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Area deprivation and regional disparities in treatment and outcome quality of 29,284 pediatric patients with type 1 diabetes in Germany: a cross-sectional multicenter DPV analysis.

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Title page

Area deprivation and regional disparities in treatment and outcome quality of 29,284 pediatric patients with type 1 diabetes in Germany: a cross-sectional multicenter DPV analysis.

Short-running-title:

Area deprivation and type 1 diabetes

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Abstract (250 words)

Objective

To analyze whether area deprivation is associated with disparities in pediatric diabetes care in Germany.

Research Design and Methods

We selected patients younger than 20 years of age with type 1 diabetes and German residence documented in the “diabetes patient follow-up” (DPV) registry for the years 2015/16. Area deprivation was assessed by quintiles of the "German Index of Multiple Deprivation" (GIMD 2010) at district level and was assigned to patients. To investigate associations between GIMD 2010 and indicators of diabetes care, we used multivariable regression models (linear, logistic, and Poisson) adjusting for sex, age, migration background, diabetes duration, and German federal states.

Results

We analyzed data from 29,284 patients. From the least to the most deprived quintile, use of continuous glucose monitoring systems decreased from 6.3% to 3.4% and use of long-acting insulin analogs decreased from 80.8% to 64.3%, whereas use of rapid-acting insulin analogs increased from 74.7% to 79.0%; average HbA1c increased from 7.84% to 8.07% (62 to 65 mmol/mol), and the prevalence of overweight from 11.8% to 15.5%, but the rate of severe hypoglycemia decreased from 12.1 to 6.9 events/100 patient-years. Associations with other parameters showed a more

76 complex pattern (use of insulin pump) or were not significant (e.g., rate of diabetic
77 ketoacidosis).
78
79 **Conclusions**
80 Area deprivation was associated with half the analyzed indicators. Investigation of
81 potential mediating variables, such as accessibility of care, quality of housing and
82 transportation, or density of urban green spaces, might allow a better understanding
83 of the underlying mechanisms of the observed associations.

Main text (4,080 words, 2 tables and 2 figures)

Over the last two decades, the management of pediatric type 1 diabetes has changed considerably, in particular with regard to increased use of insulin analogs, basal-bolus regimens, and insulin pump therapy. However, major geographic variations in metabolic control and diabetes-related complications have persisted between countries around the world (1,2). Treatment and outcome quality of patients with type 1 diabetes also vary within countries. In Brazil, large discrepancies were found in clinical care across different regions (3). In Germany, significant disparities in the use of insulin pumps and rapid-acting or long-acting analogs, HbA1c levels, the prevalence of overweight, and the rate of severe hypoglycemia have been reported between the federal states (4).

Regional variations in treatment and outcome quality of patients with type 1 diabetes care are not completely explained. Concerning type 2 diabetes, a notable number of studies have shown that both area-level and individual socioeconomic factors are associated with worse indicators of outcome quality, such as body mass index (BMI), HbA1c, lipid profile, and short-term or long-term diabetes-related complications (5,6). Concerning type 1 diabetes, the evidence of associations between area-level or individual socioeconomic factors and diabetes-related outcomes is weaker (7–12). Furthermore, individual socioeconomic indicators (income, education, and occupation) have often been analyzed, whereas associations between area deprivation and type 1 diabetes outcomes have been investigated in a few countries only, as in the UK, Canada, New Zealand, and Australia (7–12).

Indices of Multiple Deprivation, which encompass several domains of deprivation such as income, employment, environment, or security, are a useful tool to study associations of area deprivation and health outcomes. First developed in the UK (13), such indices have been used increasingly since the year 2000 for epidemiological research and public policy (14). In Germany, Indices of Multiple Deprivation started to be used in public health-related research in 2011 (15). Maier and colleagues adopted the conceptual and technical approach used in the UK to develop Indices of Multiple Deprivation for Germany (German Index of Multiple Deprivation, GIMD, and its regional versions) (16,17). Associations were shown between the GIMDs and several health outcomes, for example the prevalence of type 2 diabetes and obesity (6,18), or with health service indicators such as hip and knee replacement (19).

The objective of our study was to analyze whether area deprivation, assessed by the GIMD from the year 2010 (GIMD 2010), is associated with regional disparities in the treatment and outcome quality of pediatric patients with type 1 diabetes in Germany.

Research Design and Methods

Study population

We used data from the multicenter “diabetes patient follow-up” registry (**D**iabetes-**P**atienten-**V**erlaufsdokumentation, DPV). Currently, 459 diabetes care centers, mainly in Germany (n=416) and Austria (n=40), participate in the DPV initiative and prospectively document demographic and clinical data on treatment and outcome quality. Twice a year, centers transmit locally collected and anonymized data to the University of Ulm, Germany, for central analysis and quality assurance (20). Inconsistent or implausible data are reported back to centers for verification or correction. Data collection and analysis of anonymized data from the DPV registry

were approved by the Ethics Committee of the Medical Faculty of the University of Ulm, Germany, and by the local review boards of participating centers.

As of March 2017, 484,365 patients with any type of diabetes were documented in the DPV database. We included only patients younger than 20 years of age with type 1 diabetes and German residence documented in the DPV for the time period 2015 and 2016. For each patient, we aggregated clinical data for the years 2015 and 2016 as median, percentage, or rate per 1 or 100 patient-years (PY) for continuous, categorical, and event variables respectively.

Area deprivation

Area deprivation was assessed using the German Index of Multiple Deprivation from the year 2010 (GIMD 2010). The GIMD includes seven domains of deprivation with different weighting: income (25%), employment (25%), education (15%), municipal/district revenue (15%), social capital (10%), environment (5%), and security (5%) (16,17). The GIMD 2010 was generated for all 412 districts of Germany (boundaries at 31 December 2010). Districts were categorized into deprivation quintiles, with quintile 1 (Q1) representing the least deprived and quintile 5 (Q5) the most deprived districts. We used the five-digit postal code of the patient's residence to assign the district of residence. In case the postal code of residence was not available, we used the postal code of the treating diabetes center as proxy.

Indicators of diabetes care

Indicators of medical treatment in our analysis were: use of insulin pump therapy (CSII), use of continuous glucose monitoring systems (CGMS), frequency of self-monitoring of blood glucose (SMBG), use of rapid-acting or long-acting insulin

analogs in patients on injection therapy, and participation in diabetes education programs. CGMS includes real-time continuous glucose monitoring (rtCGM) and continuous glucose monitoring with intermittent scanning (iscCGM; also called “flash glucose monitoring”, FGM). Diabetes education was documented if a teaching session lasted for at least 45 min and if the patient and/or members of his/her family or other caregivers participated (21).

Indicators of outcome quality were: body mass index (BMI), presence of overweight or obesity, HbA1c, rates of severe hypoglycemia (with or without coma) and of severe hypoglycemia with coma, rates of diabetic ketoacidosis (DKA) and of severe DKA, and number of hospital days per person and year (/PY). BMI values, expressed as weight in kilograms/squared height in meters (kg/m^2), were transformed to a standard deviation score (BMI SDS) using national reference data from the German Health Interview and Examination Survey for Children and Adolescents (KIGGS) (22). A BMI above the 90th or 97th percentile of this reference population was defined as overweight (including obesity) or obesity respectively (22). HbA1c was standardized to the Diabetes Control and Complications Trial (DCCT) reference of 4.05–6.05% (21–43 mmol/mol), applying the “multiple-of-the-mean” transformation method in order to adjust for differences between local laboratories (23). Severe hypoglycemia (with or without coma) was defined as self-reported unconsciousness, convulsion, or being unable to take glucose without third-party assistance (24) or, in preschool children, as an altered mental status and an inability to assist in hypoglycemia treatment (25). DKA was defined as pH< 7.3 and/or requirement of hospital treatment; severe DKA was defined as pH< 7.1. DKA at diabetes onset was not considered in this analysis.

187 **Statistical analysis**

188 We presented descriptive data as median (lower–upper quartile), percentage, or rate
189 per 1 or 100 patient-years (PY) for continuous, categorical, and event variables
190 respectively.

191

192 In order to illustrate the regional distribution of CSII, HbA1c, prevalence of
193 overweight, rate of severe hypoglycemia, and rate of DKA at district level in
194 Germany, we created quintile-based choropleth maps (Figure 1, B–F). For this
195 purpose, we derived district-specific adjusted mean estimates (least square means)
196 for each of these outcomes from multivariable regression models (linear, logistic, or
197 Poisson considering overdispersion) with district as the categorical independent
198 variable, adjusting for sex, age group (<6 years, 6–<12 years, 12–<20 years),
199 migration background (defined as at least one parent or the child itself born outside
200 Germany), and diabetes duration (<2 years, ≥2 years). Adjusted mean estimates for
201 districts were then categorized into outcome quintiles.

202

203 To investigate the association between the GIMD 2010 quintiles and indicators of
204 diabetes care, we performed multivariable regression models (linear, logistic, or
205 Poisson considering overdispersion) with GIMD 2010 quintiles as the categorical
206 independent variable and adjusting for sex, age group, migration background, and
207 diabetes duration. In a second step, we also adjusted for German federal states in
208 regression models to investigate whether the effects of area deprivation were
209 independent of the federal structure of Germany. Results of regression analyses are
210 presented as adjusted mean estimates (least square means) with respective 95%
211 confidence intervals (95% CI). Results for CSII, HbA1c, prevalence of overweight,
212 rate of severe hypoglycemia, and rate of DKA are illustrated graphically (Figure 2);

results for other outcomes are presented in Table 2. All analyses were repeated stratified by sex to examine possible differences in the associations of GIMD 2010 with indicators of care between girls and boys.

The number of cases used in the analysis of each variable is indicated in the tables and figures. The level of significance of two-sided tests was set at $p<0.01$. Statistical analysis was performed using the software SAS 9.4 (Statistical Analysis Software, SAS Institute, Cary, NC, USA). Choropleth maps were created using the open source software “QGIS”, version 2.14.

Results

The study population comprised 29,284 children and adolescents with type 1 diabetes (selection presented in Supplemental figure S1). Of all subjects included, 45.6% used CSII, 6.3% CGMS, and 46.8% participated in a diabetes education program. Median HbA1c was 7.62% (60 mmol/mol), IQR: 6.94–8.50% (52–69 mmol/mol). The rate of severe hypoglycemia was 10.2 events/100 PY, and of DKA 1.8 events/100 PY. Thirteen percent (13.4%) of the patients were overweight (including obesity) and 3.5% obese. The number of hospital days was 4.9 /PY. Demographic data of the study population stratified by GIMD 2010 quintiles are given in Table 1.

Medical treatment

Visual comparison of the regional distributions of CSII and GIMD 2010 (Figure 1) indicated that CSII was used less frequently in the least deprived districts. Regression analyses with and without adjusting for federal states confirmed this finding (CSII use: 41.7% in Q1, 42.4–48.0% in other quintiles, in the model adjusting

for federal states), but showed further that use of CSII decreased from Q2 to Q5 (Figure 2 A). Regression analyses with and without adjusting for federal states showed that CGMS was used less frequently in districts with higher deprivation (3.4% in Q5 versus 6.3% in Q1 in the model adjusting for federal states) (Table 2). Rapid-acting insulin analogs among patients on injection therapy tended to be used more frequently with increasing area deprivation according to the model not considering federal states. However, differences between deprivation quintiles became smaller after adjusting for federal states (79.0% in Q5 versus 74.7% in Q1). In the model without federal states, the pattern of association between long-acting insulin analogs and area deprivation appeared to be more complex (highest use in Q1 and Q5, lowest use in Q2 and Q3). After adjustment for federal states, long-acting insulin analogs tended to be used less frequently with increasing area deprivation (64.3% in Q5 versus 80.8% in Q1 and Q3). In all models, associations with frequency of SMBG were not significant. With increasing area deprivation, patients and their family participated more often in diabetes education programs, but these associations were no longer significant after additional adjustment for federal states.

Outcome quality

Visual comparison of the regional distributions of HbA1c and GIMD 2010 (Figure 1) indicated that HbA1c was higher in the most deprived districts. Regression analyses with and without adjusting for federal states confirmed this finding. Average HbA1c increased almost linearly from the least to the most deprived districts (from 7.84% (62 mmol/mol) in Q1 to 8.07% (65 mmol/mol) in Q5, after adjusting for federal state) (Figure 2 B). In contrast to HbA1c, the rate of severe hypoglycemia (with or without coma) decreased in all models with higher area deprivation (from 12.1 events/100 PY to 6.9 events/100 PY in the model adjusted for federal state) (Figure 2 C), whereas

the rate of severe hypoglycemia with coma did not vary significantly with area deprivation level (Table 2). Positive associations between area deprivation and DKA (Figure 2 D) or severe DKA (pH< 7.1) (Table 2) were not significant. The prevalence of overweight (including obesity) with increasing deprivation increased steadily with area deprivation, and this association was stronger when additionally adjusting for federal states (from 11.8% in Q1 to 15.5% in Q5) (Figure 2 E). The pattern of association was similar for BMI SDS (Table 2). The increase in obesity prevalence was not significant. The number of hospital days (rate/PY) increased with higher area deprivation in the model not adjusting for federal state, but this association was no longer significant after controlling for federal states (Table 2).

Analysis by sex

Considering the model adjusting for federal states, stratified by sex, most of the results were similar in boys and girls (Supplemental table S2). However, the association between area deprivation and the use of CGMS (less frequent use with increasing area deprivation), as well as between area deprivation and the prevalence of overweight (higher prevalence with increasing area deprivation) was significant in boys, but not in girls. In addition, we found a slight but significantly less frequent SMBG only in boys in Q5 compared with other deprivation quintiles.

Conclusions

We found that area deprivation was associated with the use of CSII, CGMS, rapid-acting or long-acting insulin analogs, HbA1c levels, the rate of severe hypoglycemia, BMI SDS, and the prevalence of overweight, independently of the federal states. Associations of other factors with area deprivation were not significant regardless of the model considered or no longer significant after adjustment for federal states.

Association between area deprivation and SMBG was significant only in boys, but differences between quintiles were very small and not clinically relevant.

Our analysis showed a significantly less frequent use of CSII in the least deprived districts (Q1) compared with others (Q2–Q5). Most of the least deprived districts (Q1) are located in Southern Germany (federal states of Bavaria and Baden-Württemberg) where a previous study with data from the years 2012 and 2013 has already shown a lower use of CSII (4). However, adjustment for federal states did not change the observed pattern of association between area deprivation and CSII. Differences in health insurance (private versus statutory), in discount agreements with pharmaceutical companies or in marketing, as well as patient preferences (e.g., technique affinity) may lead to this finding. Furthermore, in Germany, CSII is reimbursed on a case-by-case basis, if certain medical criteria have been met (approval by the health insurance company), for instance if intensified conventional insulin therapy is not sufficient to achieve goals for glycemic control (26). We found the lowest HbA1c levels in the least deprived districts (Q1) where pump use was also less frequent. It is possible that, in these districts (Q1), HbA1c goals are more often achieved with intensified conventional insulin therapy compared with more deprived districts. Further, in districts in deprivation quintiles Q2 to Q5, CSII was used less frequently with increasing area deprivation. This pattern may be associated with the uncertainty of reimbursement of the insulin pump, which may constitute an obstacle for some families in more deprived regions. To the best of our knowledge, there is no study investigating associations between area deprivation or individual socioeconomic status (SES) and CSII in patients with type 1 diabetes. However, some studies have indicated that individuals in higher socioeconomic groups injected insulin more frequently each day and were also more likely to use insulin pumps (7).

317

318 We found that CGMS was used less in more deprived districts. Associations between
319 area deprivation or individual SES and CGMS have not been investigated yet. Since
320 June 2016 only, rtCGM, but not iscCGM, has been reimbursed by statutory health
321 insurance in Germany. Absence of reimbursement until this date may have led to
322 avoidance of CGMS use, particularly in more deprived regions. The difference in
323 significance of associations between girls and boys may result from the different
324 numbers of cases in each category.

325

326 Use of rapid-acting insulin analogs was positively associated with area deprivation.
327 We know that rapid-acting insulin analogs are used more frequently in Eastern
328 Germany, where a significant number of deprived districts are located (4). After
329 controlling for federal states, this pattern of association between area deprivation and
330 the use of rapid-acting insulin analogs was attenuated but remained significant. In
331 contrast, long-acting insulin analogs were used less frequently with increasing area
332 deprivation, after adjustment for federal state. Many factors may interact in a complex
333 manner. Possible explanations include, among other things, differences in patients'
334 health insurance (private versus statutory) or regionally different local discount
335 agreements with pharmaceutical companies (27,28).

336

337 With regard to indicators of outcome quality, our results concerning the association
338 between area deprivation and HbA1c are in line with the findings from previous
339 studies. Several reports on patients with type 1 diabetes have shown significant
340 associations between higher area deprivation and poorer metabolic control in
341 children (8,11,12) and adults (9).

342

We also found a positive association between area deprivation and overweight or BMI SDS, and these findings are also consistent with previous reports in the general population (6,29). For example, significant associations between area deprivation and obesity have been reported in adults in Germany, after controlling for education (6). A strong association between area deprivation and weight status was also confirmed in British children: children living in more deprived locations had both greater waist circumference and greater body mass, even after controlling for confounders (age, sex, stature, hip circumference) (29). Similar to our findings, differences between girls and boys in the relationship between social factors and overweight have been reported previously, in particular in Swedish children: social inequality at individual level was related to overweight only in boys younger than 13 years of age (30). However, we cannot exclude the possibility that, in our study, the difference in the significance of associations between girls and boys is caused by the different numbers of cases in each category. Finally, given that area deprivation is associated with higher BMI, and that higher BMI itself is associated with higher HbA1c (31), overweight (also resulting from less physical activity) might be an intermediate factor in the causal pathway between area deprivation and HbA1c. In addition, it is possible that area deprivation affects glycemic control independently of body weight.

In contrast to previous reports (32), we found a negative association between area deprivation and the rate of severe hypoglycemia (with or without coma). Recent studies have demonstrated that the evidence for an association between low HbA1c and hypoglycemia risk in type 1 diabetes no longer exists (33). However, we cannot exclude the possibility that, in our setting, the lower rate of severe hypoglycemia in the most deprived districts is associated with higher HbA1c, which is related to higher

area deprivation in our study. Another hypothesis could be that parents of children with type 1 diabetes living in more deprived areas tend to underreport severe hypoglycemia more often (minimization of the medical relevance or social desirability bias) compared with parents of children living in less deprived districts. In fact, contrary to DKA, which requires a visit to the diabetes care center, severe hypoglycemia can be treated by patients or parents themselves, and may easily be forgotten until the next medical visit. In accordance with this explanation, no association was observed between area deprivation and severe hypoglycemia with coma, where underreporting is less likely.

In our results, higher area deprivation tended to be associated with higher risk of hospital admission for DKA, and this is consistent with previous findings (34).

Overall, many factors may contribute to the differences in treatment and outcome quality in pediatric patients with type 1 diabetes within Germany. The GIMD 2010 partly reflects East–West inequalities in Germany: districts in less deprived quintiles were mostly located in the western part, whereas districts in the most deprived quintiles were mostly located in the eastern part of the country (Table 1 and Figure 1 A). Although the living conditions in former Eastern and Western Germany have slowly converged since German reunification (35), economic performance is still lower and the proportion of people affected by poverty and unemployment remains higher in the eastern compared with the western part of the country (36). The health status of children and adolescents has become more similar, but some important differences in health behavior still remain. In particular, compared with peers living in the western part of the country, more adolescents in Eastern Germany regularly drink alcohol or smoke, and fewer children are members of a sports club (37). However,

our study indicates that half of the analyzed diabetes-related outcomes (use of CSII, CGMS, or insulin analogs, HbA1c, rate of severe hypoglycemia, BMI SDS, and prevalence of overweight) were significantly associated with area deprivation independently of the federal states and, thus, independently of East–West disparities.

The major strength of this study is the use of a nationwide diabetes follow-up registry covering more than 85% of the pediatric subjects with type 1 diabetes in Germany, so that the results can be considered as representative of this population. Moreover, detailed information on the patients' demographic and clinical characteristics were available, which allows comprehensive control of potential confounders.

One limitation of this study is that analyses could not consider individual-level SES. In DPV, education level is incompletely documented and household income is not available. Studies on patients with type 2 diabetes have demonstrated that the effect of area deprivation remains significant after controlling for individual SES (6,18). Maier and colleagues argue that individual SES and area deprivation may "act through different pathways" (18). Several mechanisms probably act together. For instance, a strong net of social safety, as well as dedicated resources through social spending to "stable housing, educational opportunities, nutrition and transportation" is considered to play a decisive role in enhancing the quality of care, especially for populations with lower income, lower educational level, or minority status (38). Accessibility of health services, urban green spaces (39), sports facilities, or density of fast food outlets are also potential intermediate variables that could help to gain a better understanding of the association between area deprivation and health (14). Thus, these parameters should be investigated in further research.

Another weakness is the heterogeneity of German districts: they are administrative units that vary considerably in area and population size (from about 35,000 up to more than one million inhabitants). We assume that the analysis could be less sensitive in larger districts than in smaller ones. However, application of the GIMD at district level fits the structure of pediatric diabetes care in Germany.

Further shortcomings of this study are that complete data were not available for each patient and, on account of the multicenter design, variability in the measurements of clinical characteristics cannot be completely excluded. However, we standardized locally measured HbA1c values to the DCCT standard. Finally, because of the cross-sectional design, this study does not allow us to draw any causal interpretation.

In conclusion, we showed that, in pediatric patients with type 1 diabetes in Germany, area deprivation was significantly associated with many indicators of treatment and outcome quality, independently of the federal states. The underlying mechanisms are still unclear. Controlling for individual factors (SES, type of patients' health insurance) and investigating potential intermediate variables, such as accessibility of diabetes care facilities, quality of housing and transportation, as well as the density of urban green spaces, would allow a better understanding of the observed associations.

Acknowledgments

Author Contributions. M.A., S.L., B.B., J.R., and W.M. designed the study. S.L., J.R., and W.M. analyzed the study data and reviewed/edited the manuscript. M.A. wrote the manuscript and created the figures. W.M. created the maps. P.K., U.K.-K.,

P.M.H., K.P., J.H., R.B., B.B., J.R., and W.M. contributed to the discussion and reviewed/edited the manuscript. B.B. is the guarantor of this work and, as such, had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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616 Tables

617 **Table 1.** Characteristics of the study population by GIMD 2010 quintiles

618 **Table 2.** Multiple adjusted mean estimates (95% CI) of indicators of diabetes care by
619 GIMD 2010 quintiles

620

621 Figures

622

623 **Figure 1. Quintile-based distribution of the German Index of Multiple**
624 **Deprivation 2010 (GIMD 2010) (A) and of selected indicators of diabetes care at**
625 **district level (B–F)**

626 ***Legend (B–F):***

627 Adjusted mean estimates (least square means) from regression models (linear,
628 logistic, and Poisson), adjusting for sex, age group, migration, and diabetes duration,
629 with district as the categorical independent variable, categorized into outcome
630 quintiles.

631

632 **Figure 2. Multiple adjusted mean estimates of indicators of diabetes care by**
633 **GIMD 2010 quintiles**

634 ***Legend:***

635 Black triangles: Adjusted mean estimates (least square means) from regression
636 models (linear, logistic, and Poisson), with GIMD 2010 quintiles as the categorical
637 independent variable, adjusting for sex, age group, migration, and diabetes duration
638 (Model 1)

White circles: Adjusted mean estimates (least square means) from regression models (linear, logistic, and Poisson), with GIMD 2010 quintiles as the categorical independent variable, adjusting for sex, age group, migration, diabetes duration, and federal state (Model 2)

Online-Only Supplemental Material: 1 figure, 1 table, 1 appendix

Supplemental Figure S1. Selection of the study population

Supplemental Table S2. Multiple adjusted mean estimates (95% CI) of indicators of diabetes care by GIMD 2010 quintiles, stratified by sex

Supplemental Appendix S3: List of all centers contributing data to this analysis

653 **Table 1. Characteristics of the study population by GIMD 2010 quintiles**

654

	All patients (n= 29,284)	Q1 (n= 7,109)	Q2 (n= 7,541)	Q3 (n= 5,353)	Q4 (n= 5,804)	Q5 (n= 3,477)
Girls, %	47.2	46.7	48.1	48.2	46.2	46.6
Age, years*	13.4 (9.8–16.2)	13.5 (9.9–16.3)	13.4 (9.9–16.2)	13.3 (9.8–16.2)	13.3 (9.7–16.2)	13.1 (9.7–16.0)
Age at onset, years*	7.7 (4.4–11.1)	7.8 (4.4–11.2)	7.6 (4.4–11.1)	7.8 (4.4–11.1)	7.6 (4.4–11.1)	7.7 (4.5–11.1)
Diabetes duration, years*	4.0 (1.3–7.5)	4.0 (1.4–7.5)	4.1 (1.4–7.6)	4.0 (1.3–7.5)	3.9 (1.2–7.5)	3.7 (1.2–7.3)
Migration background, %	21.6	21.1	23.7	22.5	23.9	13.3
East German residence (new federal states), %	15.9	0.0	0.4	3.1	30.5	77.3

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657 Unadjusted data. *Data are median (lower–upper quartile).

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Table 2. Multiple adjusted mean estimates (95% CI) of indicators of diabetes care by GIMD 2010 quintiles*

Outcome	n	Q1	Q2	Q3	Q4	Q5	p-value**
Treatment							
CGMS, %	29,284	7.3 (6.7 to 7.9)	5.6 (5.2 to 6.2)	5.6 (5.1 to 6.3)	4.8 (4.3 to 5.4)	4.5 (3.9 to 5.2)	<0.001
		6.3 (5.7 to 7.0)‡	5.6 (5.1 to 6.2)‡	5.7 (5.1 to 6.4)‡	5.3 (4.7 to 6.0)‡	3.4 (2.7 to 4.3)‡	<0.001‡
Rapid-acting insulin	15,719†	66.8 (65.3 to 68.3)	70.4 (68.8 to 71.9)	66.7 (64.8 to 68.5)	78.0 (76.5 to 79.5)	87.8 (86.2 to 89.2)	<0.001
analogs, %		74.7 (73.1 to 76.2)‡	75.9 (74.3 to 77.4)‡	70.9 (68.9 to 72.7)‡	76.7 (74.9 to 78.3)‡	79.0 (75.8 to 81.8)‡	<0.001‡
Long-acting insulin	15,719†	77.8 (76.5 to 79.2)	71.5 (69.9 to 73.0)	75.2 (73.4 to 76.8)	72.5 (70.8 to 74.1)	81.2 (79.4 to 82.9)	<0.001
analogs, %		80.8 (79.4 to 82.2)‡	77.3 (75.8 to 78.8)‡	80.8 (79.3 to 82.3)‡	72.4 (70.5 to 74.3)‡	64.3 (60.4 to 68.0)‡	<0.001‡
SMBG	27,335	5.8 (5.7 to 5.8)	5.7 (5.7 to 5.8)	5.8 (5.7 to 5.8)	5.7 (5.7 to 5.8)	5.6 (5.6 to 5.7)	0.02
		5.7 (5.7 to 5.8)‡	5.7 (5.7 to 5.8)‡	5.7 (5.7 to 5.8) ‡	5.8 (5.8 to 5.9)‡	5.7 (5.6 to 5.8)‡	0.02‡
Diabetes education	29,284	44.2 (43.0 to 45.4)	46.8 (45.7 to 48.0)	46.1 (44.8 to 47.5)	47.7 (46.4 to 49.0)	51.7 (50.0 to 53.5)	<0.001
program, %		46.0 (44.6 to 47.4)‡	48.2 (47.0 to 49.5)‡	46.6 (45.1 to 48.1)‡	46.6 (45.1 to 48.1)‡	46.0 (43.4 to 48.7)‡	0.13‡
Outcome quality							
Severe hypoglycemia with	29,284	1.8 (1.5 to 2.2)	2.1 (1.8 to 2.5)	2.5 (2.1 to 3.0)	2.0 (1.7 to 2.4)	1.6 (1.3 to 2.2)	0.06
coma, events/100 PY		1.9 (1.6 to 2.3)‡	1.9 (1.6 to 2.3)‡	2.2 (1.8 to 2.7)‡	1.9 (1.5 to 2.3)‡	1.8 (1.2 to 2.6)‡	0.71‡
Severe DKA (pH <7.1),	28,965	0.2 (0.1 to 0.3)	0.2 (0.1 to 0.3)	0.3 (0.2 to 0.4)	0.2 (0.2 to 0.4)	0.4 (0.3 to 0.7)	0.03
events/100 PY		0.2 (0.1 to 0.3)‡	0.1 (0.1 to 0.3)‡	0.2 (0.1 to 0.5)‡	0.2 (0.1 to 0.5)‡	0.3 (0.1 to 0.8)‡	0.42‡
BMI SDS	28,327	0.28 (0.26 to 0.30)	0.33 (0.31 to 0.35)	0.35 (0.33 to 0.37)	0.33 (0.31 to 0.35)	0.36 (0.33 to 0.39)	<0.001
		0.26 (0.24 to 0.29)‡	0.29 (0.27 to 0.32)‡	0.33 (0.31 to 0.36)‡	0.35 (0.33 to 0.38)‡	0.46 (0.41 to 0.50)‡	<0.001‡
Obesity, %	28,327	3.2 (2.8 to 3.6)	3.0 (2.6 to 3.4)	3.7 (3.2 to 4.2)	3.6 (3.2 to 4.2)	3.8 (3.2 to 4.5)	0.07
		3.2 (2.8 to 3.7)‡	2.8 (2.5 to 3.3)‡	3.6 (3.1 to 4.2)‡	3.7 (3.2 to 4.3)‡	3.9 (3.0 to 5.0)‡	0.07‡
Number of hospital	29,284	3.9 (3.3 to 4.6)	4.5 (3.9 to 5.3)	4.5 (3.8 to 5.4)	4.7 (4.0 to 5.6)	6.8 (5.7 to 8.2)	<0.001
days/PY		4.2 (3.5 to 5.0) ‡	4.7 (4.0 to 5.5)‡	4.5 (3.8 to 5.5) ‡	4.7 (3.9 to 5.6)‡	5.1 (3.8 to 7.0)‡	0.85‡

* Adjusted mean estimates (least square means) with respective 95% confidence intervals are derived from logistic regression analysis (for outcomes use of CGMS, use of rapid-acting insulin analogs, use of long-acting insulin analogs, participation in diabetes education program, prevalence of obesity), linear regression analysis (for outcomes SMBG, BMI SDS), or Poisson regression analysis considering overdispersion (for outcomes rate of severe hypoglycemia with coma, rate of severe DKA (pH <7.1), number of hospital days). All regression models were performed with GIMD 2010 quintiles as the categorical independent variable and adjusting for sex, age group, migration background, and diabetes duration.

† Only patients without CSII.

‡ Estimates from regression models additionally adjusted for German federal states.

**p-value of test of no difference in outcome distribution across GIMD quintiles.

Figure 1. Quintile-based distribution of the German Index of Multiple Deprivation 2010 (GIMD 2010) (A) and of selected indicators of diabetes care at district level (B–F)

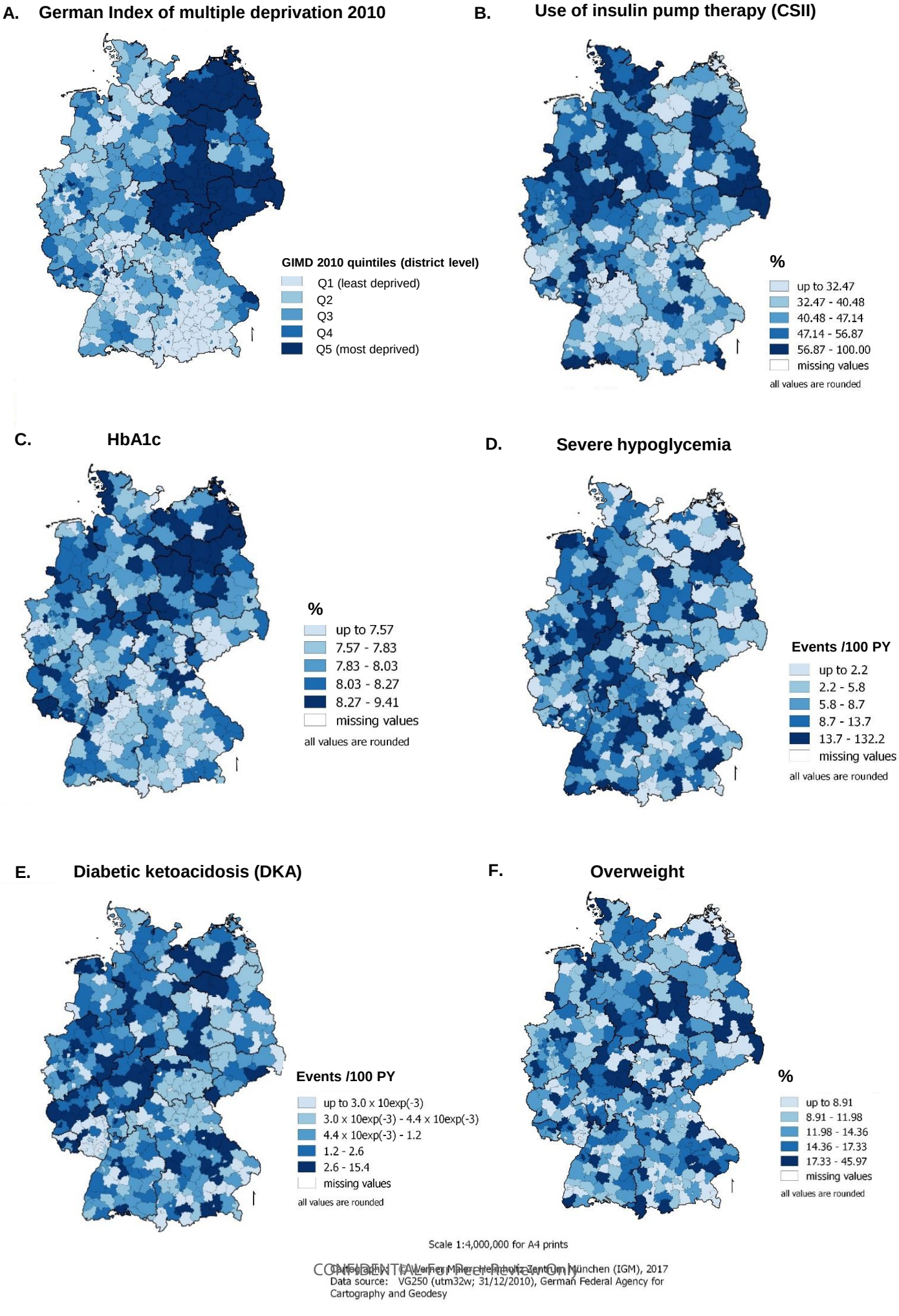
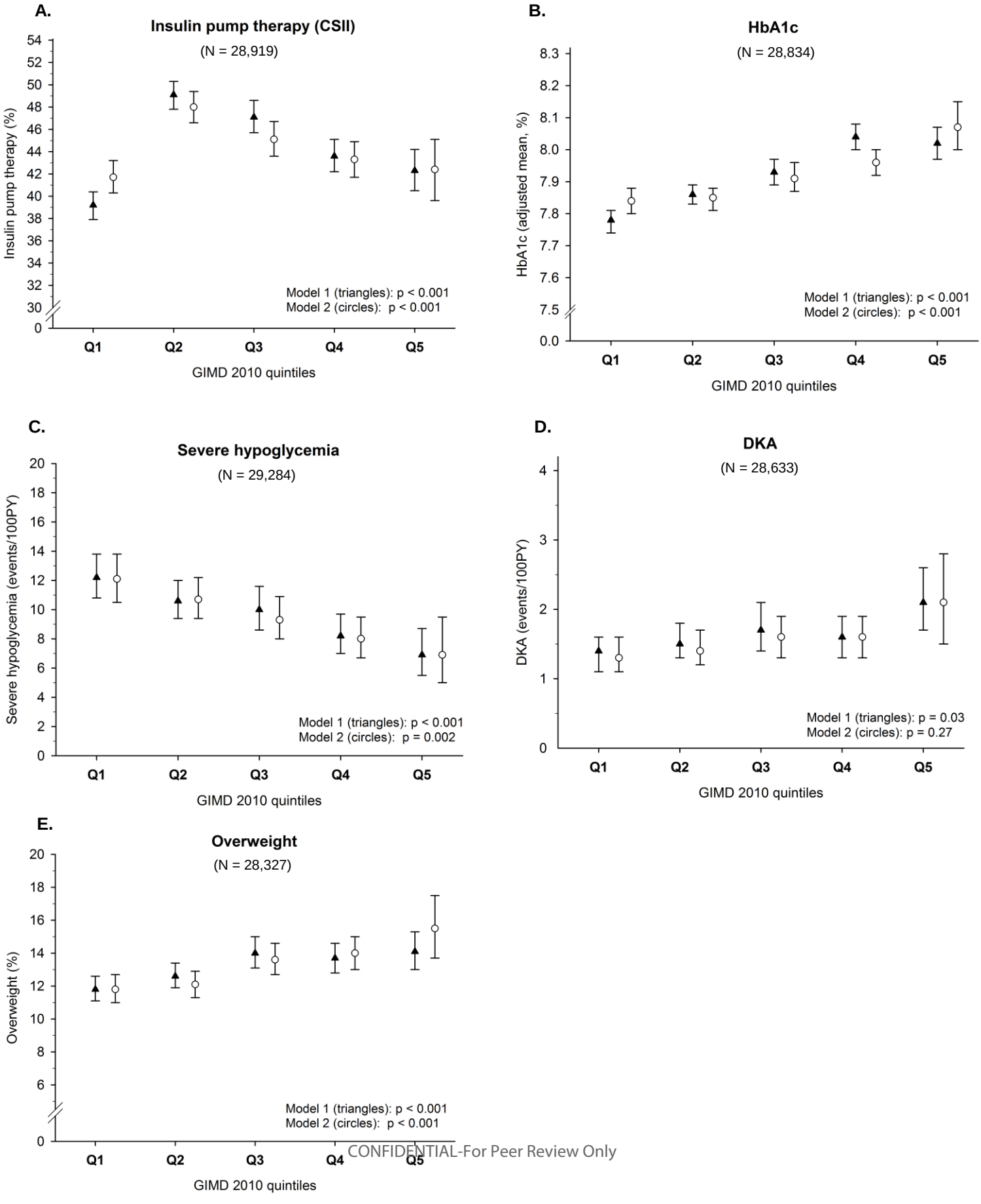


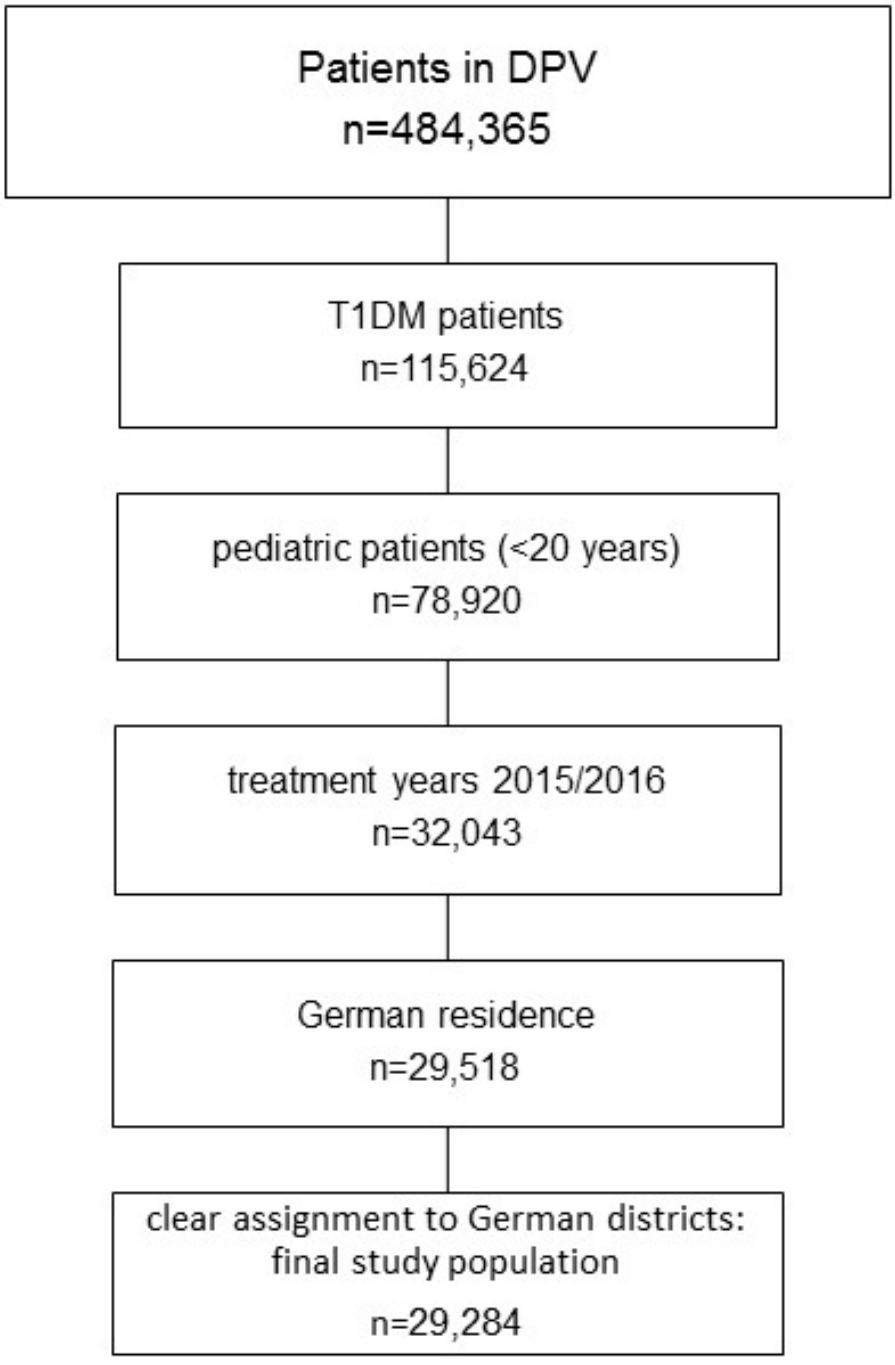
Figure 2. Multiple adjusted mean estimates of indicators of diabetes care by GIMD 2010 quintiles

Black triangles: Adjusted mean estimates (least square means) from regression models (linear, logistic and Poisson), with GIMD 2010 quintiles as the categorical independent variable, adjusting for sex, age group, migration, and diabetes duration (Model 1)

White circles: Adjusted mean estimates (least square means) from regression models (linear, logistic and Poisson), with GIMD 2010 quintiles as the categorical independent variable, adjusting for sex, age group, migration, diabetes duration, and federal state (Model 2)



Supplemental figure S1. Selection of the study population



Supplemental table S2. Multiple adjusted mean estimates (95% CI) of indicators of diabetes care by GIMD 2010 quintiles, stratified by sex*

Outcome	n	sex	Q1	Q2	Q3	Q4	Q5	p-value**
Treatment								
Insulin pump therapy	13,654	Girls	45.6 (43.5 to 47.7)	51.1 (49.1 to 53.0)	50.0 (47.8 to 52.3)	47.9 (45.6 to 50.2)	45.9 (41.9 to 49.9)	0.001
(CSII), %	15,265	Boys	38.2 (36.3 to 40.2)	45.2 (43.3 to 47.1)	40.8 (38.7 to 42.9)	39.2 (37.1 to 41.4)	39.1 (35.4 to 42.9)	<0.001
CGMS, %	13,828	Girls	6.3 (5.4 to 7.3)	5.4 (4.7 to 6.3)	5.7 (4.9 to 6.7)	5.2 (4.4 to 6.2)	3.1 (2.1 to 4.4)	0.02
	15,456	Boys	6.5 (5.7 to 7.5)	6.0 (5.2 to 6.8)	5.6 (4.8 to 6.6)	5.2 (4.4 to 6.1)	3.3 (2.4 to 4.5)	0.009
Rapid-acting insulin	6,975[†]	Girls	73.3 (70.7 to 75.6)	75.7 (73.3 to 77.9)	70.9 (68.0 to 73.6)	77.3 (74.6 to 79.8)	82.0 (77.4 to 85.9)	<0.001
analogs, %	8,744	Boys	75.2 (73.1 to 77.3)	76.1 (73.9 to 78.1)	70.6 (68.0 to 73.0)	76.2 (73.9 to 78.5)	78.4 (74.1 to 82.2)	<0.001
Long-acting insulin	6,975[†]	Girls	81.8 (79.7 to 83.8)	78.0 (75.7 to 80.1)	80.8 (78.4 to 83.0)	73.5 (70.6 to 76.2)	70.2 (64.6 to 75.2)	<0.001
analogs, %	8,744	Boys	80.0 (78.0 to 81.8)	77.1 (74.9 to 79.0)	81.1 (78.9 to 83.0)	71.8 (69.2 to 74.2)	60.5 (55.1 to 65.6)	<0.001
SMBG	12,925	Girls	5.8 (5.7 to 5.9)	5.8 (5.7 to 5.9)	5.8 (5.7 to 5.8)	5.9 (5.8 to 6.0)	5.9 (5.7 to 6.0)	0.39
	14,410	Boys	5.7 (5.6 to 5.7)	5.7 (5.6 to 5.8)	5.7 (5.6 to 5.8)	5.8 (5.7 to 5.9)	5.5 (5.3 to 5.6)	0.003
Diabetes education	13,828	Girls	47.4 (45.4 to 49.5)	50.6 (48.8 to 52.4)	47.9 (45.8 to 50.0)	48.3 (46.2 to 50.5)	45.4 (41.6 to 49.2)	0.06
program, %	15,456	Boys	44.6 (42.8 to 46.5)	46.0 (44.2 to 47.8)	45.3 (43.3 to 47.4)	45.1 (43.1 to 47.1)	46.9 (43.3 to 50.6)	0.76
Outcome quality								
HbA1c, %	13,622	Girls	7.89 (7.83 to 7.95)	7.89 (7.83 to 7.94)	7.96 (7.90 to 8.02)	8.02 (7.95 to 8.08)	8.11 (7.99 to 8.22)	0.003
	15,212	Boys	7.80 (7.74 to 7.85)	7.81 (7.76 to 7.86)	7.88 (7.82 to 7.94)	7.91 (7.85 to 7.97)	8.04 (7.94 to 8.14)	<0.001
Severe hypoglycemia (all),	13,828	Girls	11.9 (9.7 to 14.6)	9.7 (8.0 to 11.8)	9.1 (7.3 to 11.4)	7.4 (5.7 to 9.6)	7.1 (4.5 to 11.3)	0.08
events/100 PY	15,456	Boys	12.1 (10.2 to 14.5)	11.5 (9.7 to 13.6)	9.3 (7.5 to 11.4)	8.4 (6.8 to 10.4)	6.6 (4.4 to 10.0)	0.02
Severe hypoglycemia with	13,828	Girls	2.1 (1.6 to 2.8)	1.8 (1.4 to 2.4)	2.1 (1.6 to 2.8)	1.8 (1.3 to 2.4)	1.9 (1.1 to 3.3)	0.86
coma, events/100 PY	15,456	Boys	1.7 (1.3 to 2.2)	1.9 (1.5 to 2.4)	2.2 (1.7 to 2.8)	1.9 (1.5 to 2.5)	1.5 (0.9 to 2.6)	0.61
DKA, events/100 PY	13,548	Girls	1.6 (1.2 to 2.1)	1.6 (1.3 to 2.1)	2.0 (1.5 to 2.5)	1.9 (1.4 to 2.4)	2.4 (1.5 to 3.7)	0.47

	15,085	Boys	1.0 (0.8 to 1.4)	1.2 (0.9 to 1.6)	1.2 (0.9 to 1.6)	1.4 (1.0 to 1.8)	2.0 (1.3 to 3.2)	0.24
Severe DKA (pH <7.1),	13,697	Girls	0.2 (0.1 to 0.3)	0.2 (0.1 to 0.4)	0.3 (0.2 to 0.6)	0.4 (0.2 to 0.6)	0.6 (0.3 to 1.1)	0.06
events/100 PY	15,268	Boys	0.1 (0.0 to 3.4)	0.1 (0.1 to 2.3)	0.1 (0.1 to 4.4)	0.1 (0.1 to 3.0)	0.1 (0.1 to 6.5)	0.90
BMI SDS	13,372	Girls	0.35 (0.32 to 0.38)	0.39 (0.36 to 0.42)	0.41 (0.37 to 0.44)	0.45 (0.42 to 0.49)	0.55 (0.49 to 0.62)	<0.001
	14,955	Boys	0.19 (0.15 to 0.22)	0.21 (0.18 to 0.24)	0.27 (0.23 to 0.30)	0.26 (0.23 to 0.30)	0.37 (0.31 to 0.43)	<0.001
Overweight, %	13,372	Girls	13.5 (12.2 to 14.9)	13.8 (12.6 to 15.1)	15.1 (13.7 to 16.5)	15.8 (14.3 to 17.4)	16.9 (14.3 to 20.0)	0.09
	14,955	Boys	10.3 (9.3 to 11.4)	10.5 (9.5 to 11.6)	12.3 (11.1 to 13.7)	12.4 (11.2 to 13.8)	14.2 (11.9 to 17.0)	0.007
Obesity, %	13,372	Girls	3.3 (2.7 to 4.0)	3.1 (2.6 to 3.8)	3.9 (3.2 to 4.8)	4.1 (3.4 to 5.0)	5.2 (3.7 to 7.2)	0.09
	14,955	Boys	2.9 (2.4 to 3.6)	2.5 (2.0 to 3.1)	3.2 (2.6 to 4.0)	3.3 (2.7 to 4.1)	3.1 (2.1 to 4.5)	0.35
Number of hospital	13,828	Girls	4.4 (3.3 to 5.8)	5.0 (3.9 to 6.3)	4.9 (3.7 to 6.4)	5.0 (3.7 to 6.6)	5.5 (3.5 to 8.7)	0.93
days/PY	15,456	Boys	4.1 (3.2 to 5.2)	4.4 (3.5 to 5.5)	4.2 (3.3 to 5.5)	4.3 (3.4 to 5.6)	4.7 (3.1 to 7.3)	0.98

* Adjusted mean estimates (least square means) with respective 95% confidence intervals are derived from logistic regression analysis (for outcomes use of insulin pump therapy (CSII), use of CGMS, use of rapid-acting insulin analogs, use of long-acting insulin analogs, participation in diabetes education program, prevalence of overweight, prevalence of obesity), linear regression analysis (for outcomes HbA1c, SMBG, BMI SDS), or Poisson regression analysis considering overdispersion (for outcomes rate of severe hypoglycemia, rate of severe hypoglycemia with coma, rate of DKA, rate of severe DKA (pH <7.1), number of hospital days). All regression models were performed with GIMD 2010 quintiles as the categorical independent variable and adjusting for age group, migration background, and diabetes duration.

† Only patients without CSII.

** p-value of test of no difference in outcome distribution across GIMD quintiles.

Supplemental Appendix S3: List of all centers contributing data to this analysis.

Aachen - Uni-Kinderklinik RWTH, Aalen Kinderklinik, Ahlen St. Franziskus Kinderklinik, Amberg Kinderklinik St. Marien, Aue Helios Kinderklink, Augsburg IV. Med. Klinik, Augsburg Josefinum Kinderklinik, Augsburg Kinderklinik Zentralklinikum, Aurich Kinderklinik, Bad Aibling Internist. Praxis, Bad Driburg / Bad Hermannsborn Innere, Bad Hersfeld Innere, Bad Hersfeld Kinderklinik, Bad Kreuznach-Viktoriastift, Bad Kösen Median Kinderklinik, Bad Lauterberg Diabeteszentrum Innere, Bad Mergentheim - Diabetesfachklinik, Bad Mergentheim - Gemeinschaftspraxis DM-dorf Althausen, Bad Oeynhausen Herz-und Diabeteszentrum NRW, Bad Orb Spessart Klinik, Bad Reichenhall Kreisklinik Innere Med., Bad Salzungen Kinderklinik, Bautzen Oberlausitz KK, Bayreuth Innere Medizin, Berchtesgaden CJD, Berlin DRK-Kliniken Mitte Innere, Berlin DRK-Kliniken Pädiatrie, Berlin Evang. Krankenhaus Königin Elisabeth, Berlin Klinik St. Hedwig Innere, Berlin Lichtenberg - Kinderklinik, Berlin Oskar Zieten Krankenhaus Innere, Berlin Parkklinik Weissensee, Berlin Schlosspark-Klinik Innere, Berlin Virchow-Kinderklinik, Berlin Vivantes Hellersdorf Innere, Bielefeld Kinderarztpraxis, Bielefeld Kinderklinik Gilead, Bocholt Kinderklinik, Bochum Universitäts St. Josef, Bochum Universitätskinderklinik St. Josef, Bonn Uni-Kinderklinik, Bottrop Knappschaftskrankenhaus Innere, Braunschweig Kinderarztpraxis, Bremen - Kinderklinik Nord, Bremen - Mitte Innere, Bremen Zentralkrankenhaus Kinderklinik, Bremerhaven Kinderklinik, Bruchweiler Edelsteinklinik Kinder-Reha, Böblingen Kinderklinik, Castrop-Rauxel Evangelisches Krankenhaus, Castrop-Rauxel Rochus-Hospital, Celle Klinik für Kinder- und Jugendmedizin, Chemnitz Kinderklinik, Chemnitz-Hartmannsdorf Innere Medizin - DIAKOMED-1, Coburg Innere Medizin, Coburg Kinderklinik, Coesfeld Kinderklinik, Coesfeld/Dülmen Innere Med., Darmstadt Innere Medizin, Darmstadt Kinderklinik Prinz. Margaret, Datteln Vestische Kinderklinik, Deggendorf Gemeinschaftspraxis, Deggendorf Medizinische Klinik II, Deggendorf Pädiatrie-Praxis, Delmenhorst Kinderklinik, Dessau Kinderklinik, Detmold Kinderklinik, Dinslaken Kinderklinik, Dortmund Kinderklinik, Dortmund Medizinische Kliniken Nord, Dortmund-Hombruch Marienhospital, Dortmund-St. Josefshospital Innere, Dortmund-West Innere, Dresden Neustadt Kinderklinik, Dresden Uni-Kinderklinik, Duisburg Malteser Rhein-Ruhr St. Anna Innere, Duisburg Sana Kinderklinik, Duisburg-Huckingen Malteser Rhein-Ruhr ST. Johannes, Duisburg-St.Johannes Helios, Düren-Birkesdorf Kinderklinik, Düsseldorf Uni-Kinderklinik, Eisleben Lutherstadt Helios-Klinik, Erfurt Kinderklinik, Erlangen Uni Innere Medizin, Erlangen Uni-Kinderklinik, Essen Diabetes-Schwerpunktpraxis, Essen Elisabeth Kinderklinik, Essen Kinderarztpraxis, Essen Uni-Kinderklinik, Esslingen Klinik für Kinder und Jugendliche, Eutin Kinderklinik, Filderstadt Kinderklinik, Flensburg Diakonissen Kinderklinik, Forchheim Diabeteszentrum SPP, Frankenthal Kinderarztpraxis, Frankfurt Diabeteszentrum Rhein-Main-Erwachsenendiabetologie (Bürgerhospital), Frankfurt

Diabeteszentrum Rhein-Main-pädiat. Diabetologie (Clementine-Hospital), Frankfurt Uni-Kinderklinik, Frankfurt Uni-Klinik Innere, Frankfurt-Sachsenhausen Innere, Frankfurt-Sachsenhausen Innere MVZ, Freiburg St. Josef Kinderklinik, Freiburg Uni Innere, Freiburg Uni-Kinderklinik, Freudenstadt Kinderklinik, Fürth Kinderklinik, Gaissach Fachklinik der Deutschen Rentenversicherung Bayern Süd, Garmisch-Partenkirchen Kinderklinik, Geislingen Klinik Helfenstein Innere, Gelnhausen Innere, Gelnhausen Kinderklinik, Gelsenkirchen Kinderklinik Marienhospital, Gera Kinderklinik, Gießen Ev. Krankenhaus Mittelhessen, Gießen Uni-Kinderklinik, Greifswald Uni-Kinderklinik, Göppingen Innere Medizin, Göppingen Kinderklinik am Eichert, Görlitz Städtische Kinderklinik, Göttingen Uni Gastroenterologie, Göttingen Uni-Kinderklinik, Hachenburg Kinderpraxis, Hagen Kinderklinik, Halberstadt Innere Med. AMEOS Klinik, Halberstadt Kinderklinik AMEOS, Halle Uni-Kinderklinik, Hamburg Altonaer Kinderklinik, Hamburg Kinderklinik Wilhelmstift, Hamburg-Nord Kinder-MVZ, Hameln Kinderklinik, Hamm Kinderklinik, Hanau Kinderklinik, Hannover DM-SPP, Hannover Kinderklinik MHH, Hannover Kinderklinik auf der Bult, Haren Kinderarztpraxis, Heide Kinderklinik, Heidelberg St. Josefskrankenhaus, Heidelberg Uni-Kinderklinik, Heidenheim Kinderklinik, Heilbronn Innere Klinik, Heilbronn Kinderklinik, Herdecke Kinderklinik, Herford Kinderarztpraxis, Herford Klinikum Kinder & Jugendliche, Heringsdorf Inselklinik, Herne Evan. Krankenhaus Innere, Hildesheim GmbH - Innere, Hildesheim Kinderarztpraxis, Hildesheim Kinderklinik, Hof Kinderklinik, Homburg Uni-Kinderklinik Saarland, Itzehoe Kinderklinik, Jena Uni-Kinderklinik, Kaiserslautern Kinderarztpraxis, Kaiserslautern-Westpfalzklinikum Kinderklinik, Kamen Klinikum Westfalen Hellmig Krankenhaus, Karlsburg Klinik für Diabetes & Stoffwechsel, Karlsruhe Städtische Kinderklinik, Kassel Klinikum Kinder- und Jugendmedizin, Kempten Oberallgäu Kinderklinik, Kiel Städtische Kinderklinik, Kiel Universitäts-Kinderklinik, Kirchen DRK Krankenhaus Kinderklinik, Kirchheim-Nürtingen Innere, Kleve Innere Medizin, Koblenz Kemperhof 1. Med. Klinik, Koblenz Kinderklinik Kemperhof, Konstanz Innere Klinik, Konstanz Kinderklinik, Krefeld Innere Klinik, Krefeld Kinderklinik, Kreischa-Zscheckwitz Klinik Bavaria, Köln Kinderklinik Amsterdamerstrasse, Köln Uni-Kinderklinik, Landau Innere, Landshut Kinderklink, Lappersdorf Kinderarztpraxis, Leer Klinikum - Klinik Kinder & Jugendmedizin, Leipzig Uni-Kinderklinik, Leverkusen Kinderklinik, Lilienthal Diabeteszentrum, Lindenfels Luisenkrankenhaus Innere 2, Lingen Kinderklinik St. Bonifatius, Lippstadt Evangelische Kinderklinik, Ludwigsburg Kinderklinik, Ludwigshafen Kinderklinik St.Anna-Stift, Ludwigshafen diabetol. SPP, Lübeck Uni-Kinderklinik, Lüdenscheid Märkische Kliniken - Kinder & Jugendmedizin, Magdeburg Städtisches Klinikum Innere, Magdeburg Uni-Kinderklinik, Mainz Uni-Kinderklinik, Mannheim Uni-Kinderklinik, Marburg Uni-Kinderklinik, Marktredwitz Innere Medizin, Mechernich Kinderklinik, Meissen Kinderklinik Elblandklinikum, Memmingen Internistische Praxis, Memmingen Kinderklinik, Minden Kinderklinik, Moers Kinderklinik, Murnau am Staffelsee - diabetol. SPP, Mutterstadt Kinderarztpraxis, Mönchengladbach Kinderklinik Rheydt Elisabethkrankenhaus, Mühldorf am Inn Kinderarztpraxis, München 3. Orden Kinderklinik, München Kinderarztpraxis diabet. SPP, München von Haunersche Kinderklinik, München-Gauting Kinderarztzentrum, München-Harlaching Kinderklinik, München-Schwabing Kinderklinik, Münster Herz

Jesu Innere, Münster Ludgerus-Kliniken GmbH, Münster St. Franziskus Kinderklinik, Münster Uni-Kinderklinik, Münster pädiat. Schwerpunktpraxis, Neuburg Kinderklinik, Neumarkt Innere, Neunkirchen Marienhausklinik Kohlhof Kinderklinik, Neuruppin Kinderklinik, Neuss Lukas-Krankenhaus Kinderklinik, Neuss Lukaskrankenhaus Kinderklinik, Neuwied Kinderklinik Elisabeth, Neuwied Marienhaus Klinikum St. Elisabeth Innere, Nürnberg Cnopfsche Kinderklinik, Nürnberg Med. Klinik 4, Nürnberg Zentrum f Neugeb./Kinder & Jugendl., Oberhausen Kinderklinik, Oberhausen Kinderpraxis, Oberhausen St.Clemens Hospitale Sterkrade, Oberndorf Gastroenterologische Praxis Schwerpunkt Diabetologie, Offenbach/Main Innere Medizin, Offenburg Kinderklinik, Oldenburg Kinderklinik, Oldenburg Schwerpunktpraxis, Olpe pädiatrische Gemeinschaftspraxis, Osnabrück Christliches Kinderhospital, Paderborn St. Vincenz Kinderklinik, Passau Kinderklinik, Pforzheim Kinderklinik, Pfullendorf Innere Medizin, Pirmasens Städtisches Krankenhaus Innere, Plauen Vogtlandklinikum, Rastatt Kreiskrankenhaus Innere, Ravensburg Kinderklink St. Nikolaus, Regensburg Kinderklinik St. Hedwig, Rendsburg Kinderklinik, Reutlingen Kinderarztpraxis, Reutlingen Kinderklinik, Reutlingen Klinikum Steinenberg Innere, Rheine Mathiasspital Kinderklinik, Rodalben St. Elisabeth, Rosenheim Innere Medizin, Rosenheim Kinderklinik, Rosenheim Schwerpunktpraxis, Rostock Uni-Kinderklinik, Rotenburg/Wümme Agaplesion Diakonieklinikum Kinderabteilung, Rüsselsheim Kinderklinik, Saaldorf-Surheim Diabetespraxis, Saarbrücken Kinderklinik Winterberg, Saarlouis Kinderklinik, Scheidegg Prinzregent Luitpold, Schw. Gmünd Stauferklinik Kinderklinik, Schweinfurt Kinderklinik, Schwerin Innere Medizin, Schwerin Kinderklinik, Schwäbisch Hall Diakonie Kinderklinik, Siegen Kinderklinik, Singen - Hegauklinik Kinderklinik, Singen Kinderarztpraxis, Spaichingen Innere, Speyer Diakonissen Stiftungskrankenhaus Pädiatrie, St. Augustin Kinderklinik, Stade Kinderklinik, Stolberg Kinderklinik, Stuttgart Olgahospital Kinderklinik, Suhl Kinderklinik, Sylt Rehaklinik, Tettnang Innere Medizin, Traunstein Kinderklinik, Traunstein diabetol. Schwerpunktpraxis, Trier Kinderklinik der Borromäerinnen, Tübingen Uni-Kinderklinik, Ulm Endokrinologikum, Ulm Uni-Kinderklinik, Vechta Kinderklinik, Viersen Kinderkrankenhaus St. Nikolaus, Villingen-Schwenningen Schwarzwald Baar Klinikum Kinderklinik, Villingen-Schwenningen Schwarzwald-Baar-Klinikum Innere, Waldshut Kinderpraxis, Waldshut-Tiengen Kinderpraxis Biberbau, Wangen Oberschwabenklinik Innere Medizin, Waren-Müritz Kinderklinik, Weiden Kinderklinik, Weingarten Kinderarztpraxis, Weisswasser Kreiskrankenhaus, Wesel Marienhospital Kinderklinik, Wiesbaden Helios Horst-Schmidt-Kinderkliniken, Wiesbaden Kinderklinik DKD, Wilhelmshaven Klinikum Kinderklinik, Winnenden Rems-Murr Kinderklinik, Wismar Kinderklinik, Wittenberg Kinderklinik, Worms - Weierhof, Worms Kinderklinik, Wuppertal Kinderklinik, Würzburg Kinderarztpraxis, Zweibrücken Kinderarztpraxis.