

Inpatient Rehabilitation for Children and Adolescents With Diabetes in Germany Between 2006 and 2013

Descriptive study based on data from the German Statutory Pension Insurance Scheme

Authors

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ABSTRACT

Introduction In Germany, inpatient rehabilitation is a well-established additive option in the therapeutic concept for children and adolescents with diabetes. However, its contribution in pediatric diabetes care is not known exactly. Our objective was to analyze inpatient rehabilitation in pediatric diabetes over eight years in Germany.

Methods We requested secondary data from the German Statutory Pension Insurance Scheme to evaluate all completed inpatient rehabilitations for children and adolescents with diabetes (ICD-code E10-14) reimbursed by this institution between 2006 and 2013. For each type of diabetes, we analyzed the distribution of admissions by year, age-group, sex, nationality, and other documented diagnoses. All analyses were conducted via remote computing with IBM SPSS Version 24.

Results Between 2006 and 2013, 5,403 admissions to inpatient rehabilitation for 4,746 children and adolescents with diabetes were documented. For type 1 diabetes (T1D; 88.5% of admissions), the number of yearly admissions increased from 458 in 2006 to 688 in 2013 ($p = 0.013$), especially for age-group > 5-10. The increase for type 2 diabetes (T2D) was not significant. Admissions were more frequent for girls (53.6%, $p \leq 0.001$), age > 10-15 years (42.8%, $p = 0.001$), and German nationality (98.5%). Obesity (T1D: 11.1%; T2D: 87.9%) and mental disorders (T1D: 11.6%; T2D: 27.4%) were the most frequent documented diagnoses in addition to diabetes.

Conclusion This study provides a comprehensive overview of inpatient rehabilitation for children and adolescents with diabetes over many years in Germany. Until 2013, inpatient rehabilitation remained important in pediatric diabetes care, especially for children with mental disorders or obesity.

Introduction

Education is widely recognized as an essential part of diabetes management for children and adolescents with diabetes mellitus. In high-income countries, long-term pediatric diabetes care includes structured education programs, according to the International Society for Pediatric and Adolescent Diabetes guidelines [1]. In addition to general information on diabetes care, individual treatment goals are defined and disease management skills are trained. Objectives are not only self-management, but also psychosocial integration and the improvement of health-related quality of life [2].

In Germany, inpatient rehabilitation can be proposed when education offered in the framework of acute hospital and outpatient care is not sufficient or when age appropriate education programs are not available [3, 4]. Indications are both medical and psychosocial [3, 5]. At the primarily medical level, target groups are pediatric patients with insufficient metabolic control, recurrent severe hypoglycemia or ketoacidosis, comorbidities or organ complications. At the psychosocial level, the objective is to help children with school and/or family problems to cope better with the disease, and thereby to enhance participation in social activities. There is some evidence that spending a long time (generally four, sometimes six weeks) with other affected children of the same age and sharing experiences can improve self-management attitudes [6]. Furthermore, inpatient rehabilitation can be proposed for age appropriate initial education following diabetes onset, or for training of insulin pump therapy, when such education is not available in the hometown [4, 7].

Until recently, inpatient rehabilitation for pediatric patients with diabetes only existed in Germany. In Austria, the first specific inpatient rehabilitation center for children with chronic diseases, including metabolic disorders, started in 2016-2017 [8, 9]. Contrary to inpatient rehabilitation, summer camps for children with diabetes are widespread all over the world to socialize with peers and develop autonomy [6]. Most of the summer camps also include structured training with a multidisciplinary team in addition to recreational activities. However, participation to summer camps does not require an additional medical indication besides diabetes. In contrast, inpatient rehabilitation often targets children and adolescents with specific diabetes-related problems which cannot be treated on an outpatient basis, and require longer multidisciplinary care not available in the acute hospital setting [10].

Inpatient rehabilitation for pediatric patients with diabetes is well established in Germany [10]. Positive effects in self-care management, metabolic control and participation were demonstrated for the year after the rehabilitation [3]. Nevertheless, mainly single center studies are available [11]. An integrative view of inpatient rehabilitation for children and adolescents with diabetes in Germany is therefore lacking. Our objective was to analyze inpatient rehabilitation of children with diabetes between 2006 and 2013 in Germany in order to get a better understanding of its contribution to pediatric diabetes care.

Material and Methods

Study population

We requested secondary data from the German Statutory Pension Insurance Scheme and considered all admissions to inpatient rehabilitation for children and adolescents with any type of diabetes res-

imbursed by this institution during the years 2006-2013 (“Abgeschlossene Rehabilitation im Versicherungsverlauf 2006–2013. Quelle: Forschungsdatenzentrum der Rentenversicherung, FDZ-RV”). Inpatient rehabilitation for children and adolescents, as a category defined by the German Statutory Pension Insurance Scheme (“Kinderrehabilitation”), includes not only all inpatient rehabilitations of patients until the age of 18, but also those until the age of 27 in case of vocational training, voluntary work in the social or environmental sector, federal volunteer service or disability with inability to care for oneself. We selected cases if one of the five possible diagnoses in the discharge report was type 1 diabetes (T1D, coded as E10), type 2 diabetes (T2D, coded as E11) or other types of diabetes mellitus (coded as E12-14), according to ICD-10.

Statistical analysis

For each type of diabetes, we analyzed the distribution of admissions to inpatient rehabilitation by admission year, age group, sex, nationality, federal state of residence, duration of rehabilitation stay, diagnosis for rehabilitation approval, as well as the prevalence of other diagnoses documented in the discharge report in addition to diabetes.

Age was calculated as the difference between the year of the beginning of rehabilitation stay and the year of birth and was categorized into five groups (0-5, > 5-10, > 10-15, > 15-20, > 20-27 years). Duration of rehabilitation stay was given in days, whereupon admission and discharge days were considered as a half day each. Approval diagnosis was categorized by the German Statutory Pension Insurance Scheme into ten major groups: musculoskeletal disorders, circulatory system diseases, endocrine and metabolic disorders, respiratory disease (including asthma), neoplasms, genitourinary disorders, mental disorders, nervous system disorders, skin disorders, and other disorders. For each rehabilitation stay, up to five diagnoses coded according to the ICD-10 and partly pooled by the German Statutory Pension Insurance Scheme were mentioned in the discharge report. We grouped the most frequent diagnoses besides diabetes into the following categories: obesity (ICD-E65-68), mental disorders (ICD-F06-07, F10-48, F51-69, F90-99) including eating disorders (ICD-E50), respiratory infections (ICD-J00-42, J80-99), disorders of the thyroid gland (ICD-E00-07), asthma (ICD-J45-47), back pain (ICD-M40-41, M54), coeliac disease (ICD-K90-93), hypertension (ICD-I10-15), metabolic disorders, including lactose intolerance or cystic fibrosis (ICD-E70-90), infectious and parasitic diseases (ICD-A00-99, B00-09, B15-99), disease of the blood (D50-85, D87-89), and neoplasms (ICD-C00-26, C30-41, C4354, C56-58, C60-97, D00-48, D86).

The number of children with T1D in each federal state was calculated by multiplying the number of inhabitants under 15 years by federal state in 2011 (German Federal Statistical Office [12]) by the assumed uniformly distributed national prevalence of 162 per 100,000 children for T1D [13]. The prevalence of inpatient rehabilitation in each federal state was then estimated by dividing the mean number of admissions of patients per year by the number of children with T1D in each federal state.

We assessed whether the number of admissions for each type of diabetes depended on sex, on admission year or on age group using Pearson Chi²-test, and whether the prevalence of mental disorders and obesity depended on age group using Pearson Chi²-test for T1D and Fisher's exact test for T2D. The level of significance of

two-sided tests was set at $p < 0.05$. All statistical analyses were conducted via remote computing with IBM SPSS Version 24.

Results

Between 2006 and 2013, 5,403 admissions to inpatient rehabilitation for 4,746 children or adolescents with diabetes were documented. Of all patients, 11.8% were admitted two or more times to rehabilitation in the analyzed time period.

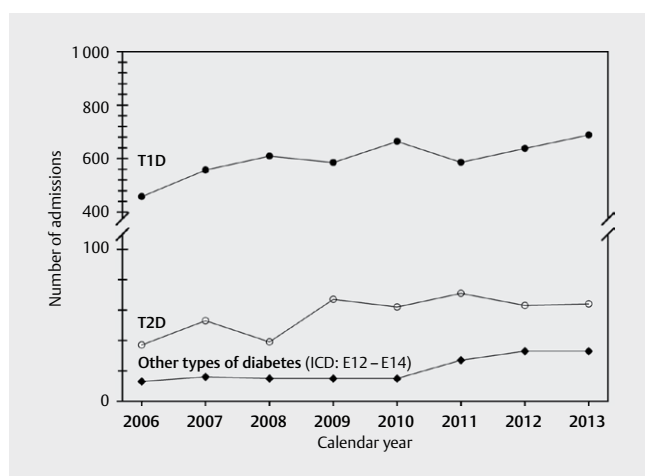
T1D was indicated in 88.5% of the discharge reports ($n = 4,785$), T2D in 8.4% ($n = 456$), and other types of diabetes in 3.1% ($n = 167$) (clear assignment was not possible in five cases because of double documentation). Median duration of rehabilitation stay was higher for T2D (42 days) than for all other types of diabetes (28 days).

As indicated in ► **Fig. 1**, the number of admissions to inpatient rehabilitation increased between 2006 and 2013 for all types of diabetes, particularly for patients with T1D (from 458 in 2006 to 688 in 2013, $p = 0.013$), and for patients with other types of diabetes ($p = 0.019$). For patients with T2D, the number of admissions did not increase significantly ($p = 0.09$). Relative frequencies of admissions for each type of diabetes remained stable in the considered time period.

Demographic analysis

For each type of diabetes, the number of admissions depended on age group ($p < 0.001$). In patients with T1D, most of the admissions (42.7%) concerned patients aged > 10 -15 (► **Fig. 2b**). The relative frequency of admissions for children aged > 5 -10 increased from 25.8% in 2006 to 35.8% in 2013, whereas admissions of children aged > 15 -20 decreased from 21.0% to 16.0% in the same period (► **Fig. 2b**). For patients with T2D or other types of diabetes, the largest part of the admissions (92.3% and 80.2%, respectively) were for age-groups > 10 -15 and > 15 -20 (► **Fig. 2c and d**).

Female preponderance was present in admissions for all types of diabetes (52.1% in T1D, 64.5% in T2D, and 66.5% in other types of diabetes, all $p \leq 0.001$) and remained stable over time. Almost all admis-



► **Fig. 1** Admissions to pediatric inpatient rehabilitation by diabetes type between 2006 and 2013. Data source: German Statutory Pension Insurance Scheme (FDZ-RV - RSDLV13ZIBMT).

sions concerned patients with German nationality (98.5%), even if this proportion decreased slightly from 99.4% in 2008 to 97.3% in 2013.

As displayed on ► **Fig. 3**, the estimated prevalence of inpatient rehabilitation among patients with T1D under 15 years of age living in the “new” federal states (former Eastern Germany, GDR, without Berlin) was higher in the considered time period than among those living in the “old” federal states (former Western Germany, FRG).

Other diagnoses besides diabetes

The most frequent diagnosis mentioned in the approval for inpatient rehabilitation for pediatric patients with diabetes was “endocrine and metabolic disorders” (96.3% for patients with T1D, 84.4% for patients with T2D or other types of diabetes). Approvals were also given for the diagnosis of mental disorders (1.7% for T1D, 9.0% for T2D and 4.8% for other types of diabetes) or for respiratory diseases (0.7% for T1D, 2.9% for T2D, and 4.8% for other types of diabetes).

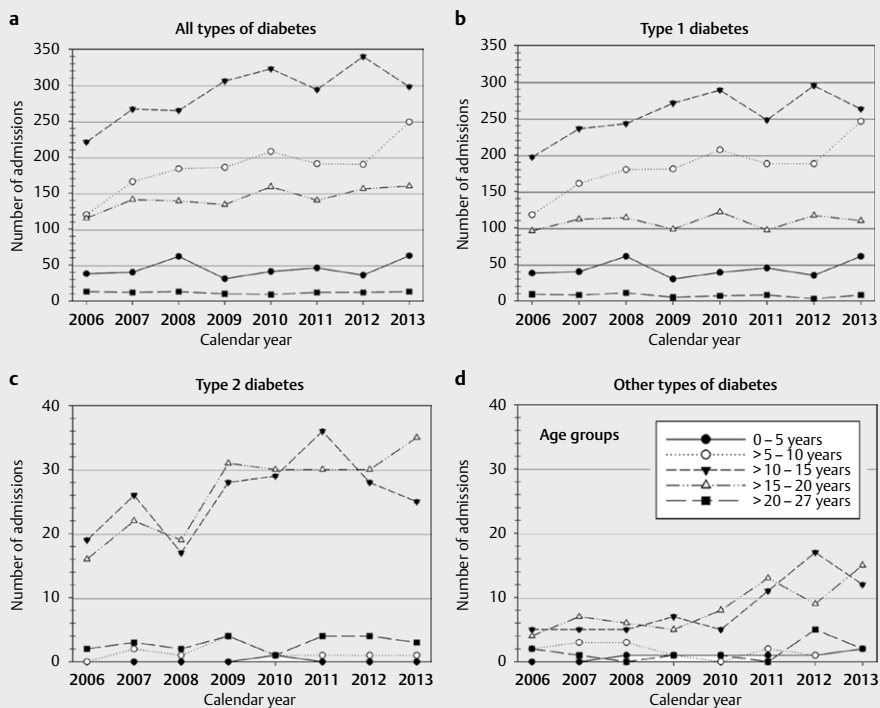
Besides diabetes, 0.6 diagnoses were documented on average in the discharge report for T1D patients, compared with 1.9 for T2D patients. Overall, more diagnoses were documented for patients admitted more than one time in rehabilitation (0.8 diagnoses for T1D and 2.2 for T2D patients). ► **Table 1** lists the most frequent diagnoses documented in addition to diabetes during inpatient rehabilitation. Mental disorders, obesity or respiratory infections were documented in about one-tenth of the discharge reports for patients with T1D. Obesity was the most frequent documented diagnosis for patients with T2D (present in almost 90% of the discharge reports), followed by mental disorders and hypertension. Results indicated no clear time trend for the prevalence of documented obesity or mental disorders between 2006 and 2013.

For both T1D and T2D, the prevalence of mental disorders documented in discharge reports increased with age. The increase was more pronounced in patients with T2D (from 9.1% for patients aged > 5 -10 years to 65.2% for patients older than 20 years, $p = 0.028$), compared to patients with T1D (from 7.9% to 23.7%, $p < 0.001$) (► **Fig. 4**). Documentation of obesity in discharge reports increased significantly with age in patients with T1D only (from 3.2 to 20.3%, from the youngest to the oldest age group, $p < 0.001$). Increase of documented obesity with age was not significant in patients with T2D ($p = 0.09$) (► **Fig. 4**).

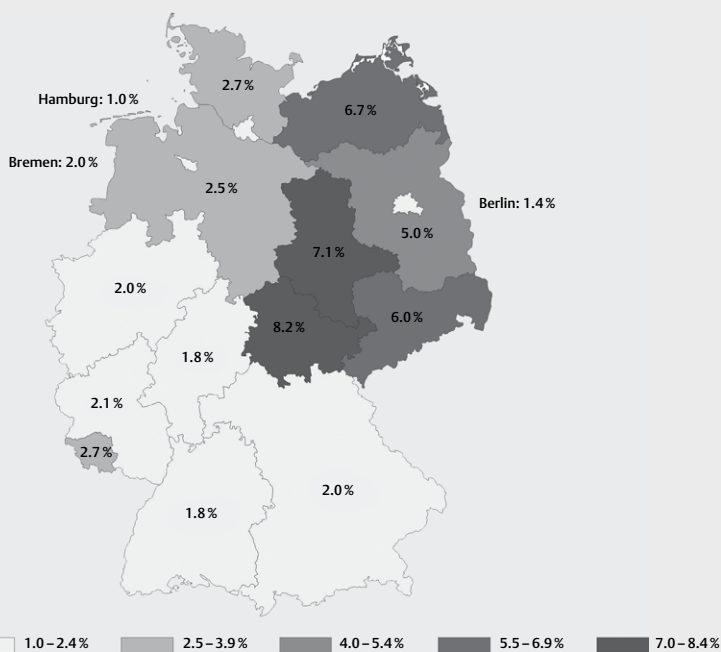
Most frequent diagnoses documented in discharge reports for patients older than 18 years ($n = 240$ admissions) are listed in ► **Table 15** (Supporting Information, online).

Discussion and Conclusions

This analysis aimed to give an integrative view of inpatient rehabilitation for children and adolescents with diabetes in Germany between 2006 and 2013. We found that T1D was specified in 88.5%, T2D in 8.4%, and other types of diabetes in 3.1% of the discharge reports. The number of admissions increased significantly in this time period for T1D (especially for age group > 5 -10) and other types of diabetes, but not for T2D. Overall, admissions were more frequent for girls, for German nationality, and for residents of the former Eastern Germany. For both T1D and T2D, the most frequent documented diagnoses besides diabetes were obesity and mental disorders. The prevalence of both diseases increased with age, except for obesity in patients with T2D, which remained quite stable at a high level.



► **Fig. 2** Admissions to pediatric inpatient rehabilitation by diabetes type and age group between 2006 and 2013. Data source: German Statutory Pension Insurance Scheme (FDZ-RV - RSDLV13ZIBMT).

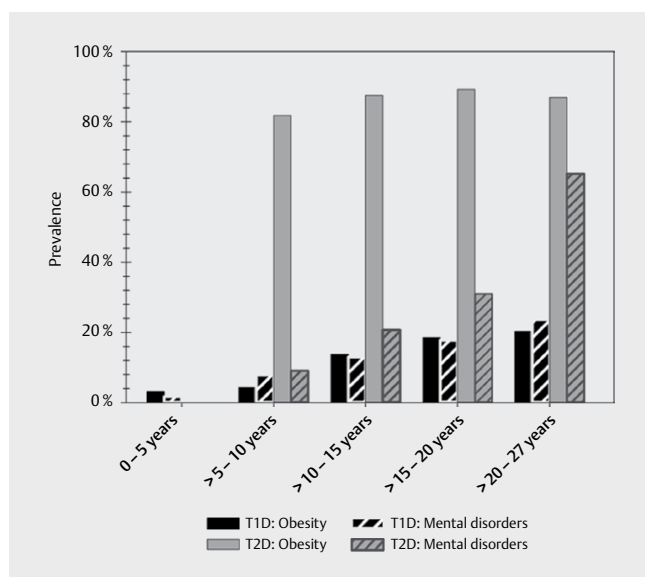


► **Fig. 3** Prevalence of pediatric inpatient rehabilitation by federal states (estimations for 2006–2013 in patients with type 1 diabetes younger than 15 years).

► **Table 1** Most frequent documented diagnoses besides diabetes, stratified by diabetes type.

Other diagnoses documented	Type 1 diabetes (n = 4,785 admissions *)		Type 2 diabetes (n = 456 admissions *)		Other types of diabetes ** (n = 167 admissions *) (** ICD: E12-E14)	
	Number	Percentage	Number	Percentage	Number	Percentage
Mental disorders (of which eating disorders)	556 (32)	11.6% (0.7%)	125 (16)	27.4% (3.5%)	23 (3)	13.8% (1.8%)
Obesity	529	11.1%	401	87.9%	83	49.7%
Respiratory infections	516	10.8%	40	8.8%	17	10.2%
Disorders of the thyroid gland	298	6.2%	48	10.5%	17	10.2%
Asthma	244	5.1%	46	10.1%	16	9.6%
Back pain	197	4.1%	35	7.7%	7	4.2%
Coeliac disease	183	3.8%	1	0.2%	2	1.2%
Hypertension	127	2.7%	105	23.0%	23	13.8%
Metabolic disorders (e. g. lactose intolerance, cystic fibrosis)	110	2.3%	63	13.8%	61	36.5%
Infectious and parasitic diseases	84	1.8%	9	2.0%	24	14.4%
Disease of the blood	22	0.5%	2	0.4%	3	1.8%
Neoplasms	11	0.2%	9	2.0%	3	1.8%

Absolute and relative frequencies of diagnoses documented in addition to diabetes in discharge reports for pediatric inpatient rehabilitation between 2006 and 2013 (each discharge report contains up to five diagnoses); Data source: German Statutory Pension Insurance Scheme (FDZ-RV – RSDLV13ZIBMT); * Overall n = 5,408 admissions, of which five documenting two different types of diabetes.



► **Fig. 4** Prevalence of obesity and mental disorders by age group in discharge reports of inpatient rehabilitation for children and adolescents with diabetes between 2006 and 2013. Data source: German Statutory Pension Insurance Scheme (FDZ-RV - RSDLV13ZIBMT).

T1D was the most frequent type of diabetes documented in discharge reports. Inpatient rehabilitation is a well-established additive option in the therapeutic concept for children and adolescents with T1D in Germany. Inpatient rehabilitation is not only indicated in case of insufficient metabolic control, recurrent severe hypoglycemia or ketoacidosis, comorbidities or organ complications, but also to enable the composition of age-appropriate education groups [3, 4, 7].

Discharge reports indicated a higher number of comorbidities for children and adolescents with T2D compared to patients with

T1D. In addition to obesity, present in almost 90% of the discharge reports for T2D, mental disorders, hypertension, metabolic disorders, disorders of the thyroid gland, and/or asthma were the most frequent diagnoses mentioned. International studies confirmed that childhood obesity is associated with higher risk of psychological and physical comorbidities, in particular asthma, metabolic risk factors, internalizing disorders, attention deficit hyperactivity disorder, and decreased health-related quality of life [14]. Furthermore, the higher prevalence of comorbidities in T2D might be one explanation for the longer mean duration of rehabilitation stay found for these patients compared with patients with other types of diabetes.

Our findings indicate that admissions to inpatient rehabilitation for children and adolescents with T1D and other types of diabetes significantly increased between 2006 and 2013, whereas increase of admissions for children with T2D was not significant. These results are in line with the increasing incidence of T1D and the stable incidence of T2D observed since 2005 in the German pediatric population [15, 16]. The magnitude of the increase in the admissions for T1D (about 50% between 2006 and 2013) corresponds to the increase of the incidence rate of childhood T1D reported by Patterson and colleagues (approximately 3 – 4% per annum across Europe for the time period 1989–2008) [17]. On the other hand, the increase of the admissions to inpatient rehabilitation for children and adolescents with T1D contrasts with the general decline of the admissions to inpatient rehabilitation for children and adolescents in Germany in this time period (-15% between 2006 and 2013) [18].

Between 2006 and 2013, the proportion of admissions for patients with T1D aged > 5-10 increased whereas the proportion aged > 15-20 decreased in the same period. In conformity with these results, our group reported recently that the chance of hospital admissions for pediatric patients with T1D compared to that without T1D in Germany was the highest for the age group > 5-10 [19]. One explanation is that the increase of T1D incidence in Europe is highest in the youngest children [16]. Therefore we

assume that inpatient rehabilitation following complications have become less frequent compared to indications related to diabetes onset, like e. g. initial education or training for insulin pump. Moreover, due to changes in society, rehabilitation seems to have become less attractive for adolescents than for children of other age categories [20].

Preponderance of girls in inpatient rehabilitation conforms to a monocentric analysis considering inpatient rehabilitation for pediatric diabetes between 2004 and 2016 [11]. Girls with T1D have also a higher chance of hospital admission compared to boys, probably in consequence of more frequent acute diabetes-related complications [19]. Furthermore, we can speculate if the willingness to spend many weeks outside of the family is higher in girls than in boys.

Almost all admissions to inpatient rehabilitation were for patients with German nationality, even if the proportion of foreign patients tended to increase very slowly. The definition of German nationality includes persons with migration background, when they have at least one German parent, or when they are born in Germany from 2000 on, with one parent living in Germany since eight years or longer. Official German statistics indicate a lower proportion of children with German nationality (90%-93%, depending on the age range) compared to that in children with diabetes participating in rehabilitation [21]. Several facts could explain why foreign patients with diabetes were underrepresented in inpatient rehabilitation. First, application for rehabilitation might constitute an obstacle for some foreign families (fear of administrative procedures and language comprehension difficulties) [20]. Furthermore, there may exist cultural barriers against long stays of children outside of the family [20]. Finally, the prevalence of T1D tends to be smaller in some non-European populations [22, 23].

We found that children with T1D living in the “new” federal states utilized more inpatient rehabilitations compared to those living in the Western part of the country. This is possibly due to historical differences in health systems and different traditions of inpatient rehabilitation that are lasting after German reunification. Until 1989, diabetes structures with a multidisciplinary team were scarce in the Eastern part of the country, especially in Saxony-Anhalt and Thuringia, where mainly small hospitals were present. A centralized institution, the Central institute for diabetes in Karlsburg (Mecklenburg-West Pomerania) therefore organized diabetes education for children and adults with diabetes for the Eastern part of Germany, in the form of holiday camps or inpatient rehabilitation [24]. Hence, inpatient rehabilitation was common in this part of the country.

The two most frequent diagnoses documented besides diabetes in discharge reports were obesity and mental disorders. This is in line with the most frequent diagnoses mentioned in approval decision for inpatient rehabilitation for all pediatric patients (with or without diabetes) in Germany: mental disorders (24.0%), followed by obesity (19.3%), and asthma (17.2%) [25]. Inpatient rehabilitation for pediatric diabetes is primarily proposed to patients with additional problems besides diabetes, in particular family or school problems, or insufficient metabolic control. Thus we expected a higher prevalence of mental disorders and of obesity in children and adolescents with diabetes who took part in rehabilitation compared to peers with diabetes who did not. Data from the DPV registry from 2014 indicate a prevalence of 7.5% of mental disorders in T1D patients younger than 18 years of age [26]. As expect-

ed, this is less than in our results. Similarly, prevalence of obesity in discharge reports for T1D is higher compared to peers with T1D outside of rehabilitation (5% in the age group 2- < 18 years, based on KiGGS reference data, German Health Interview and Examination Survey for Children and Adolescents) [27].

In our findings, the prevalence of mental disorders documented in discharge reports increased with age for both T1D and T2D, and the prevalence of obesity became more frequent with age in patients with T1D. In pediatric patients without diabetes in Germany, the prevalence of obesity increased with age [28] but not the risk of mental disorders [29].

Multicenter studies on inpatient rehabilitation in children and adolescents with diabetes in Germany are very scarce. To our best knowledge, only one national multicenter study exists, analyzing the effect of inpatient rehabilitation in a selection of 1,282 pediatric patients with T1D between 1996 and 2010 [3]. However, we are not able to ascertain the representativeness of the selected population. Moreover, comparisons with our findings are difficult, because in this study, nationality was not reported and age groups differed. Furthermore, data on other types of diabetes or comorbidities were not available.

We used data from the German Statutory Pension Insurance Scheme that funds almost all inpatient rehabilitation for children and adolescents in Germany, so that we assume a high representativeness [30]. However, we could not evaluate data completeness and quality. In particular comorbidities may have been underreported. In addition, diagnoses for rehabilitation approval as well as diagnoses in discharge reports were partly pooled by the German Statutory Pension Insurance Scheme, so that comparisons are difficult. A further limitation is that data about metabolic parameters are not collected by the German Statutory Pension Insurance Scheme; hence, no information on metabolic control could be given. Nevertheless, this seems to be the first study which describes demographics and comorbidities of almost all inpatient rehabilitation of children with diabetes in Germany, and their time trends over many years.

Note added in proof: After submission of this work, Schiel et al. published an analysis of pediatric patients with diabetes admitted to rehabilitation in Germany based on the DPV registry, which also includes admissions financed by the German Statutory Health Insurance [31].

Author Contributions

M.A. and R.W.H. designed the study. M.A. analyzed the study data, wrote the manuscript and created figures. B.B., R.S., R.S., S.K., T.H., and R.W.H. contributed to the discussion and reviewed/edited the manuscript.

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Conflict of Interest

No conflict of interest has been declared by the authors.

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Supplementary Material

► **Table 15** Most frequent documented diagnoses besides diabetes for adolescents older than 18 years, stratified by diabetes type.

Other diagnoses documented	Type 1 diabetes (n = 155 admissions)		Type 2 diabetes (n = 61 admissions)		Other types of diabetes * * (n = 24 admissions) (* * ICD: E12–E14)	
	Absolute	Relative (%)	Absolute	Relative (%)	Absolute	Relative (%)
Mental disorders (of which eating disorders)	36 (6)	23.2% (3.9%)	26 (8)	42.6% (13.1%)	5 (*)	20.8% (*)
Obesity	28	18.1%	52	85.2%	4	16.7%
Respiratory infections	9	5.8%	4	6.6%	*	*
Disorders of the thyroid gland	30	19.4%	9	14.8%	*	*
Asthma	9	5.8%	6	9.8%	4	16.7%
Back pain	10	6.5%	6	9.8%	*	*
Coeliac disease	*	*	*	*	*	*
Hypertension	8	5.2%	16	26.2%	*	*
Metabolic disorders (e. g. lactose intolerance, cystic fibrosis)	19	12.3%	11	18.0%	14	58.3%
Infectious and parasitic diseases	*	*	*	*	7	29.2%
Disease of the blood	6	3.9%	*	*	*	*
Neoplasms	5	3.2%	*	*	*	*

Absolute and relative frequencies of diagnoses documented in addition to diabetes in discharge reports for inpatient rehabilitation for adolescents older than 18 years between 2006 and 2013 (each discharge report contains up to five diagnoses); * 3 admissions or less; Data source: German Statutory Pension Insurance Scheme (FDZ-RV – RSDLV13ZIBMT).