Quality of diabetes follow-up care and hospital admissions

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Abstract

As diabetes may lead to severe complications, disease prevention and improvement of medical follow-up represent today a major public health issue. Previous studies have reported that quality of diabetes management is associated with better health outcomes and fewer hospital admissions. The aim of this study was to measure the impact of adherence to French follow-up guidelines on hospitalisation of people with diabetes. We used claim data of the years 2010 to 2013 collected for 52,027 people aged over 18, affiliated to a French social security provider and treated for diabetes (types I and II). We estimated panel data models to explore the determinants of different measures of hospitalisation. We controlled for patients' socioeconomic features, diabetes treatment, medical care and health status. The population-averaged models were adjusted for variables related to the patient's home, such as the density of medical practitioners and of hospital beds, the size of the area and the local prevalence of diabetes. The results show that inpatient admissions concerned at least a quarter of our sample each year and among those admitted to hospital, the mean annual number of stays and of days in hospital were around 2 and 20, respectively. The adherence to guidelines was on the increase over the period for 4 of them, notably the regular dosages of glycated haemoglobin, whereas a constant trend was observed for the other ones except for the electrocardiogram (ECG). The models showed, among other results, that adherence to 4 guidelines was associated with a significant decrease in hospital admission rate. In addition, our analyses confirmed the presence of a strong protective income effect and a significant positive impact of supply side characteristics. In conclusion, good adherence to French diabetes guidelines may prevent acute conditions that could necessitate inpatient admissions, but its preventive role is efficient when examinations are carried out on a regular basis.

1. Introduction

Diabetes mellitus is a chronic disorder characterized by hyperglycemia due to relative lack of endogenous insulin. Diabetes treatment must be managed in function of the diabetes type. Diabetes type 1 requires insulin administration and is usually diagnosed in relatively young people. Diabetes type 2 may not require medical treatment and, depending on the severity of the disease, different options concerning care is available, ranging from simple dietary changes and exercise to insulin injections. Standards of medical care in diabetes treatment are provided by guidelines that are globally recognized by the actors involved in the treatment and control of this disease. In France for example, the National Authority for Health (HAS) recommends regular monitoring of patients with diabetes, including quarterly determination of glycated haemoglobin (HbA1c), together with a complete lipid profile, determination of microalbuminuria and of serum creatinine, a fundus exam, an electrocardiogram (ECG) and a dental exam annually, as well as seasonal influenza vaccination.

Since diabetes may lead to health complications, notably vascular conditions that are major causes of mortality and morbidity in the long term, appropriate follow-up care is determinant to prevent serious and sometimes life-threatening related affections (Malcolm et al 2008). Given the epidemic context of continuous growth in the prevalence of diabetes worldwide, important debates occur around the crucial role of medical follow-up in hyperglycaemia treatment, and good practices in diabetes management, mainly in outpatient care, become a matter of major importance for health regulators in countries desiring to optimize quality of care and public spending on health care (Clarke et al 2008, Battacharyya & Else 1999).

Indeed, adequate follow-up of diabetes may not only reduce complications and increase quality of life of patients but could also have an impact on the use of health care resources, in particular hospital admissions. Most studies examining the association between the quality of diabetes follow-up care and hospital admissions come from England. The results are rather encouraging, but the significance is sometimes weak. Saxena et al (2006) used available information on 31 Primary Care Trusts (PCTs), statutory entities in charge of commissioning health care, in London in the early of year 2000. They found that PCTs with a higher percentage of family practitioners who were offering health promotion clinics for patients with diabetes had lower hospital admission rates for diabetes. Bottle et al (2008) analysed all 303 English PCTs and found that, after controlling for area deprivation and diabetes

prevalence, PCTs with higher average quality and outcomes framework (QOF) scores for diabetes management had significantly lower admission rates for patients aged 60 and older. Dusheiko et al (2011) analysed this time the impact of ambulatory care on emergency hospital admissions using all practice electronic QOF records. They showed that improving glycaemic control was associated with a decrease in the rate of emergency admissions for short term diabetic complications. Finally, one study from the United States (Chen et al 2010) showed in patients with diabetes enrolled in a preferred provider organization (PPO) that those who received quality care were less likely to be admitted to hospital than those who did not.

Moreover, there is empirical evidence that poor adherence to diabetes medications is associated with an increased risk of hospital visits (Heaton PC et al 2013). Following theses evidences, our hypothesis is that adherence to HAS' good practice recommendations is likely to reduce hospitalisation rates of patients with diabetes. The rationale behind this hypothesis is that good outpatient care may avoid acute and sensitive conditions that could lead to hospital stays. From an economic point of view, because diabetes is today a major concern of public health as regards its rapid prevalence, investing in programs that could optimize the adherence to guidelines in diabetes treatment could be interesting as it could contribute to prevent hospital admissions related to complications and to reduce their high consequential costs.

The main goal of this paper is to estimate the association between the quality of diabetes follow-up care and hospital admissions in France, where diabetes follow-up recommendations exist. In fact, we aim at assessing if the quality of follow-up care for diabetes, administered mostly in outpatient care, may prevent acute care and hospitalisations, which incur substantial costs. To our knowledge, this article is the first to explore that research question in France. The measurement of quality in diabetes follow-up care is not here an aggregate score, as it is often the case in the literature, but is defined in terms of adherence to each diabetes management guideline taken separately and identified through reimbursement claim data. The originality of our research design also relies on the use of several panel data models to estimate the determinants of different measures of hospitalisation: the probability of hospital admission, the number of hospital stays and the total amount of days in hospital throughout the year. Moreover, as health system peculiarities may have some effect on the demand of health care services, we added some macroeconomic characteristics to take into account

possible exogenous effects, notably the impact of health care supply, on the probability and the frequency of hospital admissions.

2. Methods

2.1 Data and sample

Our study used information on affiliates of a major French social security provider (MGEN), aged at least 18 years old under anti-diabetic medication (oral agents or insulin) from 1st January 2010 to 31st December 2013. Persons for whom information was not complete were excluded, leading to a final total number of individuals followed through these 4 years of analysis of 52,027.

2.2 Variables

The variable to be explained is alternatively the dummy variable "any hospital admission" taking the value 1 if the individual had at least one hospital admission in the full calendar year t and 0 otherwise, or the continuous variable "number of hospital admissions", corresponding to the number of hospital admissions in the year t, or "total inpatient days" giving the number of days in which the patient stayed in the hospital in the year t.

We formed our dataset from information on individual characteristics that could affect the probability as well the frequency of hospital stays or days in persons with diabetes. The independent variables include sociodemographic features (i.e., age, gender, marital status, employment status, income), diabetes treatment features (i.e., type of treatment - oral monotherapy, bitherapy or tritherapy, or insulin -), health status (i.e., long term illness, other cardiovascular treatment) and medical follow-up (i.e., at least one visit to a general practitioner - GP - or to an endocrinologist, respectively). More precisely, the income variable corresponds to the subject's annual revenue retrieved from the tax authorities. The long term illness variable identifies individuals who benefited from a social health care program for chronic illnesses (ALD program). Finally, the variables concerning drug treatments or medical visits were constructed on the basis of the information contained in reimbursement claim data. The variables concerning the type of diabetes treatment such as monotherapy or insulin were considered as proxies for disease severity levels. The variable "other

cardiovascular pathology" takes the value 1 if the individual had claims concerning antihypertensive medications, statins or low-dose aspirin or 0 otherwise.

Given the main purpose of our research question, we also collected information concerning diabetes management. These variables are indicators taking the value 1 if the individual with diabetes had done the recommended follow-up examination in the year t or 0 otherwise. Here is the list of the recommended medical interventions whose annual achievement was measured: HbA1c test at least three times, a complete cholesterol test, a microalbuminuria test, a creatinine blood test, a fundus exam, an ECG, a dental visit and a flu shot.

In addition, we used macroeconomic variables characterising mostly the supply side characteristics in the geographical area (department level) that could affect health demand: the density of physicians (GPs and specialists) and of hospital beds, the local prevalence of diabetes, defined as the percentage of individuals living with diabetes in each department, and the size of the town where the subject lived, which can be considered as a proxy variable of the distance to the closest hospital (Eco-Santé, INSEE).

2.3. Statistical analysis

For each dependent variable measured, we used a distinct panel data model to estimate the association between adherence to guidelines and hospitalisation (Table 1). As our analysis focused on the variance between individuals and we could not assume independence between the unobserved heterogeneity and the explanatory variables, we opted for population-averaged (PA) models. The first model (Model 1) was a probit model estimating the probability of hospital admission in the year t. Then, count data models were used when the frequency of hospitalisation (stays or days) was considered as dependent variable. The second and third analyses used a Poisson regression model considering as dependent variable the number of hospital stays (Model 2) and the total amount of days in hospital (Model 3) in the year t, respectively. Indeed, the simplest panel models used in count data analysis specify the conditional mean to be of exponential form, and specify the conditional distribution to be Poisson or, in some settings, a particular variant of the negative binomial, or any other non-linear model that takes into account the great amount of zero values in the dependent variable.

2.4. Sensitivity analysis

First, as our model intends to capture the temporal effect of health care consumption and preventive health behaviours on hospitalisation, the models were also estimated using lagged variables concerning patient's adherence to the recommendations (Table 2). Second, given the heterogeneity in the characteristics of patients with diabetes within our sample, we estimated our model by stratifying our regression analysis following methods of risk adjustment. In this sense, we modelled the determinants of hospital admissions according to the severity of the disease that could be approximated using the type of diabetes treatment. Indeed, the therapeutic strategy in diabetes care changes in function of the diabetes type. Given the specific characteristics of insulin lack and low age of patients, diabetic type 1 individuals are immediately treated by insulin. The heterogeneity of type 2 diabetic patients requires different treatments in relation to the level of severity of the diabetes. Hence, the therapeutic strategy in diabetes type 2 care is to start by monotherapy in the simplest or beginning cases of the disease, and then one can consider that the more the treatment is complex and close to the insulin and the more the diabetes is classed as severe. We thus modelled the probability of hospital admissions and their frequency and length in each category of diabetes treatment: oral monotherapy, bitherapy or tritherapy, or insulin.

3. Results

3.1. Descriptive statistics

In 2013, the mean age of the population study here was 70.1 years old. The sample was almost equally shared between women (49.4%) and men (50.6%). Most of them lived in couple (68.7%) and their income was 2,184.7 € on average. A vast majority of them were eligible for long-term illness health insurance (89.3%) and suffered from another cardiovascular disorder (89.7%). Moreover, 96.9% of them saw a GP at least once, whereas only 11.4% consulted an endocrinologist. Finally, interesting trends were observed over the period. The proportion of individuals in active employment decreased from 19.3% in 2010 to 14.4% in 2013, while that of people receiving insulin increased from 19.6% to 25.2%.

As regards diabetes follow-up, we observed a stable adherence over the period for the complete lipid profile, the fundus exam and the dental visit (Figure 1). However, an increasing trend was found for the 3 dosages of HbA1c (45.1% to 54.2%), the determination

of microalbuminuria (37.4% to 40.5%) and of serum creatinine (82.2% to 86.0%), and the flu vaccination (53.3% to 58.0%). Finally, no clear-cut trend was found for the ECG.

As regards hospitalisation, the probability of inpatient admission in our sample increased from 25.0% in 2010 to 27.8% in 2013 (Figure 2). For those hospitalised, the annual mean number of hospital stays raised from 1.8 to 2.1 over the period, while the average total amount of days in hospital per year increased from 17.4 to 21.3.

Finally, concerning macroeconomic variables, there were on average 173 physicians and 623 hospital beds per 100,000 inhabitants in a geographical area. One third of people with diabetes (34.7%) lived in big towns (at least 500,000 inhabitants), whereas another third (28.6%) were settled in a small urban or rural area (less than 50,000 inhabitants).

3.2. Panel model results

In all the 3 models, the dependent variable was positively correlated with age, tritherapy or insulin treatment, chronic illness, GP consultation, density of hospital beds and urban concentration, while marital status and income were associated with lower levels of hospitalisation (Table 1). We observed that women had a lower probability of hospitalisation and fewer hospital admissions, however they were more likely to experience longer stays in hospital. Moreover, although consulting an endocrinologist had no significant effect on the odds of being hospitalised at least once in the year, it appeared to be associated with fewer admissions and fewer days in hospital per year.

Out of the 8 follow-up guidelines, 4 of them (quarterly dosage of HbA1c, complete lipid profile, microalbuminuria and influenza vaccination) turned out to be negatively correlated with all the measures of hospitalisation, whereas 2 of them (serum creatinine and ECG) were systematically positively associated. However, we found mixed results for the fundus exam and the dental visit.

3.3. Sensitivity analysis

We lagged the variables corresponding to the recommendations and the results were almost the same for all the 3 measures of hospitalisation (Table 2). However, the 3 dosages of HbA1c

and the influenza vaccination did no longer have a negative impact except for the annual number of hospital days. We then stratified the multivariate analysis according to diabetes severity. The results showed similar patterns, with the exception of the 3 dosages of HbA1c which kept its protective impact on the probability of being hospitalised only for the least severe cases.

4. Discussion

The present study reveals that adherence to recommendations, such as quarterly dosages of glycated haemoglobin, complete lipid profile, determination of microalbuminuria and influenza vaccination, may be effective in preventing hospitalisation among people with diabetes. This finding is robust for any degree of disease severity, even the most complicated cases treated by insulin. However, concerning HbA1c, we observed a short-term preventive effect since its protective impact mostly disappears when the dosage is not realised in the current year. In addition, this study highlights the importance of certain patient's sociodemographic features. In particular, besides age and marital status, it reveals a strong income effect, with a lower risk of hospitalisation for the wealthier individuals.

This paper confirms the importance of optimum follow-up care for people with diabetes in preventing clinical complications that could lead to hospital admissions. Particularly, our results suggest that regular dosages of HbA1c and glycaemic control are essential to keep people with diabetes in relatively good health, and this for any level of diabetes severity. At first glance, the existence of a positive and significant correlation between some recommendations and the risk of hospitalisation may be surprising. On the one hand, the realisation of some examinations may reveal a certain degree of comorbidity or severity. Indeed, the protective impact of the determination of microalbuminuria and the opposite effect observed for serum creatinine could be explained by the fact that the latter may be interpreted as a sign of impaired renal function as microalbuminuria is generally no longer determined in patients experiencing renal failure. It is the same for the fundus exam. In fact, it is carried out annually only for the moderate to severe cases, the mild ones having their exam every two years only. On the other hand, some of the recommended examinations such as the ECG are systematically conducted for any stay at hospital.

Our results corroborate the well-documented effects of age and marital status on health and use of care. One striking finding concerning sociodemographic variables is the major role of income. The study of McCall et al (2004) has already highlighted a significant association between low socioeconomic status and higher hospital admission rate in people with diabetes. In addition, we found a positive association between GP visits and hospitalisation. However, recourse to GPs is frequent among chronically ill patients and all the more it is not specific of diabetes care. On the contrary, our findings show that consulting an endocrinologist is related to fewer days in hospital and this brings to mind the wide debate on inequalities of specialty health care access, notably due to increasing out-of-pocket costs in France.

By comparison, the ENTRED study undertook on French adults with diabetes reported similar factors associated with hospital admissions (Assogba et al 2013). They found that the probability of being hospitalised at least once in the year was relatively high in people with diabetes (31%) and increased essentially with higher age, financial difficulties, history of complications, inadequate glycaemic control and insulin therapy. Moreover, hospital patients benefited more often from long-term illness health insurance coverage. However, this study did not find any link between gender and hospital admission.

The issue raised here concerning the need for better follow-up care refers to the vast literature on pay-for-performance. Recent studies have demonstrated that financial incentives for quality in primary care may improve diabetes follow-up (Scott et al 2009) and reduce inpatient admissions (Chen et al 2010, Fiorentini et al 2011, Iezzi et al 2014, Lee et al 2010, Lippi Bruni et al 2009).

Overall, our findings must be interpreted with recognition of several limitations. Firstly, we had no information on the cause of hospital admission, in particular we did not know if people with diabetes were hospitalised to undergo comprehensive health checkup. In addition, people with diabetes that were hospitalised were probably more likely to undertake the recommended examinations, with the exceptions of the fundus exam and the dental visit, as these are generally systematically realised in people with diabetes for any cause of hospitalisation. However, we used 3 different measures for hospitalisation, and notably the 2 variables approaching the frequency allow us to tackle this endogeneity problem and to bypass the potential associated bias. Secondly, some exams carried out in public hospitals may not be visible in our dataset. Thirdly, since we tracked information on patients with diabetes using

their prescription claims, this may create a selection bias when estimating demand parameters. Indeed, our population of patients with diabetes is restricted to those under treatment and may thus be more likely to consume health care services than patients who are not prescribed medication for their diabetes. Fourthly, the impact of adherence to follow-up guidelines on hospitalisation may be overestimated in our models since compliant individuals may intrinsically have a lower probability of being admitted to hospital due to certain unobserved characteristics related to better health behaviours (i.e., balanced diet, physical activity, etc.). In addition, it is possible that compliant individuals may be more likely to benefit from better medical care and to have a higher probability of being prescribed the recommended exams. Finally, given that we do not have explicit information on general health status, in particular the diabetes type and age at onset, some of the variables evaluated represent proxies for unmeasurable drivers of individual demand for health care, and this may possibly result in an omitted variable bias. In particular, diseases were identified using reimbursement claims for specific pharmaceuticals or medical procedures.

5. Conclusion

Outpatient care plays an essential role in preventing complications related to chronic conditions. For diabetes, this is all the more a fundamental aspect in the current context of growing prevalence and associated costs. Financial incentives for primary care practitioners may be a means of achieving better quality of follow-up care. However, patient compliance is determinant and efforts should, consequently, be made in parallel to provide therapeutic education that could lead to a better patient's comprehension of diabetes care.

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Figure 1. Evolution of the proportion of people with diabetes who followed each recommendation during the year between the years 2010 and 2013

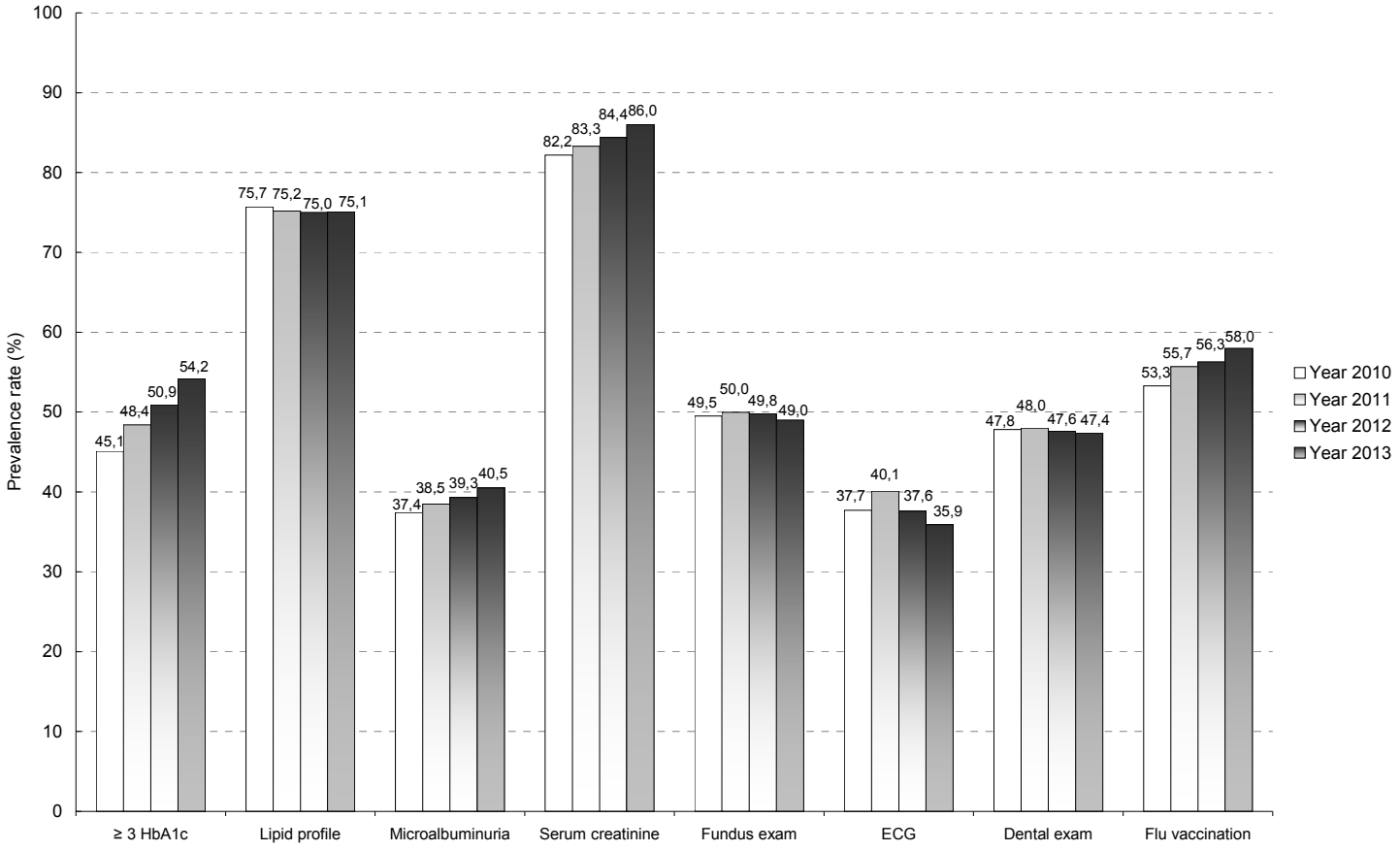

Figure 2. Evolution of the proportion of people with diabetes with at least one hospital admission during the year and of the annual mean number of hospital admissions and of inpatient days in those hospitalised between the years 2010 and 2013

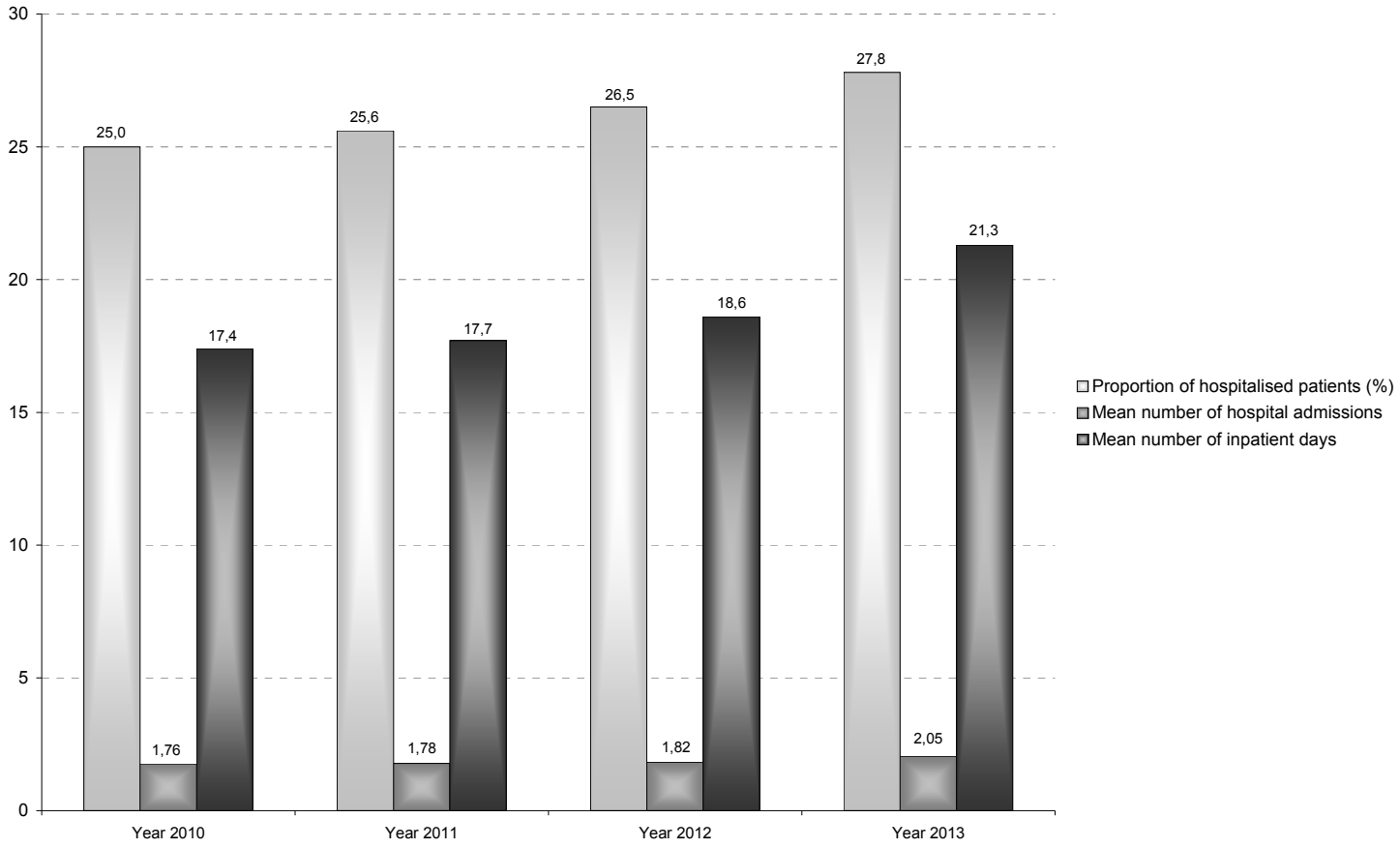

Table 1. Panel data models estimating the risk of hospital admission

Explanatory variables	Model 1 N = 52 027		Model 2 N = 52 027		Model 3 N = 52 027	
Sociodemographic						
Age	0.006	***	0.010	***	0.020	***
	(0.001)		(0.001)		(0.001)	
Woman	-0.025	**	-0.070	***	0.055	***
	(0.008)		(0.008)		(0.003)	
Married	-0.058	***	-0.150	***	-0.378	***
	(0.008)		(0.008)		(0.002)	
Employed	0.004		-0.074	***	-0.154	***
	(0.013)		(0.015)		(0.005)	
Income	-0.028	***	-0.044	***	-0.082	***
	(0.004)		(0.004)		(0.001)	
Diabetes treatment						
Oral monotherapy	0.000		0.000		0.000	
Oral bitherapy	-0.002		0.010		0.051	***
	(0.009)		(0.010)		(0.003)	
Oral tritherapy	0.035	**	0.067	***	0.072	***
	(0.011)		(0.012)		(0.004)	
Insulin	0.420	***	0.655	***	0.831	***
	(0.010)		(0.010)		(0.003)	
General health status						
Long term illness	0.157	***	0.362	***	0.537	***
	(0.011)		(0.014)		(0.005)	
Other cardiovascular pathology	0.094	***	0.209	***	0.272	***
	(0.012)		(0.014)		(0.005)	
Medical follow-up						
At least one GP visit	0.134	***	0.170	***	0.110	***
	(0.020)		(0.023)		(0.007)	
At least one endocrinologist visit	0.034	**	-0.020		-0.054	***
	(0.011)		(0.011)		(0.004)	
Annual follow-up recommendations						
≥ 3 determinations of glycated haemoglobin	-0.018	**	-0.092	***	-0.225	***
	(0.007)		(0.007)		(0.002)	
Complete lipid profile	-0.173	***	-0.309	***	-0.408	***
	(0.008)		(0.008)		(0.002)	
Determination of microalbuminuria	-0.101	***	-0.196	***	-0.293	***
	(0.007)		(0.007)		(0.002)	
Determination of serum creatinine	0.339	***	0.625	***	0.777	***
	(0.010)		(0.012)		(0.004)	
Fundus exam	0.083	***	0.033	***	-0.214	***
	(0.006)		(0.007)		(0.002)	
Electrocardiogram	0.485	***	0.664	***	0.722	***
	(0.006)		(0.007)		(0.002)	
Dental exam	0.024	***	-0.018	**	-0.054	***
	(0.006)		(0.007)		(0.002)	
Seasonal influenza vaccination	-0.015	*	-0.122	***	-0.261	***
	(0.007)		(0.008)		(0.002)	
Macroeconomic						
Density of physicians	-0.001		-0.001		-0.001	***
	(0.001)		(0.001)		(0.001)	
Density of hospital beds	0.001	***	0.001	***	0.001	***
	(0.001)		(0.001)		(0.001)	
Location in a rural area	0.000		0.000		0.000	
Location in a middle-sized town	0.018	*	0.036	***	0.065	***
	(0.009)		(0.010)		(0.003)	
Location in a large town	0.054	***	0.111	***	0.161	***
	(0.010)		(0.011)		(0.003)	
Prevalence of diabetes	-0.016	**	-0.032	***	-0.064	***
	(0.005)		(0.005)		(0.001)	
Y_{2011}	-0.010		-0.008		-0.010	***
	(0.008)		(0.008)		(0.003)	
Y_{2012}	0.012		0.029	**	0.044	***

	(0.008)		(0.009)		(0.003)	
Y_{2013}	0.045	***	0.178	***	0.195	***
	(0.008)		(0.008)		(0.003)	
Constant	-1.778	***	-2.651	***	-0.923	***
	(0.050)		(0.055)		(0.017)	

Model 1 is a population-averaged probit model estimating the probability of hospital admission in the year t. Models 2 and 3 are population-averaged Poisson models considering as dependent variable the number of hospital stays and the total amount of days in hospital in the year t, respectively. All models consider as independent variables the characteristics listed above. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2. Sensitivity analysis for panel data models estimating the risk of hospital admission

Explanatory variables	Model 4 N = 52 027		Model 5 N = 52 027		Model 6 N = 52 027	
Annual follow-up recommendations						
≥ 3 determinations of glycated haemoglobin$_{t-1}$	0.001		0.003		-0.052	***
	(0.008)		(0.008)		(0.002)	
Complete lipid profile$_{t-1}$	-0.042	***	-0.068	***	-0.034	***
	(0.009)		(0.009)		(0.003)	
Determination of microalbuminuria$_{t-1}$	-0.034	***	-0.087	***	-0.155	***
	(0.008)		(0.008)		(0.003)	
Determination of serum creatinine$_{t-1}$	0.100	***	0.186	***	0.215	***
	(0.011)		(0.012)		(0.004)	
Fundus exam$_{t-1}$	0.020	**	-0.011		-0.116	***
	(0.007)		(0.007)		(0.002)	
Electrocardiogram$_{t-1}$	0.107	***	0.150	***	0.140	***
	(0.007)		(0.008)		(0.002)	
Dental exam$_{t-1}$	0.018	*	-0.016	*	-0.048	***
	(0.007)		(0.007)		(0.002)	
Seasonal influenza vaccination$_{t-1}$	0.017	*	-0.014		-0.098	***
	(0.008)		(0.009)		(0.003)	

Model 4 is a population-averaged probit model estimating the probability of hospital admission in the year t. Models 5 and 6 are population-averaged Poisson models considering as dependent variable the number of hospital stays and the total amount of days in hospital in the year t, respectively. All models consider as independent variables the recommendations listed above. The following are also included as independent variables in all models: age, gender, marital status, employment status, income, type of diabetes treatment, long term illness, other cardiovascular treatment, at least one visit to a general practitioner or to an endocrinologist, density of physicians and of hospital beds, town size, local prevalence of diabetes, Y_{2011}, Y_{2012} and Y_{2013}. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$