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## Trends on Diabetes Mellitus's healthcare management in Spain 2007–2015



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### ABSTRACT

**Aims:** To analyze the trends on diabetes mellitus (DM) healthcare management in Spain.

**Methods:** Retrospective observational study between January 1st 2007 and 31st December 2015 with DM as the principal diagnosis. The main clinical outcome measures were all-cause, in-hospital mortality and 30-day readmissions. We also analyze three Prevention Quality Indicators (PQI) for DM.

**Results:** The number of hospitalization episodes decreased significantly as well as the frequentation rate and average length of stay (Incidence Rate Ratio [IRR] = 0.963,  $p < 0.001$ ; 0.91,  $p < 0.001$  and 0.986,  $p < 0.001$ , respectively). Crude in-hospital mortality and readmissions rates and risk-standardized in-hospital mortality rates (RSMR), however, remained stable (IRR = 0.988,  $p = 0.073$ ; IRR = 1.003,  $p = 0.334$  and IRR = 0.997,  $p = 0.116$ , respectively). A relevant variability in RSMR, both at hospital (Median Odds Ratio 1.49) and regional level, was found. High volume hospitals ( $\geq 105$  DM discharges at year) showed better outcomes. High variability was also found in PQI indicators at regional level.

**Conclusion:** The present analysis shows an improvement in hospitalizations related to DM in Spain in the period 2007–2015. There was also a decrease in the frequentation rate and in the average length of stay. These findings are probably explained by quality improvements in the healthcare management of the DM at the ambulatory level. However, there were important differences in the management of diabetic inpatients both at the hospital and the regional level.

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## 1. Introduction

Diabetes mellitus (DM) is increasing worldwide. In Spain, recent data from the Di@bet.es Study [1] show that almost 30% of the study population had some carbohydrate disturbance. The overall prevalence of DM adjusted for age and sex was 13.8%, of which about half had unknown DM. DM is one of the chronic diseases with the greatest impact affecting the patient, the health system, and the society.

The cost associated with the hospitalizations for DM and its complications are of great magnitude. They are estimated to be 6–8% of total healthcare cost in developed countries. Analyzing these costs, 50% of all healthcare expenditures in this population are linked to the direct costs of DM-related complications, with high hospital admission rates and lengthy mean hospital stay [1,2]. The total direct annual cost of DM in Spain has been estimated recently in 5.809 million euros, representing 8.2% of the total Spanish health expenditure [3]: Drug-associated costs was the major component of total cost, 38%, the cost of complications was 37% and the related to hospitalization accounted for a 33%. Thus, the evaluation of the trends in DM hospitalization is of interest for the study of the current costs associated to DM, and also for the planification of future strategies.

A Spanish study (1997–2010) analyzed the hospitalizations of patients with DM [4], showing a two-times increase in the number of hospitalizations and also an increase in the duration of hospitalizations in these patients. However, in this study they analyzed the hospitalizations with DM as principal diagnosis or as comorbidity. In another recent study, the authors found significant reduction in national trends for DM-related potentially preventable hospitalizations in Spain [5].

The objective of the present study was to analyze the trends and outcomes variability on DM healthcare management in Spain. For this purpose, we analyzed the hospitalizations with DM as the main cause of admission.

## 2. Methods

### 2.1. Study design, data source and patient population

To analyze trends on DM healthcare management in Spain, we performed a retrospective observational study of patients discharged with DM as the principal diagnosis. Data were obtained from the Minimum Basic Data Set (MBDS), an administrative database that includes both demographic and clinical data of all patients discharged (alive or death) from all public hospitals affiliated to the Spanish National Health System, which covers 98.4% of the Spanish population. MBDS data include, among others, age, sex, length of stay, information about the type of hospital, principal diagnosis, defined as the condition, after study, which occasioned the admission to the hospital, up to 13 secondary diagnoses, and 20 procedures performed during hospitalization, all coded according to the international classification of diseases, 9th Revision Clinical modification (ICD-9-CM) [6].

Study population included patients older than 17 years, discharged between January the 1st, 2007 and December the 31st

of 2015, with DM as the principal diagnosis (code 250.\*\*). Patients were identified in the MBDS by their health card code, encrypted by a random number to ensure their privacy and thus consent from the patients was not necessary.

The Autonomous Communities of Spain are different geographical regions with independent political power over budget, organization and management of the public health care. Consequently, the Spanish National Health System is decentralized in Regional Health Services –RHS–. There are 17 Autonomous Communities with populations that range from less than 300,000 to almost 8 million inhabitants.

### 2.2. Outcome measures

The main clinical outcome measures were all-cause, in-hospital mortality and 30-day readmissions (unplanned hospital admission to the same hospital within 30 days after discharge).

In addition, we used as DM outcomes measures three Prevention Quality Indicators (PQI) developed by the Agency for Healthcare Research and Quality (AHRQ), based on the assumption that high-quality ambulatory care results in fewer hospitalizations: PQI 01 Diabetes Short-term Complications Admission Rate, PQI 03 Diabetes Long-term Complications Admission Rate and PQI 14 Uncontrolled Diabetes Admission Rate [7] (Supplementary Table 1). All rates were calculated adjusted by age and sex, using the population obtained from the National Statistics Institute of Spain on 1 July of each of the years considered [8], in order to analyze their interannual evolution. We also studied the association between mortality and the volume of patients admitted for DM

### 2.3. Statistical analysis

Continuous variables are presented as mean and standard deviation (SD) and categorical variables are expressed as frequencies and percentages. Considering patient's risk of mortality during admission as a combination of individual causes and the quality of the attention given [9,10], we used a multilevel logistic regression risk adjustment model taking into account the patients' demographic and clinical variables (sex, age, elective or unplanned admission, Charlson Comorbidity Index [11,12] and length of stay) together with a center-specific effect [13–15]. We considered three groups for Charlson comorbidity: index: 0, index: 1 and 2, and index >2. To select the variables included in the adjustment model we used a backward elimination technique. Levels of significance for selecting and eliminating risk factors were  $p < 0.05$  and  $p \geq 0.10$ , respectively. Model discrimination was assessed by the area under the receiver-operating characteristics (AUROC) curve.

The risk-standardized in-hospital mortality rates (RSMRs) were calculated as the ratio of the number of in-hospital deaths predicted on the basis of the hospital's performance with its observed case mix to the number of in-hospital deaths expected on the basis of the all-hospitals performance with that hospital's case mix, multiplied by the all-hospitals unadjusted in-hospital mortality [15]. Accordingly, if the ratio

of in-hospital mortality for a specific hospital is higher than the gross mortality rate, then the probability of mortality in that hospital is above the mean rate for the studied hospitals.

Temporal trends of RSMR and PQIs rates during the study period were assessed by a Poisson regression model, with the year as the only independent variable. In every model the Incidence Rate Ratio (IRR) was calculated with 95% confidence intervals (CI).

We calculated the Median Odds Ratio (MOR), defined as the median value of the odds ratio between the hospital at highest risk and the hospital at lowest risk when randomly picking out two hospitals. MOR is a measure of the probability that mortality due to DM is determined by the characteristics of the hospital where the patient is attended. If MOR has a value of 1, it indicates that there are no differences between hospitals. By contrast, a MOR higher than 1 indicates that differences between hospitals are relevant for explaining the variability in the individual probability of dying.

Because the age-adjusted PQIs and DM admission rates by RHS are population-based, rates are calculated for each RHS, ninety-five percent confidence intervals (CI) were calculated for all the rates, and these are used to determine if a RHS rate is statistically significantly different from the nationwide rate; those that do differ are deemed high or low.

Statistical analysis of the relationship between PQI or volume and the indicators of hospital performance (RSMR and average length of stay) was undertaken using the Pearson correlation coefficient ( $r$ ) and its contrast of hypothesis. Comparisons of quantitative variables were performed by the Student's  $t$ -test or ANOVA test, correcting with the Bonferroni test for the level of significance when appropriate. Categorical variables were compared by the Chi squared test or Fisher's exact test.

All statistical contrasts were bilateral, and differences were considered significant for  $p < 0.05$ . Statistical analysis was performed using STATA 13 and SPSS 21.0.

### 3. Results

A total of 211,964 hospitalization episodes of patients older than 17 years and DM as principal diagnosis were identified in the MBDS during the study period (2007–2015). The average length of stay was  $9.3 \pm 12$  days and the in-hospital mortality crude rate, 3.9%. The discrimination of the logistic regression multilevel risk adjustment model (Supplementary Table 2) for in-hospital DM mortality was good (AUROC = 0.807; CI: 0.803–0.812) and the MOR was 1.49, denoting high interhospital variability independent from patient demographics and clinical characteristics. Charlson index  $>2$  was the risk factor with the highest predictive weight for in-hospital mortality.

Trends in the number of DM episodes (discharges), frequentation rate (discharges per 100,000 inhabitants), average length of stay, in-hospital mortality crude and adjusted (RSMR) rates, and 30-day readmissions crude rate are shown in Table 1. The number of hospitalization episodes decreased significantly as well as the frequentation rate and average length of stay (IRR = 0.963,  $p < 0.001$ ; 0.91,  $p < 0.001$  and 0.986,  $p < 0.001$ , respectively). Crude in-hospital mortality and readmissions rates and RSMR, however, remained stable

**Table 1 – Trends in Diabetes Mellitus hospitalization indicators.**

Year	Episodes	FR	ALOS	CMR (%)	RSMR (%)	CRR (%)
2007	27,037	72.5	9.9	4.4	4.49	11.2
2008	26,192	69.2	9.8	4.1	4.12	10.7
2009	25,530	66.9	9.7	3.9	3.96	11.8
2010	24,661	64.4	9.3	3.7	3.75	11.0
2011	23,650	61.6	9.0	3.9	4.04	11.8
2012	22,408	58.3	9.0	4.1	4.08	11.6
2013	21,453	56.1	9.0	3.7	3.69	11.0
2014	20,750	54.4	8.9	4.1	4.11	11.5
2015	20,283	53.3	9.0	3.7	3.84	11.4

FR: Frequentation rate (hospital discharges per 100 000 inhabitants older than 17 years). ALOS: Average length of stay, CMR: Crude mortality rate, RSMR: Risk-standardized in-hospital mortality rate. CRR: Crude readmissions rate.

(IRR = 0.988,  $p = 0.073$ ; IRR = 1.003,  $p = 0.334$  and IRR = 0.997,  $p = 0.116$ , respectively). At hospital level there was a statically significant correlation between RSMR and average length of stay (ALOS) ( $r$ : 0.313;  $p < 0.001$ ).

We found a high dispersion of RSMR at hospital level, with a MOR of 1.49 (Fig. 1). The cut-off point between hospitals with high and low volume was set at 105 discharges per year for DM as principal diagnosis. The contrast of the RSMR for DM discharges showed a lower rate in hospitals with greater volume (4.03%:4.48%;  $p < 0.001$ ) (Table 2).

Trends of hospital discharge rates for DM complications are shown in Table 3. PQI rates adjusted by age and gender for the three indicators diminished significantly throughout the analyzed period (IRR of 0.96 and 0.94, for short- and long-term complication rates, respectively;  $p < 0.001$ ).

There were significant differences in PQI-adjusted indicators according to different RHS (Table 4). Table 5 shows the variability in DM hospital indicators among RHS. At RHS level, we did not find a significant correlation between PQI for DM and the indicators of hospital performance (RSMR and average length of stay). However, a correlation between RSMR and average length of stay was found ( $r$ : 0.586;  $p < 0.001$ ).

### 4. Discussion

In the present study, rates of hospital discharges for DM and DM complications diminished significantly along the period 2007–2015, indicating a notorious improvement in the ambulatory management of DM in the national public health system. However, there were significant differences in frequentation rates for DM and DM complications at regional level. Although ALOS significantly diminished along 2007–2015, RSMR for DM did not. There was a significant variability in RSMR at hospital and regional levels, indicating the possibility for further improvements. RSMR was lower in high volume hospitals. The three Prevention Quality Indicators for DM selected for this study diminished significantly throughout the analyzed period, although it was particularly relevant the decrease of PQI 14 Uncontrolled Diabetes Admission Rate.

These findings are probably explained by quality improvements in the healthcare management of the DM at the

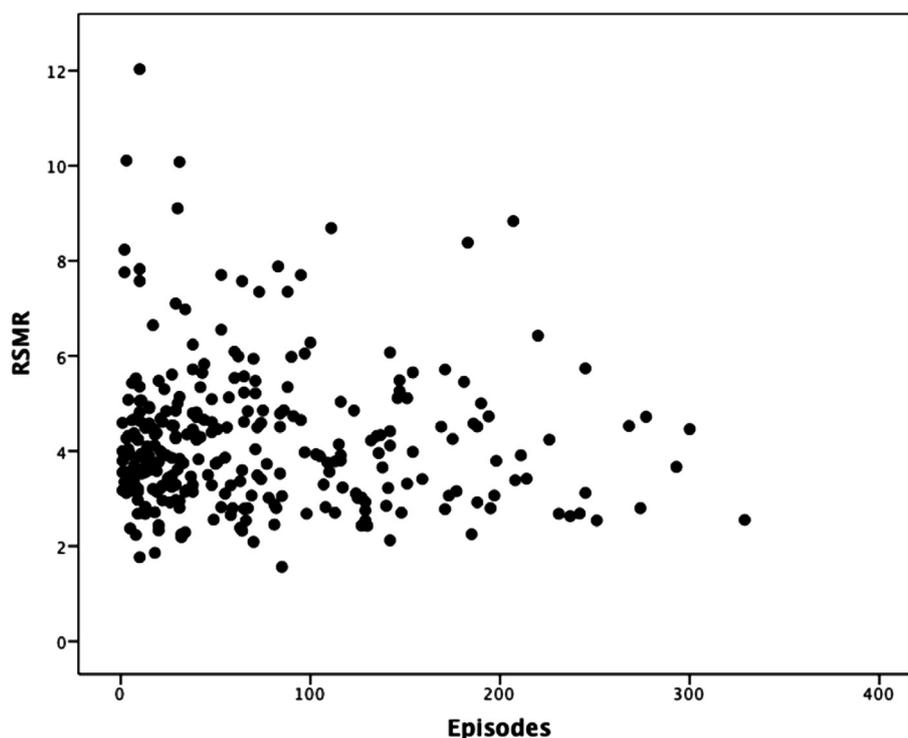


Fig. 1 – Relationship between volume and adjusted mortality in diabetes discharges, 2015.

ambulatory level, with the more widespread use of drugs such as statins, antihypertensives, platelet antiaggregants and antidiabetic drugs with a more favorable cardiometabolic profile. Ambulatory care of DM has been accompanied by a reduction of “preventive” DM admission rates adjusted by age and sex, suggesting an improvement in the clinical management of DM at the community level [16]. As an example, the availability of day hospital of DM may prevent hospitalizations in type 2 DM initiating insulin, and also may reduce the admissions for acute DM complications [17].

The high variability in DM and preventive quality indicators rates, between hospital and between regions, is probably due to differences in the clinical and, perhaps, organizational management of DM. Studies in other countries have found high variability in DM rates of complications between regions [18–21], and geographic and ethnic barriers have been identified as possible causes for variability [20], but the underlying causes for these differences remain basically unexplored and should be studied within each country.

Recent data from Spain shows a constant increase in hospital admissions due to heart failure in DM subjects [22], in both absolute and relative numbers, and also an increase in the incidence of discharge of patients with pulmonary embolism increased significantly during the 2004–2013 period, with a higher risk of hospitalizations in DM subjects [23]. Thus, the observed decrease in hospitalizations related to DM may be a result of an improvement in ambulatory and in-patient management, despite of the increase in hospitalization for other diseases in DM subjects.

Despite these positive data, RSRM and readmission rates remained practically the same. There are different reasons which may contribute to this finding. First, there are several risk factors for readmission, such as lower socioeconomic status, racial/ethnic minority, comorbidity burden, emergent or urgent admission, and a history of recent prior hospitalization [24], which are difficult to improve. Second, the use of certain antidiabetic therapies may have also influenced these data. Regarding this, among patients with type 2 DM, sulfonylurea use was associated with an approximately 30% increased risk for readmission compared to other antidiabetic treatments [25]. The use of sulfonylureas in Spain had decreased

**Table 2 – Comparison of Diabetes Mellitus hospitalization measures between hospitals with high (>106 discharges for diabetes) and low (<105 discharges for diabetes) care volume.**

	Volume group	N	Mean	SD	p
ALOS	<105	7516	8.43	10.44	<0.001
	>105	12,977	9.27	12.22	
CMR	<105	7516	4.4	3.8	<0.001
	>105	12,977	3.4	2.1	
CRR	<105	7516	12.1	5.9	<0.001
	>105	12,977	11.2	4.1	
RSMR	<105	7516	4.48	1.83	<0.001
	>105	12,977	4.03	1.62	

N: Number of episodes. SD: Standard deviation. ALOS: Average length of stay, CMR: Crude mortality rate. CRR: Crude readmissions rate. RSMR: Risk-standardized in-hospital mortality rate.

**Table 3 – Trends of hospital discharge rates for Diabetes Mellitus complications.**

Year	PQI 01	95% CI	PQI 03	95% CI	PQI 14	95% CI
2007	17.1	16.7–17.5	49.5	48.8–50.3	3.3	3.1–3.5
2008	16.2	15.8–16.6	47.2	46.5–47.9	3.2	3.0–3.3
2009	15.3	14.9–15.7	45.5	44.8–46.2	3.1	2.9–3.2
2010	14.4	14.0–14.8	43.5	42.9–44.2	2.8	2.6–3.0
2011	14.0	13.6–14.4	40.8	40.2–41.5	2.3	2.1–2.4
2012	14.2	13.8–14.5	37.0	36.4–37.6	2.0	1.8–2.1
2013	12.9	12.5–13.2	35.6	35.00–36.2	1.7	1.6–1.8
2014	12.7	12.4–13.1	33.8	33.2–34.4	1.5	1.4–1.6
2015	12.9	12.5–13.2	31.9	31.3–32.4	1.3	1.2–1.4

Rates adjusted by age and sex per 100.000 Inhabitants. PQI 01: Diabetes Short-term Complications Admission Rate. PQI 03: Diabetes Long-term Complications Admission Rate. PQI 14 Uncontrolled Diabetes Admission Rate.

**Table 4 – Preventive quality indicators for DM. Regional Healthcare Services (2015).**

Regional Healthcare Services	PQI 01	CI 95%	PQI 03	CI 95%	PQI 14	CI 95%
1	9.4*	8.6–10.1	28.0*	26.7–29.3	1.1	0.8–1.3
2	12.8	10.7–14.9	40.4*	36.8–44.0	2.2	1.3–3.0
3	14.7	12.2–17.1	43.0*	39.0–47.0	1.0	0.4–1.6
4	12.2	9.9–14.5	43.2*	38.8–47.7	0.3*	0.0–0.7
5	12.4	10.7–14.1	31.3	28.6–34.1	0.7	0.3–1.1
6	15.2	11.8–18.6	40.5*	35.0–45.9	1.0	0.1–2.0
7	12.5	11.0–14.0	41.8*	39.2–44.3	0.9	0.5–1.3
8	14.2	12.4–16.0	31.6	28.9–34.2	0.3*	0.0–0.6
9	14.7*	13.7–15.6	28.4*	27.1–29.7	1.2	0.9–1.4
10	17.5*	16.2–18.8	42.8*	40.7–44.8	2.6*	2.1–3.1
11	12.5	10.2–14.8	29.0	25.5–32.4	4.0*	2.7–5.3
12	16.7*	15.1–18.3	29.9	27.8–32.0	1.5	1.0–2.0
13	9.8*	9.0–10.7	24.8*	23.4–26.2	1.6	1.2–1.9
14	13.0	10.9–15.2	53.7*	49.2–58.2	1.4	0.7–2.1
15	8.1*	5.7–10.5	33.5	28.6–38.4	0.2*	0.0–0.6
16	11.7	10.1–13.3	42.9*	40.0–45.7	1.1	0.6–1.5
17	17.6	12.5–22.7	71.2*	61.2–81.2	0.0*	0.0–0.0
Spain	12.9	12.5–13.2	31.9	31.3–32.4	1.3	1.2–1.4

PQI: Preventive Quality Indicators; CI: coefficient interval.  
\* Statically significant different from the nationwide rate.

in the last years [26], although they remain a frequently used treatment, at least in some regions. Thus, the high risk of severe hypoglycaemia associated with the use of these drugs may contribute to the differences between regions.

We have found a greater variability in RSMR and higher mean RSMR in low-volume hospitals (<105 admissions for DM per year) compared with high-volume hospitals (>105 admissions per year). These findings suggest that the health-care management of DM requiring hospital admission benefits from a concentration of cases. High volume hospitals have longer ALOS than low volume hospitals. Moreover, the association between lower RSMR and higher ALOS was also found when analyzing the relationship between hospitals and also between regions.

In a recently published study from Gomez-Huelgas and cols [5], a significant reduction in national trends for DM-related potentially preventable hospitalizations in Spain was found. These findings could suggest a sustained improvement in DM care in Spain, despite the burden of these DM-related complications and the increase in the DM prevalence. Despite the differences on the statistical approach for analyzing these trends between the Gomez-Huelgas's study and ours, the

finding of similar trends reinforces their conclusions. The authors of this study, however, include among their limitations that they do not analyzed the regional differences in PQI of DM, that we have addressed in our paper. The significant differences in PQIs and hospital performance indicators between RHS found in our study are probably indicative of opportunities for improving outcomes of DM management, that may help in the future planification of health policies.

In a study from Carral et al. [27], DM patients (DM as principal or secondary diagnosis) were hospitalized, on average, for 4 days longer than non-diabetic patients, and they had higher risks of readmission and of mortality during the inpatient period than non-diabetic patients. Confirming our results, Gonzalez-Pascual et al has found that the hospitalizations with acute DM-related complications decreased during the period 2007–2011 [28], suggesting an improvement of DM control in Spain [29], thereby reducing the use of health care resources involved.

A relationship between a lower hospital frequentation and higher mortality could be expected, due to the selection of more severe cases, but we have not found such association at RHS level. This finding probably reinforces the specificity

**Table 5 – DM hospital indicators. Regional Healthcare Service (2015).**

Regional healthcare services	Unadjusted rate	ALOS	CMR	RSMR
1	32	9.58	5.3	5.69*
2	55	9.90	3.9	3.59*
3	67	9.69	3.5	4.04*
4	46	10.44	2.5	3.68*
5	38	15.83**	4.0	5.36*
6	56	13.93**	5.9	5.93*
7	60	8.64	4.0	3.68*
8	41	8.82**	4.3	3.59*
9	44	7.80**	2.5	3.11*
10	56	6.77	2.6	4.40*
11	45	8.53	4.1	5.07*
12	49	10.46	6.3	4.82*
13	31	8.64	3.3	3.14*
14	55	9.56	4.7	4.21*
15	49	10.88**	2.6	3.43*
16	57	7.10	3.7	3.45*
17	86	7.84	2.2	2.56*
Mean	51	9.7	3.8	4.1
Median	49	9.6	3.9	3.7
Standard Deviation	13	2.3	1.2	1.0
Min	31	6.8	2.2	2.6
Max	86	15.8	6.3	5.9

RSMR: \* Statically significant ( $p < 0.05$ ) differences between all Regional Healthcare Services –RHS– and RHS 1.

ALOS: \*\* Statically significant differences between these RHS and RHS 1.

ALOS: Average Length of Stay; CMR: Crude Mortality Rate; RSMR: Risk Standardized Mortality Rate.

of IPQ as an indicator of the healthcare performance at the ambulatory level.

One possible limitation of the present study is the variability in the coding among hospital and regions, although all regions used standardized coding methods. In addition, we did not analyze social and individual disparities or the accessibility to DM care that could be possible reasons affecting readmissions. The strengths of the present study are the inclusion of all public hospitals affiliated to the Spanish National Health System which covers 98.4% of the Spanish population. Finally, the analysis of differences between Regional Health Services can result in an improvement of the future development of health policies.

In summary, the present analysis shows an improvement in hospitalizations related to DM in Spain in the period 2007–2015. There was also a decrease in the frequentation rate and in the average length of stay. These findings are probably explained by quality improvements in the healthcare management of the DM at the ambulatory level. However, significant differences remain at hospital and regional level. These findings may help for the planification of future health strategies on DM management.

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## Declaration of Competing Interest

The authors have no conflict of interests to disclose.

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## Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.diabres.2019.107824>.

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