	**0.85 (0.69; 1.05)**	**0.87 (0.68; 1.06)**	**<.001**[b]
Insulin pump treatment	49%	**47%**	**53%**	**<.001**[c]
HbA1c (%)[a]	7.8 (7.1; 8.8)	**7.7 (7.0; 8.7)**	**8.0 (7.2; 9.1)**	**<.001**[b]
HbA1c ≥ 9.0%	22%	**19%**	**26%**	**<.001**[c]
Microalbuminuria	8.3%	8.8%	7.7%	.05[c]
Retinopathy	0.8%	0.8%	0.8%	.91[c]
Rate of severe hypoglycemia (per patient-year)[e]	0.132 (0.005)	0.140 (0.007)	0.121 (0.007)	.09[f]
Rate of episodes of DKA (per patient-year)[e]	0.025 (0.001)	**0.021 (0.001)**	**0.032 (0.002)**	**<.001**[f]
Hospital admission rate (per patient-year)[e]	0.526 (0.005)	**0.437 (0.006)**	**0.660 (0.009)**	**<.001**[g]

Abbreviations: BMI, body mass index; DKA, diabetic ketoacidosis.

Note: The most recent available data during the time period 2009 until 2017 was used. Bold values: *P* < .05.

[a]Data expressed as median (lower quartile and upper quartile).

[b]Wilcoxon-test (without vs with psychological care), adjusted for multiple testing by Holm-Bonferroni method.

[c]χ^2 test (without vs with psychological care), adjusted for multiple testing by Holm-Bonferroni method.

[d]Data expressed as mean ± SD.

[e]Data expressed as per patient-year (confidence interval range).

[f]Negative binomial regression (without vs with psychological care), adjusted for multiple testing by Holm-Bonferroni method.

[g]Poisson model (without vs with psychological care), adjusted for multiple testing by Holm-Bonferroni method.

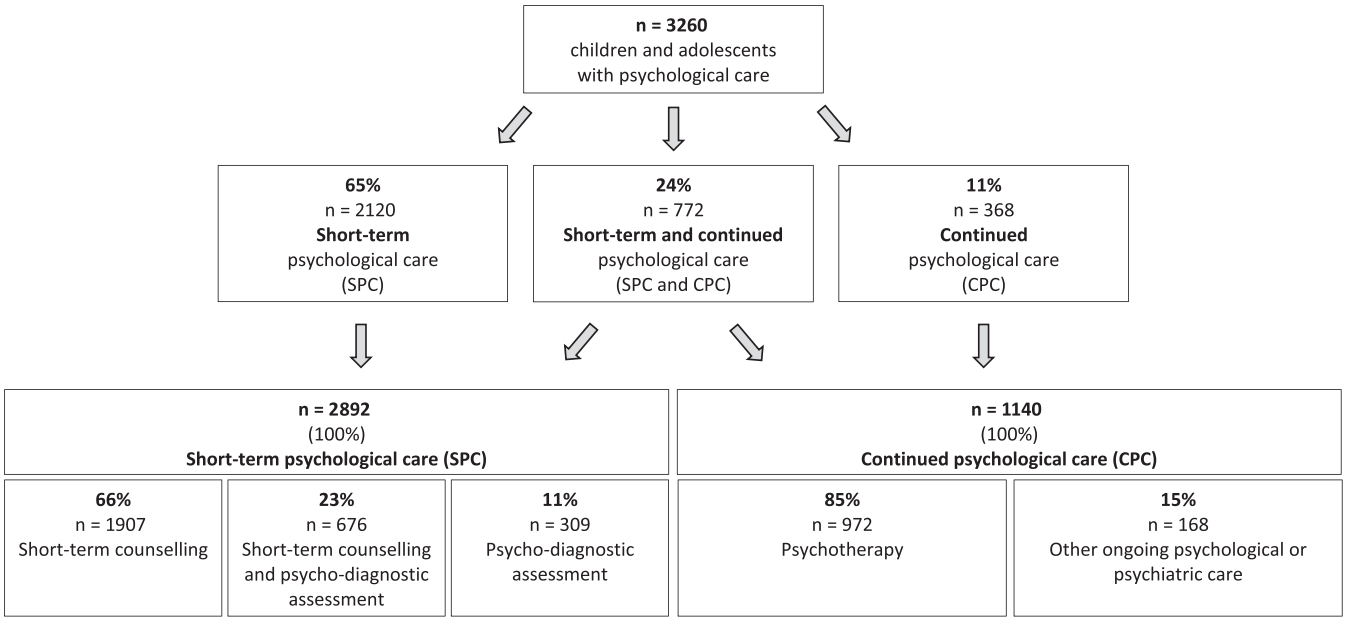

FIGURE 2 Details about the type of psychological care were available in 3 260 children and adolescents with type 1 diabetes

TABLE 2 Characteristics of age-, sex-, diabetes duration-, and migratory background-matched children and adolescents with type 1 diabetes with continued psychological care (CPC) and without psychological care at baseline and after follow-up time of two years

	Without psychological care (n = 1675)			With continued psychological care (CPC) (n = 335)			
	Baseline	Follow-up	*P*-value (baseline vs follow-up)	baseline (1 year before CPC started)	follow-up	*P*-value (baseline vs follow-up)	*P*-value (without psychological care vs with CPC)
Age (y)[a]	13.0 (10.6; 15.0)	15.0 (12.7; 17.1)	–	13.2 (11.0; 15.0)	15.0 (12.8; 16.7)	–	–
Sex ratio (male/female)	52%/48%		–	52%/48%		–	–
Migratory background	28%		–	26%		–	–
Diabetes duration (y)[a]	5.5 (3.1; 7.9)	7.6 (5.2; 10.0)	–	5.6 (3.4; 8.1)	7.4 (5.1; 10.1)	–	–
BMI SDS[b]	+0.29 ± 0.83	+0.32 ± 0.86	–	+0.35 ± 0.88	+0.39 ± 0.97	–	–
Insulin pump treatment	52%	57%	–	61%	67%	–	–
HbA1c (%)[a]	**7.5 (6.9; 8.3)**	**7.8 (7.1; 8.6)**	**<.001**[c]	8.5 (7.6; 9.7)	8.4 (7.6; 9.7)	1.0[c]	–
Difference HbA1c (%) (baseline vs follow-up)	**+0.3**		–	**−0.1**		–	**<.001**[d]
HbA1c ≥ 9.0%	**13%**	**17%**	**<.001**[e]	38%	37%	1.0[e]	–
Severe hypoglycemia	5.8%	6.1%	1.0[e]	14.9%	9.6%	0.11[e]	–
Difference severe hypoglycemia (baseline vs follow-up)	**+0.3%**		–	**−5.3%**		–	**.005**[d]
DKA	2.0%	2.0%	1.0[e]	5.1%	4.2%	1.0[e]	–
Difference DKA (baseline vs follow-up)	±0.0%		–	−0.9%		–	0.47[d]

Abbreviations: BMI, body mass index; DKA, diabetic ketoacidosis.
Note: Bold values: $P < .05$
[a]Data expressed as median (lower quartile; upper quartile).
[b]Data expressed as mean ± SD.
[c]Paired *t* test (baseline vs follow-up), adjusted for multiple testing by Holm-Bonferroni method.
[d]Wilcoxon test (without psychological care vs with continued psychological care).
[e]McNemar test (baseline vs follow-up), adjusted for multiple testing by Holm-Bonferroni method.

TABLE 3 Characteristics of age-, sex-, diabetes duration-, migratory background-, and HbA1c-matched children and adolescents with type 1 diabetes with continued psychological care (CPC) and without psychological care at baseline and after follow-up time of two years

	Without psychological care (n = 1350)			With continued psychological care (CPC) (n = 270)			
	Baseline	Follow-up	*P*-value (baseline vs follow-up)	Baseline (1 year before CPC started)	Follow-up	*P*-value (baseline vs follow-up)	*P*-value (without psychological care vs with CPC)
Age (y)[a]	12.7 (10.1; 14.9)	14.7 (12.2; 16.9)	–	13.1 (10.4; 15.0)	14.9 (12.2; 16.9)	–	–
Sex ratio (male/female)	52%/48%		–	52%/48%		–	–
Migratory background	27%		–	23%		–	–
Diabetes duration (y)[a]	5.2 (3.0; 7.6)	7.2 (5.1; 9.8)	–	5.4 (3.1; 8.1)	7.2 (5.1; 10.0)	–	–
BMI SDS[b]	+0.35 ± 0.85	+0.39 ± 0.87	–	+0.33 ± 0.88	+0.36 ± 0.97	–	–
Insulin pump treatment	54%	59%	–	63%	69%	–	–
HbA1c (%)[a]	**8.0 (7.3; 8.9)**	**8.1 (7.4; 9.1)**	**<.001**[c]	8.1 (7.5; 9.0)	8.2 (7.4; 9.1)	.22[c]	–
Difference HbA1c (%) (baseline vs follow-up)	+0.1		–	+0.1		–	.49[d]
HbA1c ≥ 9.0%	**23%**	**26%**	**.03**[e]	26%	28%	1.0[e]	–
Severe hypoglycemia	5.5%	5.8%	1.0[e]	16.3%	10.7%	.22[e]	–
Difference severe hypoglycemia (baseline vs follow-up)	**+0.3%**		–	**−5.6%**		–	**.009**[e]
DKA	1.9%	2.0%	1.0[e]	4.8%	3.3%	1.0[e]	–
Difference DKA (baseline vs follow-up)	+0.1%		–	−1.5%		–	.26[d]

Abbreviations: BMI, body mass index; DKA, diabetic ketoacidosis.
Note: Bold values P <.05.
[a]Data are expressed as median (lower quartile; upper quartile).
[b]Data are expressed as mean ± SD.
[c]Paired *t* test (baseline vs follow-up), adjusted for multiple testing by Holm-Bonferroni method.
[d]Wilcoxon test (without psychological care vs with continued psychological care).
[e]McNemar test (baseline vs follow-up), adjusted for multiple testing by Holm-Bonferroni method.

matching analysis was conducted. HbA1c was added into the matching, facilitating comparison of children with similar age, sex, diabetes duration, migratory background, and similar glycemic control (see Table 3). During follow-up, HbA1c levels increased slightly by 0.1% in children without psychological care (*P* <.001, see Table 3). In contrast, HbA1c levels did not significantly change in children with CPC (see Table 3). The change in HbA1c during follow-up was not different between the groups (HbA1c 8.0% and 8.1% at baseline, vs 8.1% and 8.2% after two years, see Table 3). The percentage of children with severe hypoglycemia again decreased (from 16.3% at baseline to 10.7% after two years) in children supported by CPC, which was significantly different from the change in the group of children without psychological care (percentage of severe hypoglycemia 5.5% at baseline vs 5.8% after two years, see Table 3).

4 | DISCUSSION

International guidelines recommend that children and adolescents with type 1 diabetes should be managed by an interdisciplinary health care team involving psychologists, psychiatrists, and social workers.[4] The purpose of the present analysis was to characterize psychological care in a real-world setting and to examine associations with outcome parameters in pediatric and adolescent type 1 diabetes. To our knowledge, the present publication is the first one to publish data about patient-centered provision of psychological care in pediatric type 1 diabetes in a real-world setting in a large number of patients and diabetes care centers. In this survey, which included 199 diabetes care centers in Germany from 2009 until 2017, almost 40% of children and adolescents with type 1 diabetes and their families had been supported by psychological care. Most children, adolescents and their families had short-term psychological care or assessment. Notably, about a third was supported by continued psychological care. However, 60% of children and adolescents and their families did not receive psychological care at all.

There are a number of reasons why these children and their families were not supported by psychological care. Possibly, there was no need or no indication for psychological care from the point of view of the treating physician or health care team. Interestingly, in our survey, children and adolescents with CPC had higher HbA1c levels before psychological care started compared to those without psychological care. Moreover, the rate of DKA was significantly higher in children with psychological care. Probably, the treating pediatrician and health care team felt that psychological care was a particular requisite in

children and adolescents with episodes of DKA.[15,25] Second, neither the child, the adolescent, nor the parents probably saw any need of psychological care. Barriers, for instance, refusal of psychological care by the child or the family, precluded implementation of psychological care. Stigma, especially about emotional and psychiatric disorders, is negatively associated with help seeking and may lead to refusal of psychological help.[33-35] Finally, institutional circumstances could have been the cause why psychological care was not offered or given to the child and the family. In Europe, 24% of diabetes care centers do not have access to a mental health care specialist and making referrals to psychological care outside the diabetes care center may be difficult.[25] The mental health care specialist, either a psychologist, psychotherapist, or psychiatrist, can be a member or affiliate of the diabetes care center or an outside provider.[4,15] Although many diabetes care centers have access to mental health specialists, it may not be possible for the individual family to make use of the offer of psychological care because of different time frames or not easily accessible facilities.[15,25]

In the present analysis, glycemic control was worse in age- sex-, diabetes duration, and migratory background-matched children before CPC started. Up to date and to our knowledge, this result from a real-world setting has not yet been described before. Health care teams possibly recommend and initiate psychological care more often if high HbA1c levels are present, especially if access to a mental health care specialist is difficult.[15,25] Worse glycemic control may also point to psychological distress, emotional problems or underlying psychiatric disorders.[4,15] Many studies find more emotional problems and psychiatric disorders in children and adolescents with worse glycemic control.[4-15] In the present survey, we did not find improvement of glycemic control in children supported by CPC. Instead, HbA1c levels stayed stable over the time period of two years in youth receiving psychological care in this real-world-setting. Winkley and coauthors described in their meta-analysis that psychological interventions are associated with a pooled absolute reduction in HbA1c of 0.48%.[19] Other reviews and meta-analyses of psychological interventions in study settings find only minor or non-significant improvements of glycemic control.[4,23,24] Frequently, the duration of intervention studies is short.[4,19,23,24] In the meta-analysis by Winkley for instance, mean duration was 11.4 months.[19] In our analysis, we chose a follow-up time of two years, which is relatively long compared with most intervention studies, in order to examine the long-term effects. Because of this long follow-up time, we possibly did not observe the short-term improvement of HbA1c but only stable glycemic control over a longer time period. In our opinion, given the HbA1c rise in this age period,[36,37] stability of glycemic control is a positive outcome.

With respect to other outcome parameters, although the rate of DKA was significantly higher in children with psychological care, we did not find any differences between the rates of DKA in matched children with and without CPC during follow-up. It must be pointed out that the absolute numbers of episodes of DKA were relatively low in our survey; therefore, small differences might not reach significance in our analysis. Interestingly, the percentage of severe hypoglycemia in children receiving CPC decreased significantly compared with HbA1c-matched children without psychological care. Therefore, in our opinion overall outcome improved, because CPC was associated with stable glycemic control and decreased frequency of severe hypoglycemia. A probable explanation for the decreased rate of severe hypoglycemia is that in a real-world setting psychological care is often combined with educational interventions.[4,15,19,23,24] In Germany, diabetes education programs comprise educational as well as psychosocial contents. Therefore, non-psychological interventions, for instance, educational interventions and knowledge-based teachings, might have had an additional positive effect on outcome parameters, for example, the rate of severe hypoglycemia, and possibly contributed to the observed association.[4,15,19,23,24]

There are several limitations of this analysis. In this real-world survey, not all diabetes care centers within the prospective survey DPV participated and provided data about psychological care. Therefore, we were not able to rule out any bias with respect to the participating centers. However, we included data from most (ie, 77%) children and adolescents with type 1 diabetes within the survey. Furthermore, we had no information about details of psychological interventions with regard to structure or content. Psychological care and support may take place during outpatient diabetes clinic visits, as part of outpatient or in-clinic interventions, and during hospitalizations, for example, after an episode of DKA.[4,15,25] Furthermore, we were not able to report whether psychological care was delivered by a member of the interdisciplinary diabetes care team or referred to an outside mental health specialist. Psychological interventions address either the child, adolescent, or the parents or the whole family. Intervention trials include cognitive behavior therapy, counseling, and family systems therapy.[4,19,23,24] There is evidence that interventions studies focusing on family therapy improve metabolic outcome in children and adolescents with type 1 diabetes.[4,38] No information about the type of intervention or the type of psychotherapy, or whether the psychological interventions were family-centered, individual-, or group-based, was available. Moreover, no detailed data about additional educational or social interventions were available in our survey. Most intervention trials include a combination of knowledge-based and behavioral or psychosocial interventions.[4,19,23,24] Finally, we had only limited and scarce information about underlying psychiatric disorders. Possibly, recording of psychiatric disorders was limited because the families refrained from giving consent to documentation. Furthermore, families probably did not know the exact diagnosis given that psychological care was provided by a mental health specialist outside the diabetes care center. Several other register-based publications find a higher prevalence and a different distribution of psychiatric diagnoses in youth with type 1 diabetes compared to our survey.[39-41] In contrast to our analysis, these publications integrated multiple data sources in their analysis.[39-41] However, these register-based publications have not any or only very limited data about metabolic parameters like HbA1c or frequency of DKA.[39-41] Because of the scarce data about psychiatric comorbidities in our survey we refrained from analyzing associations between outcome parameters and psychological care in different subgroups of psychiatric disorders.

In summary, almost 40% of children and adolescents with type 1 diabetes were supported by psychological care. Most of them had

SPC and one-third had CPC (psychotherapy or other ongoing psychological care). Children and adolescents with type 1 diabetes supported by CPC had more episodes of DKA and worse glycemic control before psychological care started. Glycemic control stayed stable during follow-up of two years in HbA1c-matched children and adolescents with and without CPC. Frequency of severe hypoglycemia decreased in children with CPC during follow-up. Desirably, other outcome parameters of psychological care, for instance quality of life, and subgroups of children and adolescents with different psychiatric disorders should be analyzed in the future.

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AUTHOR CONTRIBUTIONS

Angela Galler designed the research analysis, performed the research, wrote, edited, and reviewed the manuscript. Dörte Hilgard designed the research analysis, contributed to the discussion, and reviewed the manuscript. Esther Bollow designed the research analysis, performed the research, and contributed to the discussion. Berthold Maier and Ralf Schiel contributed to the discussion and reviewed the manuscript. Thomas Hermann, Nicole Kretschmer, and Kirsten Mönkemöller contributed to the discussion. Reinhard W. Holl designed the research analysis, performed the research, contributed to the discussion, and reviewed the manuscript. All authors have read and approved the manuscript.

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SUPPORTING INFORMATION

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

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