Original Article

Diabetes in the Hospital

A Nationwide Analysis of All Hospitalized Cases in Germany With and Without Diabetes, 2015–2017

Marie Auzanneau, Andreas Fritsche, Andrea Icks, Erhard Siegel, Reinhold Kilian, Wolfram Karges, Stefanie Lanzinger, Reinhard W. Holl

Summary

Background: Comprehensive data on the frequency of diabetes mellitus among hospitalized patients in Germany have not been published to date.

Methods: Among all inpatient cases aged ≥20 years that were documented in the German DRG statistics for 2015–2017, we analyzed the frequencies of five types of diabetes (type 1, type 2, other/pancreatic diabetes, "rare diabetes" with an ICD code of E12 or E14, gestational diabetes) and of pre-diabetes, stratified by sex and age group. The presence of any of these conditions was ascertained from the corresponding ICD-10 code among the main diagnoses (reasons for admission) or secondary diagnoses. We also compared the length of hospital stay, in-hospital mortality, and the frequency of various categories of main diagnosis in cases with and without diabetes in each age group.

Results: In the period 2015–2017, approximately 18% of the 16.4 to 16.7 million inpatient cases carried a main or secondary diagnosis of diabetes (in 2017: type 2, 17.1%; type 1, 0.5%). Diabetes was more common in male cases than in female cases (in 2017: type 2, 19.7% vs. 14.8%; type 1, 0.5% vs. 0.4%). In 2017, the greatest difference in length of hospital stay between patients with and without diabetes was for patients with type 1 diabetes aged 40–49 (7.3 vs. 4.5 days), while the greatest difference in in-hospital mortality was for patients with type 2 diabetes aged 70–79 (3.7% vs. 2.8%). From the age of 30 (age category 30–39), diseases of the cardiovascular system, and from the age of 50 (age category 50–59), diseases of the respiratory or urogenital systems were more frequently listed as a reason for admission in cases with than in those without diabetes.

Conclusion: The fact that diabetes is twice as prevalent in hospitalized cases as in the general population underscores the high morbidity associated with the disease and the greater need of persons with diabetes for in-hospital care, as the population of multimorbid diabetes patients continues to grow older.

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According to the International Diabetes Federation (IDF), an estimated 7.5 million adults had diagnosed diabetes in Germany in 2017 (1). Recent estimates suggests that by 2040 Germany will be the home of 10.7 to 12.3 million people with type 2 diabetes (2).

The care of patients with diabetes is not solely provided in an outpatient setting. According to a survey of the University Hospital Tübingen, 22% of its inpatients had diabetes in 2016 (3). However, due to the fact that most hospital statistics merely include the reasons for admission (main diagnoses) and do not take comorbidities (secondary diagnosis) into account—and diabetes is often only documented as a secondary diagnosis in the German DRG system—, the frequency of diabetes in the hospital may be underestimated (4).

Even if diabetes is not the primary reason for hospitalization, expertise in diabetology is essential (4, 5). Compared to persons without diabetes, persons

TABLE

Diabetes as a main diagnosis or secondary diagnosis in hospitalized cases from the age of 20 years, 2015–2017

		2015		2016		2017	
		Hospitalized cases	Proportion of all hospitalized cases (%)	Hospitalized cases	Proportion of all hospitalized cases (%)	Hospitalized cases	Proportion of all hospitalized cases (%)
With diabetes (all types)	As MD	207 072	1.26	204 667	1.22	202 546	1.21
	Only as SD	2 798 691	17.02	2 835 957	17.01	2 856 139	17.15
	Total	**3 005 763**	**18.28**	**3 040 624**	**18.23**	**3 058 685**	**18.36**
Type 1 diabetes (E10)	As MD	25 399	0.16	26 044	0.16	26 298	0.16
	Only as SD	47 972	0.29	50 297	0.30	50 287	0.30
	Total	**73 371**	**0.45**	**76 341**	**0.46**	**76 585**	**0.46**
Type 2 diabetes (E11)	As MD	164 567	1.00	160 716	0.96	157 793	0.95
	Only as SD	2 636 979	16.04	2 668 883	16.01	2 684 884	16.12
	Total	**2 801 546**	**17.04**	**2 829 599**	**16.97**	**2 842 677**	**17.07**
Other/ pancreatic diabetes (E13)	As MD	4717	0.03	4996	0.03	4901	0.03
	Only as SD	43 477	0.26	48 798	0.29	54 502	0.33
	Total	**48 194**	**0.29**	**53 794**	**0.32**	**59 403**	**0.36**
Rare types of diabetes (E12 or E14)	As MD	690	< 0.01	566	< 0.01	500	< 0.01
	Only as SD	11 820	0.07	11 220	0.07	10 950	0.07
	Total	**12 510**	**0.08**	**11 786**	**0.07**	**11 450**	**0.07**
Gestational diabetes (O24)	As MD	11 403	0.07	12 069	0.07	12 752	0.08
	Only as SD	28 303	0.17	28 313	0.17	25 872	0.15
	Total	**39 706**	**0.24**	**40 382**	**0.24**	**38 624**	**0.23**
Prediabetes (R73)	As MD	296	< 0.01	276	< 0.01	302	< 0.01
	Only as SD	30 140	0.18	28 446	0.17	29 644	0.18
	Total	**30 436**	**0.19**	**28 722**	**0.17**	**29 946**	**0.18**
All		16 445 052	100	16 674 924	100	16 656 350	100

Case with type 1 and type 2 diabetes as double secondary diagnoses (n = 926 in 2017; n = 979 in 2016; n = 991 in 2015) as well as cases of unknown age (n = 52 in 2017; n = 36 in 2016; n = 76 in 2015) were excluded.
Cases with or without diabetes with unknown sex (n = 1 073 in 2017; n = 175 in 2016; n = 285 in 2015) were assigned to the female cases (the larger group).
In order to prevent cell locking, cases with gestational diabetes aged ≥50 years were excluded (n = 12 in 2017; n = 16 in 2016; n = 11 in 2015). Cases with multiple coding of diabetes in the secondary diagnoses (especially with gestational diabetes) were only assigned to one type of diabetes (see *eMethods* section).
Percentages are rounded. MD, main diagnosis; SD, secondary diagnosis

with diabetes stay longer in the hospital for the same main diagnosis, experience complications more frequently and have higher mortality rates (3, 6, 7). For example, metabolic decompensation often develops as the result of inpatient treatment with psychiatric medications, oncology drugs or steroids and can lead to life-threatening conditions (3, 4). Patients undergoing elective procedures also require adequate pre-, peri- and postoperative diabetes treatment to prevent complications (4, 5). However, comprehensive statistical information about diabetes in the hospital setting is lacking, even though such data is required to accurately assess the need for diabetological expertise (8). Thus, the aim of our study was to describe the proportion of diabetes cases among hospitalized patients, based on the mandatory DRG statistics for 2015–2017.

Methods

All inpatient cases aged ≥ 20 years (with and without diabetes) in the DRG statistics for 2015–2017 (source: Research Data Centers [FDZ, Forschungsdatenzentren] of the German Federal and State Statistical Offices [Destatis, Statistische Ämter des Bundes und der Länder]) were included in the study. Five types of diabetes were identified in the main diagnoses or secondary diagnoses based on the corresponding ICD-10 codes:

- Type 1 diabetes (E10)
- Type 2 diabetes (E11)
- Other specified diabetes mellitus, including pancreatic diabetes (diabetes resulting from diseases of the exocrine pancreas) (E13)
- Rare types of diabetes (E12 or E14)
- Gestational diabetes (O24).

In addition, we considered the cases with prediabetes (R73) as they are also associated with a high cardiovascular risk and require diabetological expertise, too. The absolute and relative frequencies of inpatient cases were analyzed stratified by year of treatment, type of diabetes, sex, and age group. In addition, length of hospital stay (median and mean) and in-hospital mortality (proportion of inpatient cases in percent) were analyzed stratified by type of diabetes and age group. The Wilcoxon test was used for comparisons between the 2015 and 2017 results as well as between cases with and without diabetes; all p-values were adjusted using false discovery rate correction (Benjamini-Hochberg procedure). The significance level (two-sided) was set at 0.05.

Based on prevalence estimates of the Central Institute for Statutory Health Care (Zi, Zentralinstituts für die kassenärztliche Versorgung) (9) and the German population as on 31 December 2017 (10), we estimated the prevalent population with type 2 diabetes in the general population so that we could calculate the proportion of inpatient treatments among patients with type 2 diabetes in 2017, stratified by age group and sex. The frequencies of various categories of main diagnoses were compared in cases with diabetes as a secondary diagnosis and cases without diabetes in each age group (refer to the *eMethods* section for further information).

Results

Frequencies of diabetes as a main or secondary diagnosis in 2017

In 2017, a main diagnosis or secondary diagnosis of diabetes mellitus was recorded in 3 058 685 (18.4%) of the total 16 656 350 hospitalized cases *(Table)*. The vast majority of cases had type 2 diabetes (17.1% of all inpatient treatments, n = 2 842 677) which was mostly coded as a secondary diagnosis (94.4% of cases). Only 0.5% of all hospitalized cases had type 1 diabetes (n = 76 585); in 65.7% of these cases, the disease was documented as a secondary diagnosis *(Table)*.

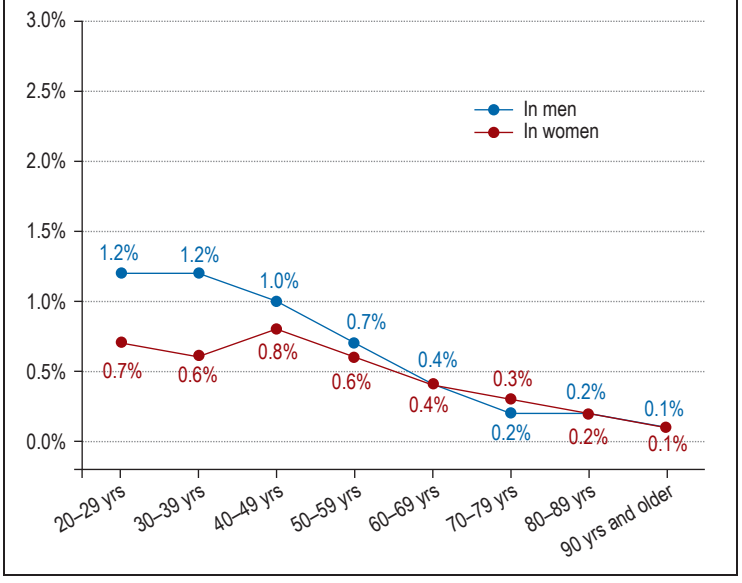
Diabetes from 2015–2017

In the period from 2015 to 2017, the proportion of all cases with diabetes as a main diagnosis or secondary diagnosis remained largely stable at about 18% of a total of 16.4 to 16.7 million inpatient treatments of patients aged ≥ 20 years. Over this three-year period, type 2 diabetes was coded less frequently as a main diagnosis and more frequently as a secondary diagnosis *(Table)*. The increase in cases documented as other/pancreatic diabetes (E13) *(Table)* is mainly due to a sharp increase in this secondary diagnosis among female, pregnant cases in the age category 20–39.

Diabetes stratified by sex and age group

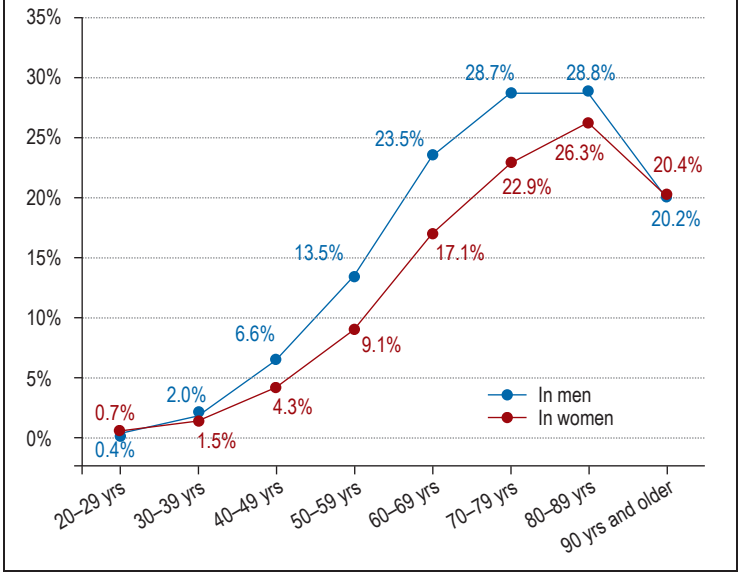
During these three years, male inpatient cases with type 1 diabetes or type 2 diabetes were more common than female cases, especially in the age category 40–79 *(eTable 1)*. In 2017, 0.5% of all male hospitalized cases

FIGURE 1a



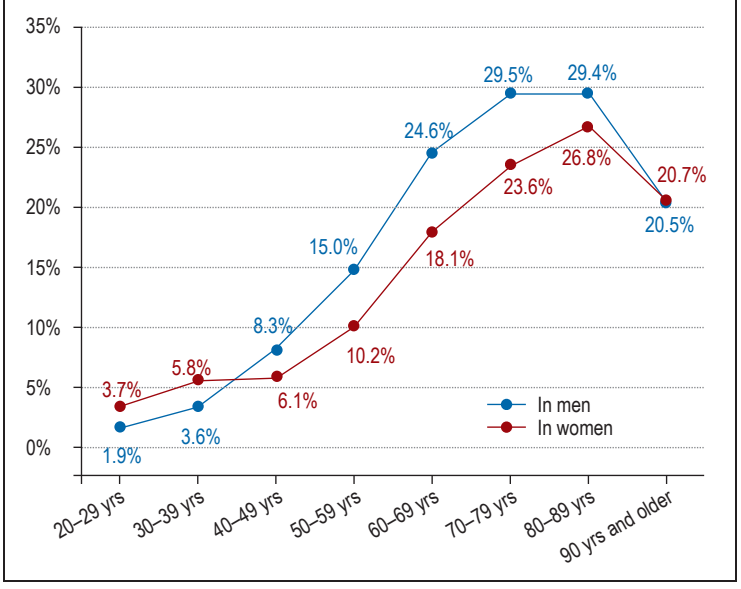
Type 1 diabetes: Relative frequency of hospitalized cases with type 1 diabetes in 2017 stratified by age group and sex. The points represent the relative frequencies (proportion of all hospitalized cases in the respective sex and age categories). yrs, years

FIGURE 1b



Type 2 diabetes: Relative frequency of hospitalized cases with type 2 diabetes in 2017 stratified by age group and sex. The points represent the relative frequencies (proportion of all hospitalized cases in the respective sex and age categories). yrs, years

FIGURE 1c



Diabetes (all types): Relative frequency of hospitalized cases with Diabetes (all types) in 2017 stratified by age group and sex. The points represent the relative frequencies (proportion of all hospitalized cases in the respective sex and age categories). yrs, years

(n = 40 605) versus 0.4% of all female hospitalized cases (n = 35 980) had type 1 diabetes and 19.7% of all male cases (1 536 988) versus 14.8% of all female cases (1 305 689) had type 2 diabetes *(eTable 1)*.

In 2017, and in the two years prior, the absolute frequency of hospitalized cases increased up to the age of 50 (age category 50–59) in patients with type 1 diabetes and up to the age of 70 (age category 70–79) in patients with type 2 diabetes *(eTable 1)*. In the period from 2017–2019, the absolute number of cases with type 2 diabetes decreased in the age category 70–79 years, while it increased in the age category 80 and older *(eTable 1)*. With growing age, the number of cases with type 1 diabetes decreased among all hospitalized cases, while the proportion of cases with type 2 diabetes or diabetes in general increased *(Figures 1a–c)*.

Proportion of inpatient cases in the estimated population with type 2 diabetes in 2017

Up to the age of 60 (age category 60–69), the estimated number of inpatient treatments per 100 patients with type 2 diabetes was higher among women than among men *(Figure 2)*. The largest difference was found in the age group of 20–39 in which more than a third of all female cases (35.2%) had a main diagnosis from the ICD group "O" (pregnancy, childbirth and the puerperium).

Length of hospital stay and in-hospital mortality

Overall, between 2015 and 2017, both mean length of hospital stay and in-hospital mortality decreased significantly across all age groups, in all hospitalized patients (with or without diabetes), except for cases with type 1 diabetes in the age group of 60–89 years *(eTable 2)*. In this three-year period, the mean length of hospital stay was significantly higher in cases with diabetes compared to cases without diabetes in each age group, especially in cases in the age category 40–69 years as well as in cases with type 1 diabetes. The largest difference in comparison to cases without diabetes was found in the cases with type 1 diabetes in the age category 40–49 years: 7.3 days vs. 4.5 days in the cases without diabetes in 2017 *(eTable 2)*.

Apart from cases with type 1 diabetes from the age of 80 (age category 80+), in-hospital mortality was higher in cases with diabetes compared to cases without diabetes in each age group. The largest difference was found in cases with type 2 diabetes in the age category 70–79: 3.7% vs. 2.8% in the cases without diabetes in 2017 *(eTable 2)*.

Main diagnosis category in hospitalized cases with and without diabetes in 2017

Already from age 30 (age category 30–39; noticeably from age 40 [age category 40–49]), a disease of the cardiovascular system was more frequently listed as a reason for admission in cases with than in those without diabetes (in the age category 50–59: 23.3% of cases with diabetes vs. 13.9% of cases without diabetes, *eFigure*). From the age of 50 (age category 50–59), diseases of the respiratory or urogenital systems were also more frequently listed as the main diagnosis in cases with diabetes. By contrast, in hospitalized cases without diabetes aged 20–39, the relative frequency of admissions for diseases of the digestive, respiratory or urogenital systems was higher than in cases with diabetes. No significant differences were found for diseases of the nervous system and neoplasms *(eFigure)*. The same is true for mental disorders/behavioral disorders, e.g. among the 40– to 49-year-olds, the age group most commonly affected by these disorders: 2.2% and 3.0% of the main diagnoses in cases with diabetes and without diabetes, respectively.

Discussion

Our analysis provides a comprehensive picture of diabetes in the hospital in Germany in the period from 2015 to 2017. The proportion of documented diabetes among hospitalized cases was stable at about three million (18%) over this period of three years. Based on nationwide billing data of panel doctors in Germany, the Central Research Institute of Ambulatory Health Care (Zi) estimated the prevalence of diabetes mellitus in 2015 to be 9.8% overall (9). The fact that the proportion of diabetes among hospitalized cases is almost twice as high in our results may be explained by the higher rate of hospitalizations in the elderly and/or by the increased need for inpatient care among people with diabetes.

Unlike other studies (3, 11), only cases with known and documented diabetes were included in our analysis. Thus, it is likely that the prevalence of diabetes in

the hospital would be higher if cases with undiagnosed diabetes were included. An international comparison based on statistical information released by the Organization for Economic Cooperation and Development (OECD) shows that the rate of hospitalization with diabetes as the main diagnosis is particularly high in Germany *(eTabelle 3)*.

Several studies indicate an increase in the prevalence of type 2 diabetes (7, 12), especially among men and among the 80– to 85-year-olds where the prevalence of diabetes is the highest (7, 9). Our analysis shows that, in line with the aging of the general population, the number of persons with diabetes in the hospital increases from the age of 80 years.

Although most of the cases in the middle age group (age category 40–79) were male, up to age 69, women with type 2 diabetes were more frequently hospitalized. One of the reasons for this could be the relatively higher diabetes-related mortality among middle-aged women (12). In addition, the number of pregnancies in women with known type 2 diabetes, including pregnancies after bariatric surgery, have steadily increased up to 2017 (13).

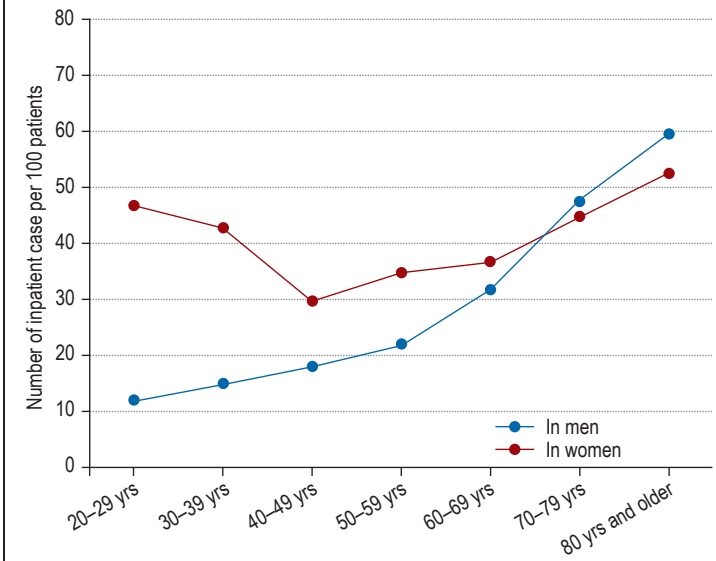
In recent years, gestational diabetes has more frequently been diagnosed, especially since the launch of the gestational diabetes screening program in 2012 (7, 13, 14). In our results, the increase in the category "other/pancreatic diabetes" can be partly explained by double coding of E13/O24 and is likely the result of incorrect coding of gestational diabetes.

Consistent with other publications (3, 6), we found a significantly higher mean length of stay and significantly higher in-hospital mortality in cases with diabetes. The lower in-hospital mortality among cases with type 1 diabetes aged 80 years and older may be explained by multiple readmissions in this patient group (lower in-hospital mortality per case, but not per person).

From the age of 40 (age category 40–49), a disease of the cardiovascular system was significantly more frequently listed as a reason for admission in cases with than in those without diabetes. It is a known fact that persons with diabetes are at a significantly increased risk of cardiovascular disease (2 to 4 times for men and 6 times for women) (15). In addition, persons with diabetes have twice the risk of heart failure (16).

Diseases of the respiratory and urogenital systems are further common reasons for admission in cases with diabetes from the age of 50 (age category 50–59). Smoking is associated with the development of diabetes (17); both diabetes and smoking are more common among individuals of low socioeconomic status (7). At the same time, smoking is the most common cause of chronic obstructive pulmonary disease and lung cancer (18). In addition, about 42% of people with type 2 diabetes are diagnosed with kidney damage in Germany. Renal failure due to diabetic nephropathy is the most common reason for renal replacement therapy (19).

FIGURE 2



Estimated number of inpatient cases per 100 patients with type 2 diabetes in 2017 stratified by age group and sex. The number of inpatient treatments per 100 patients with type 2 diabetes in 2017, stratified by age group and sex, was calculated based on the estimated prevalent population with type 2 diabetes. This population was projected based on the administrative prevalence estimates of the Central Institute for Statutory Health Care (Zi) (9) and the population as on 31 December 2017 (10) (see *eMethods* section).

Thanks to including diabetes as a main diagnosis and as a secondary diagnosis in the analysis, our study provides important information on the real prevalence of diabetes in inpatient care. Except for psychiatric and psychosomatic hospitals and rehabilitation facilities, the mandatory nationwide German DRG statistics can be regarded as representative. However, the DRG statistics consist of secondary data which were not primarily collected for research, but for billing purposes. There are certain limitations that come with this: One of these is that clinical information is lacking, another that the quality of coding, e.g. for gestational diabetes, is not guaranteed. In addition, comorbidities may be underestimated. Systematic overcoding of diabetes for billing reasons is unlikely, because diabetes, which is mostly coded as a secondary diagnosis, has currently little effect on revenue. Another limitation is that this statistical information is case-related and as such, does not allow conclusions to be drawn about the actual number of patients.

Conclusion

Since diabetes is more commonly coded as a secondary diagnosis in the DRG statistics, there is a risk that the need for expertise in diabetology is underestimated. Only 17% of hospitals have a qualification in diabetology (4). The fact that more than three million patients with diabetes are hospitalized each year underscores the need for qualified diabetes care in the hospital.

Because diabetes is associated with life-threatening hypoglycemia and hyperglycemia as well as certain comorbidities, there is a need for a flexible and individual management in the hospital (20) which can keep up with the rapid advances in the combination drug therapy of diabetes and the field of technological treatment options, such as insulin pumps and continuous tissue glucose monitoring. If this need is left unaddressed, it will likely have negative effects on the treatment of patients with diabetes in the hospital as well as adverse economic consequences for the hospitals, such as an increased length of hospital stay and higher surgical complication rates. This is why reliable and detailed information about diabetes in the hospital is indispensable.

This analysis describes the extent of inpatient diabetes care in the period 2015–2017 with a special focus on the high need of persons with diabetes for inpatient care, as the population of often multimorbid diabetes patients continues to grow older.

Data source
Research Data Centers (FDZ) of the German Federal and State Statistical Offices, DRG statistics 2015–2017, own calculations.

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Conflict of interest
Prof. Fritsche received lecture fees and consultancy fees from Sanofi, Novo Nordisk, Astra Zeneca, and Boehringer Ingelheim.

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The remaining authors declare no conflict of interest.

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► **Supplementary material**

eMethods, eTables, eFigures:
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Supplementary material to:

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eTABLE 1

Frequency of hospitalized cases with type 1 diabetes, type 2 diabetes or without diabetes in the period 2015–2017, stratified by sex and age group

Type of diabetes	Age group	2015			2016			2017		
		Sex		Total	Sex		Total	Sex		Total
		Male	Female		Male	Female		Male	Female	
T1D (MD or SD)	20–29 yrs	5162	5374	10 536	5408	5601	11 009	5226	5621	10 847
	30–39 yrs	5429	5593	11 022	5865	5886	11 751	5706	5989	11 695
	40–49 yrs	7328	5621	12 949	7039	5595	12 634	6988	5458	12 446
	50–59 yrs	8754	6177	14 931	9382	6590	15 972	9409	6561	15 970
	60–69 yrs	5859	4460	10 319	6522	4853	11 375	6616	5041	11 657
	70–79 yrs	4738	4713	9451	4675	4498	9173	4579	4580	9159
	80–89 yrs	1618	2189	3807	1772	2276	4048	1980	2467	4447
	≥ 90 yrs	98	258	356	111	268	379	101	263	364
	Total	38 986	34 385	73 371	40 774	35 567	76 341	40 605	35 980	76 585
T2D (MD or SD)	20–29 yrs	1829	4854	6683	1995	5475	7470	1863	5624	7487
	30–39 yrs	9172	12 779	21 951	9698	14 201	23 899	9603	14 926	24 529
	40–49 yrs	47 952	32 666	80 618	47 685	32 447	80 132	45 999	31 375	77 374
	50–59 yrs	179 871	103 085	282 956	183 275	104 372	287 647	181 550	102 820	284 370
	60–69 yrs	351 668	212 187	563 855	369 246	222 403	591 649	374 010	221 977	595 987
	70–79 yrs	570 037	456 774	1 026 811	554 538	435 797	990 335	545 003	417 856	962 859
	80–89 yrs	302 859	405 140	707 999	322 787	413 543	736 330	346 351	426 603	772 954
	≥ 90 yrs	27 938	82 735	110 673	29 741	82 396	112 137	32 609	84 508	117 117
	Total	1 491 326	1 310 220	2 801 546	1 518 965	1 310 634	2 829 599	1 536 988	1 305 689	2 842 677
Without diabetes*	20–29 yrs	425 638	810 920	1 236 558	433 172	830 285	1 263 457	414 779	789 162	1 203 941
	30–39 yrs	454 547	913 177	1 367 724	471 439	957 670	1 429 109	465 659	955 161	1 420 820
	40–49 yrs	694 139	726 835	1 420 974	675 002	712 637	1 387 639	639 007	679 704	1 318 711
	50–59 yrs	1 116 949	994 844	2 111 793	1 140 367	1 016 188	2 156 555	1 142 091	1 016 570	2 158 661
	60–69 yrs	1 120 273	995 649	2 115 922	1 173 972	1 044 297	2 218 269	1 201 736	1 061 859	2 263 595
	70–79 yrs	1 409 237	1 461 655	2 870 892	1 364 920	1 423 170	2 788 090	1 338 693	1 394 917	2 733 610
	80– 89 yrs	769 075	1 125 654	1 894 729	803 830	1 151 457	1 955 287	850 363	1 189 952	2 040 315
	≥ 90 yrs	110 288	309 408	419 696	116 922	317 978	434 900	127 962	329 117	457 079
	Total	6 100 146	7 338 142	13 438 288	6 179 624	7 453 682	13 633 306	6 180 290	7 416 442	13 596 732

* ICD codes E10–E14, 024 (gestational diabetes) and R73 (prediabetes) were excluded. MD, main diagnosis; yrs, years; SD, secondary diagnosis; T1D, type 1 diabetes; T2D, type 2 diabetes

eTABLE 2

Length of hospital stay and in-hospital mortality stratified by age group in hospitalized cases with and without diabetes, 2015–2017

Type of diabetes*1	Age group	2015				2016				2017			
		Length of hospital stay	p values*3 (vs. without diabetes)	In-hospital mortality	p values*3 (vs. without diabetes)	Length of hospital stay	p values*3 (vs. without diabetes)	In-hospital mortality	p values*3 (vs. without diabetes)	Length of hospital stay	p values*3 (vs. without diabetes)	In-hospital mortality	p values*3 (vs. without diabetes)
T1D	20–29 yrs	4 (5.7)	<0.001	20/10 536 (0.2%)	<0.001	4 (5.6)	<0.001	19/11 009 (0.2%)	<0.001	4 (5.5)	<0.001	14/10 847 (0.1%)	<0.001
	30–39 yrs	5 (6.5)	<0.001	51/11 022 (0.5%)	<0.001	4 (6.2)	<0.001	37/11 751 (0.3%)	<0.001	4 (6.3)	<0.001	42/11 695 (0.4%)	<0.001
	40–49 yrs	5 (7.3)	<0.001	102/12 949 (0.8%)	<0.001	5 (7.3)	<0.001	108/12 634 (0.9%)	<0.001	5 (7.3)	<0.001	103/12 446 (0.8%)	<0.001
	50–59 yrs	6 (8.1)	<0.001	212/14 931 (1.4%)	<0.001	5 (7.9)	<0.001	221/15 972 (1.4%)	<0.001	5 (8.0)	<0.001	212/15 970 (1.3%)	<0.001
	60–69 yrs	6 (8.4)	<0.001	192/10 319 (1.9%)	<0.001	6 (8.4)	<0.001	232/11 375 (2.0%)	<0.001	6 (8.3)	<0.001	259/11 657 (2.2%)	<0.001
	70–79 yrs	6 (9.0)	<0.001	256/9451 (2.7%)	<0.001	6 (8.8)	<0.001	270/9173 (2.9%)	<0.001	6 (9.0)	<0.001	271/9159 (3.0%)	<0.001
	80–89 yrs	7 (9.2)	<0.001	177/3807 (4.6%)	<0.001	7 (9.4)	<0.001	192/4048 (4.7%)	<0.001	7 (9.5)	<0.001	207/4447 (4.7%)	<0.001
	≥ 90 yrs	7 (9.1)	0.021	27/356 (7.6%)	<0.001	6 (8.6)	*0.375*	32/379 (8.4%)	<0.001	7 (8.9)	0.006	27/364 (7.4%)	<0.001
T2D	20–29 yrs	4 (5.2)	<0.001	27/6 683 (0.4%)	<0.001	4 (4.9)	<0.001	16/7 470 (0.2%)	<0.001	4 (4.9)	<0.001	16/7487 (0.2%)	<0.001
	30–39 yrs	4 (5.9)	<0.001	111/21 951 (0.5%)	<0.001	4 (5.6)	<0.001	116/23 899 (0.5%)	<0.001	4 (5.4)	<0.001	89/24 529 (0.4%)	<0.001
	40–49 yrs	4 (6.7)	<0.001	804/80 618 (1.0%)	<0.001	4 (6.6)	<0.001	747/80 132 (0.9%)	<0.001	4 (6.4)	<0.001	651/77 374 (0.8%)	<0.001
	50–59 yrs	5 (7.5)	<0.001	4 550/282 956 (1.6%)	<0.001	5 (7.4)	<0.001	4 525/287 647 (1.6%)	<0.001	5 (7.3)	<0.001	4 422/284 370 (1.6%)	<0.001
	60–69 yrs	6 (8.3)	<0.001	14 114/563 855 (2.5%)	<0.001	5 (8.2)	<0.001	14 559/591 649 (2.5%)	<0.001	5 (8.1)	<0.001	14 872/595 987 (2.5%)	<0.001
	70–79 yrs	6 (9.1)	<0.001	38 602/1 026.811(3.8%)	<0.001	6 (9.0)	<0.001	35 509/990 335 (3.6%)	<0.001	6 (8.9)	<0.001	35 147/962 859 (3.7%)	<0.001
	80–89 yrs	7 (9.6)	<0.001	44 262/707 999 (6.3%)	<0.001	7 (9.5)	<0.001	43 601/736 330 (5.9%)	<0.001	7 (9.3)	<0.001	45 940/772 954 (5.9%)	<0.001
	≥ 90 yrs	7 (8.9)	<0.001	10 979/110 673 (9.9%)	<0.001	7 (8.9)	<0.001	10 701/112 137 (9.5%)	<0.001	7 (8.8)	<0.001	11 517/117 117 (9.8%)	<0.001
All types*2	20–29 yrs	4 (5.4)	<0.001	94/34 614 (0.3%)	<0.001	4 (5.3)	<0.001	87/37 418 (0.2%)	<0.001	4 (5.2)	<0.001	68/38 105 (0.2%)	<0.001
	30–39 yrs	4 (5.7)	<0.001	247/50 493 (0.5%)	<0.001	4 (5.5)	<0.001	230/60 989 (0.4%)	<0.001	4 (5.4)	<0.001	219/76 230 (0.3%)	<0.001
	40–49 yrs	4 (6.9)	<0.001	1 135/105 132 (1.1%)	<0.001	4 (6.9)	<0.001	1 079/104 451 (1.0%)	<0.001	4 (6.7)	<0.001	966/101 679 (1.0%)	<0.001
	50–59 yrs	5 (7.7)	<0.001	5 385/313 771 (1.7%)	<0.001	5 (7.5)	<0.001	5 377/319 458 (1.7%)	<0.001	5 (7.5)	<0.001	5 273/316 890 (1.7%)	<0.001
	60–69 yrs	6 (8.4)	<0.001	15 241/592 610 (2.6%)	<0.001	5 (8.3)	<0.001	15 726/621 504 (2.5%)	<0.001	5 (8.2)	<0.001	16 080/626 309 (2.6%)	<0.001
	70–79 yrs	7 (9.1)	<0.001	40 091/1 058.503 (3.8%)	<0.001	6 (9.0)	<0.001	37 041/1 020 512 (3.6%)	<0.001	6 (8.9)	<0.001	36 665/992 605 (3.7%)	<0.001
	80–89 yrs	7 (9.6)	<0.001	45 263/722 411 (6.3%)	<0.001	7 (9.5)	<0.001	44 597/750 712 (5.9%)	<0.001	7 (9.4)	<0.001	46 967/788 119 (6.0%)	<0.001
	≥ 90 yrs	7 (8.9)	<0.001	11 180/112 475 (9.9%)	<0.001	7 (8.9)	<0.001	10 894/113 829 (9.6%)	<0.001	7 (8.8)	<0.001	11 681/118 748 (9.8%)	<0.001
Without diabetes	20–29 yrs	3 (3.6)		1 157/1 236 558 (0.1%)		3 (3.5)		1 032/1 263 457 (0.1%)		3 (3.5)		1 059/1 203 941 (0.1%)	
	30–39 yrs	3 (4.0)		2 317/1 367 724 (0.2%)		3 (3.9)		2 378/1 429 109 (0.2%)		3 (3.8)		2 437/1 420 820 (0.2%)	
	40–49 yrs	3 (4.6)		7 831/1 420 974 (0.6%)		3 (4.6)		7 519/1 387 639 (0.5%)		3 (4.5)		6 911/1 318 711 (0.5%)	
	50–59 yrs	3 (5.5)		23 630/2 111 793 (1.1%)		3 (5.4)		23 793/2 156 555 (1.1%)		3 (5.3)		23 328/2 158 661 (1.1%)	
	60–69 yrs	4 (6.3)		40 890/2 115 922 (1.9%)		4 (6.3)		42 051/2 218 269 (1.9%)		4 (6.2)		42 823/2 263 595 (1.9%)	
	70–79 yrs	5 (7.3)		82 346/2 870 892 (2.9%)		5 (7.2)		78 526/2 788 090 (2.8%)		5 (7.1)		77 726/2 733 610 (2.8%)	
	80–89 yrs	6 (8.4)		104 865/1 894 729 (5.5%)		6 (8.3)		102 770/1 955 287 (5.3%)		6 (8.2)		107 097/2 040 315 (5.2%)	
	≥ 90 yrs	6 (8.3)		40 345/419 696 (9.6%)		6 (8.2)		39 983/434 900 (9.2%)		6 (8.2)		43 522/457 079 (9.5%)	

Length of hospital stay in days: median (mean); *1 main or secondary diagnosis; *2 ICD codes E10–E14, 024 (gestational diabetes) or R73 (prediabetes)
*3 Comparisons with Wilcoxon test; p values adjusted using false discovery rate correction (Benjamini-Hochberg procedure); significance level (two-sided): 0,05; non-significant results in italics; yrs, years

eTABLE 2 – CONTINUED

Length of hospital stay and in-hospital mortality stratified by age group in hospitalized cases with and without diabetes, 2015–2017

Type of diabetes*1	Age group	p values*3 (2017 vs. 2015)	
		Length of hospital stay	In-hospital mortality
T1D	20–29 yrs	0.004	<0.001
	30–39 yrs	0.004	<0.001
	40–49 yrs	*0.088*	<0.001
	50–59 yrs	0.005	<0.001
	60–69 yrs	*0.384*	<0.001
	70–79 yrs	*0.325*	<0.001
	80–89 yrs	*0.266*	<0.001
	≥ 90 yrs	*0.996*	<0.001
T2D	20–29 yrs	0.013	<0.001
	30–39 yrs	<0.001	<0.001
	40–49 yrs	<0.001	<0.001
	50–59 yrs	<0.001	<0.001
	60–69 yrs	<0.001	<0.001
	70–79 yrs	<0.001	<0.001
	80–89 yrs	<0.001	<0.001
	≥ 90 yrs	<0.001	<0.001
All types*2	20–29 yrs	<0.001	<0.001
	30–39 yrs	<0.001	<0.001
	40–49 yrs	<0.001	<0.001
	50–59 yrs	<0.001	<0.001
	60–69 yrs	<0.001	<0.001
	70–79 yrs	<0.001	<0.001
	80–89 yrs	<0.001	<0.001
	≥ 90 yrs	<0.001	<0.001
Without diabetes	20–29 yrs	<0.001	<0.001
	30–39 yrs	<0.001	<0.001
	40–49 yrs	<0.001	<0.001
	50–59 yrs	<0.001	<0.001
	60–69 yrs	<0.001	<0.001
	70–79 yrs	<0.001	<0.001
	80–89 yrs	<0.001	<0.001
	≥ 90 yrs	<0.001	<0.001

Length of hospital stay in days: median (mean);
*1 Main or secondary diagnosis; *2 ICD codes E10–E14, 024 (gestational diabetes) or R73 (prediabetes) *3Comparisons with Wilcoxon test; p values adjusted using false discovery rate correction (Benjamini-Hochberg procedure); significance level (two-sided):0.05; non-significant results in italics; yrs, years

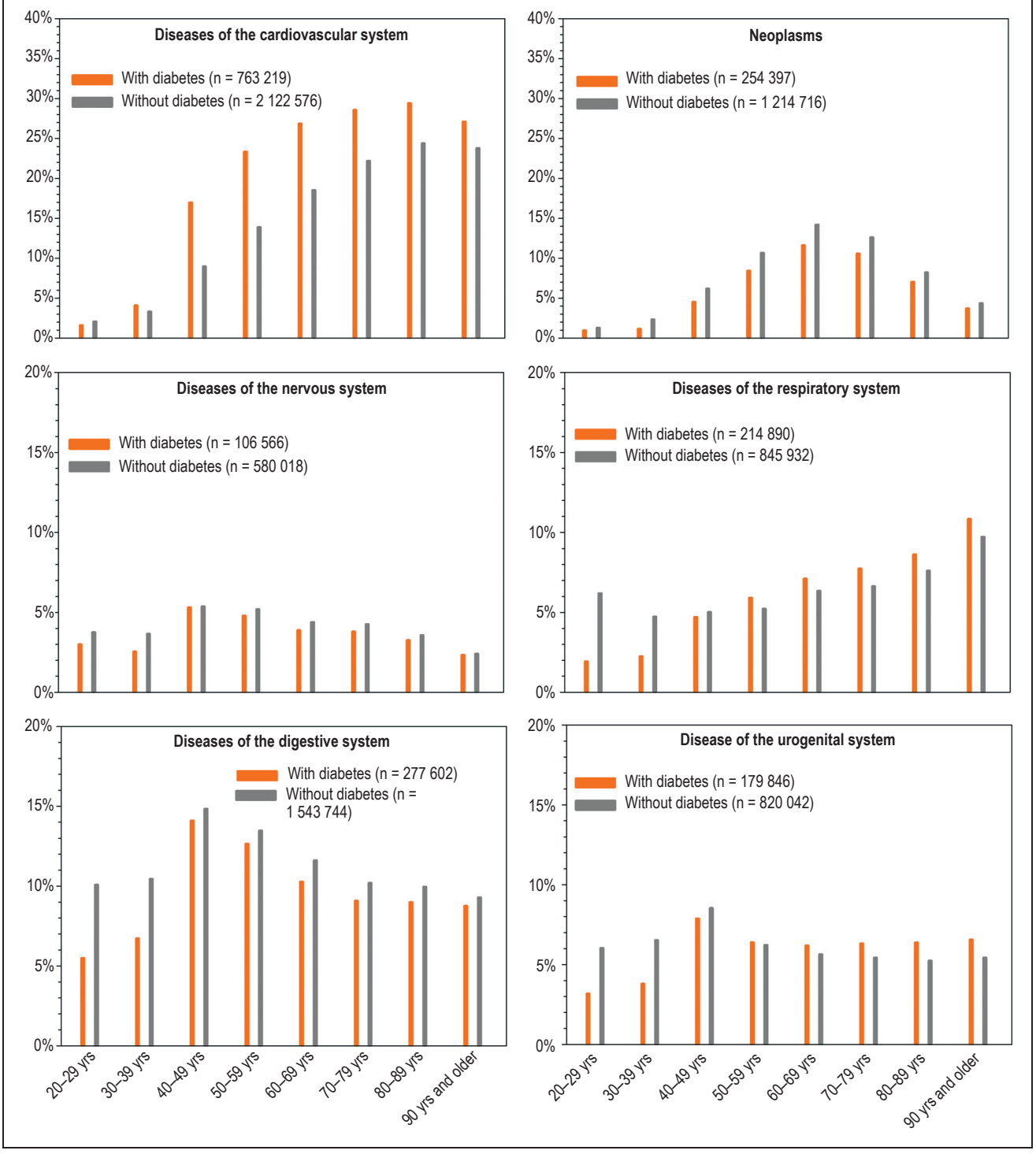
eTABLE 3

Number of hospital discharges with diabetes mellitus* by country, 2016 (OECD statistics)

Country	Hospital discharges with diabetes mellitus (per 100 000 population)
Italy	52.2
Spain	57.3
Netherlands	60.1
Israel	76.1
United Kingdom	79.9
Switzerland	81.3
Norway	86.3
Sweden	96.9
Ireland	97.0
Denmark	102.7
Canada	102.8
Finland	130.5
Australia	142.2
Belgium	142.3
France	153.8
Poland	191.3
Hungary	239.1
Austria	262.8
Germany	266.0
Turkey	320.2

Source: Statistics of the Organization for Economic Cooperation and Development(OECD) (https://stats.oecd.org/); * for Germany: only main diagnoses (ICD codes E10–E14; all age groups)

eFIGURE



Proportions of specific main diagnoses in hospitalized cases with and without diabetes stratified by age group in 2017

eMETHODS

This analysis is based on secondary statistical information, the DRG (diagnosis-related groups) statistics of the German Federal Statistical Office. Since the introduction of the DRG system in Germany in 2004, all general hospitals have been required to send annual data on all inpatient services to the Institute for the Hospital Remuneration System (InEK). The InEK then sends a legally defined list of characteristics to the German Federal Statistical Office.

To be able to analyze the most recent three years of the DRG statistics (source: Research Data Center[FDZ] of the German Federal and State Statistical Offices, DRG statistics 2015–2017) via controlled remote data processing, an application was filed with the Research Data Center of the German Federal Statistical Office (Destatis, Wiesbaden) and the fee paid. The analysis programs were created using SAS 9.4 (Statistical Analysis Software, SAS Institute, Cary, NC, USA) and sent to the FDZ. Results were released by the FDZ following the disclosure review.

All inpatient cases aged ≥20 years (with and without diabetes) were included. Since the DRG statistics is case-related and, for data protection reasons, does not contain information that would allow to identify specific individuals, it was impossible to draw conclusions on the number of patients based on the number of treatment cases. The various types of diabetes were identified in the primary diagnoses (reasons for admission) or secondary diagnoses based on the ICD code (10th revision of the International Statistical Classification of Diseases and Related Health Problems, German modification, ICD-10 GM):

- Type 1 diabetes (E10)
- Type 2 diabetes (E11)
- Other specified diabetes mellitus, including pancreatic diabetes (E13)
- Rare types of diabetes (E12 or E14)
- Gestational diabetes (O24)
- Prediabetes (R73).

Diabetes as a secondary diagnosis was only taken into account in cases without diabetes as the main diagnosis.

In cases with several types of diabetes among the secondary diagnoses, the procedure was as follows: The exclusion criterion for prediabetes was the co-occurrence of another type of diabetes, documented as a secondary diagnosis (2017: n = 1395; 2016: n = 1489; 2015: n = 1581), for gestational diabetes the co-occurrence of type 1 diabetes, type 2 diabetes, a rare diabetes or other/pancreatic diabetes (2017: n = 31 750; 2016: n = 25 614; 2015: n = 18 671), for rare types of diabetes the co-occurrence of type 1 diabetes, type 2 diabetes or other/pancreatic diabetes (2017: n = 1 124; 2016: n = 1 143; 2015: n = 1 366), and for other/pancreatic diabetes the co-occurrence of type 1 diabetes or type 2 diabetes (2017: n = 878; 2016: n = 1 007; 2015: n = 1 024). Cases with type 1 and type 2 diabetes as the double secondary diagnoses were excluded (2017: n = 926; 2016: n = 979; 2015: n = 991).

Age was classified in 10-year groups from 20–29 years to 80–89 years and ≥ 90 years. Cases with unknown age were excluded (2017: n = 52; 2016: n = 36; 2015: n = 76). Cases with or without diabetes with unknown sex (2017: n = 1 073; 2016: n = 175; 2015: n = 285) were assigned to the female cases which was the larger group. In order to prevent cell locking, cases with gestational diabetes as a main diagnosis or secondary diagnosis aged ≥50 years were excluded (2017: n = 12; 2016: n = 16; 2015: n = 11). We estimated the prevalent population with type 2 diabetes so that we could calculate the proportion of inpatient cases among patients with type 2 diabetes in 2017, stratified by age group and sex. We used the administrative prevalence estimates of the Central Institute for Statutory Health Care (Zi), which are based on the nationwide billing data of panel doctors for 2015 (9), and the population size as on 31 December 2017, which is based on the 2011 census data (10), for this calculation. In the prevalence estimates of the Central Institute for Statutory Health Care, all patients with the confirmed diagnoses E11, E14 ("not otherwise specified diabetes mellitus") or unclear diabetes mellitus (with different coding) in at least two quarters were allocated to type 2 diabetes. Furthermore, the estimates were calculated based on nationwide billing data of panel doctors (so-called VDX data, 2015) which exclude approximately 13.9% of the population (including, but not limited to, members of private health insurances) (9). However, we projected these prevalences to the entire population, stratified by age group and sex, since all inpatient cases, irrespective of their insurance status, are included in the DRG statistics. Consequently, the prevalent population with type 2 diabetes may have been overestimated, which, in turn, may have led to an underestimation of the proportion of inpatient cases among patients with type 2 diabetes.

The frequency of various categories of main diagnoses (ICD group: C, neoplasms; F, mental and behavioral disorders; G, diseases of the nervous system; I, diseases of the cardiovascular system; J, Diseases of the respiratory system; K, diseases of the digestive system, and N, diseases of the urogenital system) were compared between cases with diabetes as a secondary diagnosis (type 1 diabetes, type 2 diabetes, other/pancreatic diabetes, rare diabetes, or gestational diabetes) and cases without diabetes in each age group.