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Association between the reduction of face-to-face appointments and the control of patients with type 2 diabetes mellitus during the Covid-19 pandemic in Catalonia

Ermengol Coma [a,*], *Queralt Miró* [b], *Manuel Medina* [a], *Francesc X. Marin-Gomez* [b,c,d], *Xavier Cos* [e,f,g,h], *Mència Benítez* [a,i], *Ariadna Mas* [h], *Mireia Fàbregas* [a], *Francesc Fina* [a], *Yolanda Lejardi* [h], *Josep Vidal-Alaball* [b,c,d]

[a] *Primary Care Services Information Systems, Institut Català de la Salut, Barcelona, Spain*
[b] *Health Promotion in Rural Areas Research Group, Gerència Territorial de la Catalunya Central, Institut Català de la Salut, Spain*
[c] *Unitat de Suport a la Recerca de la Catalunya Central, Fundació Institut Universitari per a la recerca a l'Atenció Primària de Salut Jordi Gol i Gurina, Spain*
[d] *Faculty of Medicine. University of Vic - Central University of Catalonia, Vic, Spain*
[e] *DAP_Cat Research Group, Gerencia Territorial Barcelona Ciutat, Institut Català de la Salut, Spain*
[f] *Foundation University Institute for Primary Health Care Research Jordi Gol i Gurina (IDIAPJGol), Barcelona, Spain*
[g] *Universitat Autonoma de Barcelona, Spain*
[h] *Institut Català de la Salut, Spain*
[i] *Equip d'Atenció Primària de Gòtic, Institut Català de la Salut, Barcelona, Spain*

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ABSTRACT

Aim: To analyse the relation between face-to-face appointments and management of patients with type 2 diabetes mellitus (T2DM) visited in primary care practices (PCP).
Methods: Retrospective study in 287 primary care practices (PCPs) attending>300,000 patients with T2DM. We analysed the results of 9 diabetes-related indicators of the Healthcare quality standard, comprising foot and retinopathy screening, blood pressure (BP) and glycemic control; and the incidence of T2DM. We calculated each indicator's percentage of change in 2020 with respect to the results of 2019.
Results: Indicators' results were reduced in 2020 compared to 2019, highlighting the indicators of foot and retinopathy screening (-51.6% and −25.7%, respectively); the glycemic control indicator (-21.2%); the BP control indicator (–33.7%) and the incidence of T2DM (-25.6%). Conversely, the percentage of type 2 diabetes patients with HbA1c > 10% increased by 34%.

PCPs with<11 weekly face-to-face appointments offered per professional had greater reductions than those PCPs with more than 40. For instance, a reduction of −60.7% vs −38.2% (p-value < 0.001) in the foot screening's indicator; −27.5% vs −12.5% (p-value < 0.001) in glycemic control and −40.2 vs −24.3% (p-value < 0.001) in BP control.

Conclusions: Reducing face-to-face visits offered may impact T2DM patients' follow-up and thus worsen their control.

1.   Introduction

The Covid-19 pandemic and associated public health measures implemented to contain the spread of the virus have affected patients with non-COVID conditions. Several studies have analysed this collateral effect, both in hospitals and primary care [1–2]. For instance, some authors have described a decline in new diagnosis performed in primary care, suggesting a large number of undetected conditions and thus untreated diseases [3–4]. In a previous analysis, we also observed a reduction of the diagnosis, follow-up, screening and control of chronic diseases during the first wave of Covid-19 in Catalonia [3,5].

Another effect of the Covid-19 pandemic on the healthcare system is the drastic reduction of face-to-face visits [2,6–8], raising concerns about how it will affect the management and control of chronic patients, such as patients with type 2 diabetes mellitus (T2DM). Several studies have found a decrease in metabolic control, specially during the lockdown period [9–13]. T2DM and preventive counseling are usually common reasons to contact primary care practices, but since early March 2020 their frequency of contact has been reduced substantially and their distribution has changed significantly. In this context, the model of attendance has been redirected towards telemedicine in order to compensate for declining face-to-face visits [2]. Some studies have described an increase of telephones/email/Internet consultations during and after the first wave of COVID-19 [6–8]. Although a recent study showed no evidence of a negative association between decrease in outpatient visits and glycemic control in 2020 [14], there are still some concerns about possible effects on screening, follow-up and glycemic control of T2DM, as a large number of face-to-face visits were postponed during the pandemic and the access towards telemedicine could be different in regards some populations, creating some barriers to access [15].

Health care quality indicators have been used in recent years to monitorize and quantify improvements in the follow-up and control of different chronic diseases, including T2DM [16–18]. In Catalonia, the Healthcare quality standard (EQA, the Catalan acronym for Estàndard de Qualitat Assistencial) has been calculated for>10 years and includes>60 clinical indicators, some related to the follow-up, screening and control of patients with T2DM [19]. These indicators are considered a useful tool for measuring clinical practice and their results have been validated by>6,000 professionals who use them periodically [20].

The aim of the study is to estimate the relation between the number of face-to-face appointments and the T2DM diagnosis, control and chronic complications screening during the COVID-19 pandemic through the analysis of the health care quality indicators.

2.   Material and methods

We performed a retrospective cohort study conducted in the 287 primary care practices (PCP) of the Catalan Institute of Health (ICS, for its Catalan initials). ICS is the main primary care provider in Catalonia. It manages around 75% of all PCP in the Catalan public health system and covers about 5.8 million people. Our study period included years 2019 and 2020.

2.1.   Main variables

The main variables were the results of the different T2DM-related indicators from the EQA and the T2DM incidence, all of them aggregated at the PCP level. The EQA was first designed in 2006 but has evolved over the years and adapted to scientific evidence [19]. Its indicators are currently and routinely calculated in an aggregated form for all PCPs at ICS, using data from the primary care health records (EHR) of all patients over 14 years old. All primary care professionals in Catalonia use the same EHR known as ECAP. The ECAP is a software system that serves as a repository for structured data on diagnoses, clinical variables, prescription data, laboratory test results, visits, diagnostic requests and referrals to other health care specialties. Each EQA indicator is calculated on a monthly basis with data of the previous 12 months, so the results of December of EQA indicators show the performance of the whole year.

For this study, we included 9 EQA indicators referring to follow-up, screening and control of patients with T2DM: 1) Foot screening, 2) Retinopathy screening, 3) Glycated haemoglobin A (HbA1c) test performed, 4) HbA1c control < 8%, 5) HbA1c control < 8% with at least one HbA1c test performed, 6) HbA1c control > 10%; 7) Blood pressure (BP) measure performed, 8) BP control < 150/95 mmHg, 9) BP control < 150/95 mmHg with at least one BP measure performed. Complete definitions and details of the indicators are provided in Supplementary Table S1. In our study, we compared the results of these 9 indicators in December 2020 and December 2019 to analyse the percentage of change between these two years.

To calculate T2DM incidences we included all diagnoses registered in the EHR during the study period in the population older than 14 years old (ICD-10 codes provided in Supplementary Table S1). We calculated annual incidence rates of T2DM per 1000 at-risk population, excluding those with a pre-existing T2DM diagnosis.

2.2. Explanatory variables

All explanatory variables included in the study were also aggregated at the PCP level and were obtained from the same EHR used to calculate EQA indicators. They included socio-demographic variables such as the patient's mean age, gender (percentage of women), the percentage of immigration from a low-income country and the percentage of nursing home residents. We also included the COVID-19 cumulative incidence calculated as the percentage of the PCP population older than 14 years with a COVID-19 confirmed case until December 2020 to adjust by the health resources earmarked to manage the pandemic. COVID-19 data were obtained from the regional central database of reverse transcriptase polymerase chain reaction (RT-PCR) and lateral flow tests for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).

We assessed the socioeconomic status using the validated MEDEA deprivation index [21]. We categorised the MEDEA deprivation index into quartiles where 1st and 4th quartiles are least and most deprived areas, respectively. Rural areas were categorised separately and were defined as areas with<10,000 inhabitants and a population density lower than 150 inhabitants/km^2.

In addition, some organizational variables were included. Continuity of care was measured using the international index UPC (Usual Provider of Care Index) which measures the proportion of visits performed by the general practice or primary care nurse that the patient visits most frequently out of all visits [22]. This index has been used in ICS' PCPs as an indicator since 2018 [23]. We have also included the VISUBA variable, an organizational variable used to assess the organizations' orientation towards the immediacy of primary care consultations. The variable measures the percentage of visits made in schedules managed by the patients' assigned primary care professional out of the total number of the visits in a PCP. VISUBA variable is thus a continuous scale, where the lower the value the higher the degree of immediate consultation and it has been previously used as a variable to measure those PCP organizations favoring immediate consultations [23].

Finally, we included the mean number of weekly face-to-face appointments per primary care professional offered in the schedules of the GPs and primary care nurses ("Face-to-face" variable). This variable was assessed from September to December 2020, to avoid the influence of the first months of the pandemic and the summer. It was calculated as the sum of the number of visits offered in the September-December period by each GP and nurse of the PCP divided by the number of GPs and nurses of the PCP and by the number of weeks. It included all visits offered to any kind of patient to assess the degree of in-person visits. Each GP in Catalonia has on average 1212 patients older than 14 years old assigned. Face-to-face variable was used as a continuous variable and also was categorized in four groups (weekly number of appointments offered per professional of the PCP): a) 0 to 10; b) 11 to 25 ; c) 26 to 40 and 4) more than 40.

2.3. Statistical analysis

For each PCP, we calculated the percentage of change in 2020 results of EQA indicators compared to the 2019 results. We also calculated the percentage of change between T2DM cumulative incidence in 2020 compared to 2019.

For descriptive analysis, we expressed continuous variables as mean (standard deviation) and we summarised categorical variables as absolute frequency (percentage). For bivariate analyses, we used Pearson correlation coefficient for numerical variables; and T-student test or ANOVA analysis for categorical and numerical values. We adjusted a linear regression model using the percentage of change of each EQA indicator or the percentage of change of T2DM incidence as the main dependent variables. We included in the model those explanatory variables that obtained a p-value of lower than 0.05 in the previous bivariate test at least in one indicator. Adjustment variables with a p-value lower than 0.05 in Wald test were considered significant.

All statistical analyses were conducted using R software version 3.5.1 [24].

2.4. Ethics

This study is part of a project that analyses the impact of COVID-19 pandemic, related control measures and organizational changes on primary care. The project was approved by the Clinical Research Ethics Committee of the IDIAP Jordi Gol (project code 20/172-PCV). The study authors did not access identified patient-level data for these analyses that were conducted on aggregated data only (results of quality indicators and other variables at a PCP level).

3. Results

In our study, we included 287 PCPs which have a total assigned population of 4,934,404 people older than 14 years, including 381,917 patients with T2DM. Table 1 summarizes the baseline characteristics of these PCPs: 34.5% of the PCPs were in rural areas and the mean assigned population per PCP was 17,193 patients older than 14 years old. 15.7% of the PCPs offered less than 11 weekly face-to-face appointments per professional from September to December 2020 on average and 12.6% offered more than 40. Continuity of care was reduced by −10.9% in 2020 compared to 2019 and mean cumulative incidence of COVID-19 per PCP until December 2020 was 15.1%. Rural PCPs had significantly a greater mean age, less size, fewer covid-19 incidence and fewer reduction of continuity of care than urban PCPs (Table 1).

Table 2 shows the percentage of change of T2DM indicators and T2DM incidence in 2020 compared to 2019. The overall T2DM incidence was reduced by −25.6% (95% CI: −27.9 to −23.3) in 2020. Diabetic foot screening was the indicator with greater reduction with −51.6% (95% CI: −53.9 to −49.4). HbA1c control and BP control indicators were also reduced by −21.2%

Table 1 – Baseline characteristics of all the PCP included in the study. Continuous variables are presented with mean (standard deviation) and categorical variables are presented with absolute frequency (percentage).

Variables	Value	Total (N = 287)	Rural (N = 99)	Urban (N = 188)	P-value
Socioeconomic status	Number (%) of Urban - Quartile 1 (Least deprived)	48 (16.7)			
Socioeconomic status	Number (%) of Urban - Quartile 2	36 (12.5)			
Socioeconomic status	Number (%)of Urban - Quartile 3	51 (17.8)			
Socioeconomic status	Number (%) of Urban - Quartile 4 (Most deprived)	53 (18.5)			
Rurality	Number (%) of rural PCP	99 (34.5)			
Sex	% of women	50.8 (1.97)	49.6 (1.24)	51.4 (1.98)	<0.001
Age	Age in years	49 (1.9)	49.9 (2.04)	48.6 (1.68)	<0.001
Practice size	Number of patients older than 14 years old assigned to a PCP	17.193 (7576.8)	11.977 (7331)	19.940 (6135)	<0.001
Residence	% of nursing home residents	0.73 (0.71)	1.03 (0.79)	0.57 (0.61)	<0.001
Immigration	% of immigration from a low-income country	13 (7)	11.6 (5.83)	13.8 (7.45)	0.005
Continuity of care	% of change 2020–2019	−10.9 (10.1)	−7.18 (9.17)	−12.91 (10.0)	<0.001
VISUBA* GPs†	% of change 2020–2019 in GP	−18.2 (24.9)	−14.06 (22.0)	−20.41 (26.0)	0.031
VISUBA* nurses	% of change 2020–2019 in nurses	−30.8 (29.8)	−22.77 (22.0)	−34.99 (32.5)	<0.001
COVID-19 cumulative incidence	% of COVID-19	15.1 (4.4)	13.4 (4.61)	16.0 (4.08)	<0.001
Face-to-face appointments (continuous)	weekly appointments offered per professional	24.9 (15.1)	34.6 (15.8)	16.5 (9.37)	<0.001
Face-to-face appointments	PCPs‡ with 0–10 weekly appointments per professional	45 (15.7)	1 (1.01%)	44 (23.5%)	<0.001
Face-to-face appointments	PCPs‡ with 11–25 weekly appointments per professional	140 (48.9)	29 (29.3%)	111 (59.4%)	
Face-to-face appointments	PCPs‡ with 26–40 weekly appointments per professional	65 (22.7)	37 (37.4%)	28 (15.0%)	
Face-to-face appointments	PCPs‡ with > 40 weekly appointments per professional	36 (12.6)	32 (32.3%)	4 (2.14%)	

*VISUBA: Percentage of appointments booked with an assigned professional; †GP: general practice; ‡PCP: primary care practices.

Table 2 – Percentage of change (with 95% CI) of T2DM indicators results and incidence between 2020 and 2019; and mean results in 2020 and 2019.

Indicator	percentage of change (95% CI)	Mean (standard deviation) of 2019 results	Mean (standard deviation) of 2020 results
Foot screening	−51.6 (-53.9 to −49.4)	72.2 (4.9)	35 (14.6)
Retinopathy screening	−25.7 (-26.9 to −24.5)	81.8 (4.2)	60.8 (9.3)
HbA1c < 8%	−21.2 (−22.3 to −20.2)	71 (3.7)	55.9 (7)
HbA1c performed	−18.0 (-18.9 to −17.1)	85.5 (3)	70.2 (7.5)
HbA1c < 8% performed	−3.4 (-3.7 to −3.1)	82.8 (3.1)	79.9 (3.7)
HbA1c > 10%	34.0 (29.9 to 38.1)	3.5 (1.2)	4.5 (1.5)
BP < 150/95 mmHg	−33.7 (-35.1 to −32.3)	81.8 (3.2)	54.2 (10.2)
BP performed	−29.5 (-30.8 to −28.1)	87.6 (2.6)	61.9 (10.6)
BP < 150/95 mmHg performed	−7.6 (-8.2 to −7.0)	83.3 (5.4)	76.9 (6.3)
T2DM incidence*	−25.6 (-27.9 to −23.3)	4.7 (1.3)	3.4 (1)

*Incidence per 1,000 at risk population.

(95% CI: −22.3 to −20.2) and −33.7% (95% CI: −35.1 to −32.3), consistent with the reduction of HbA1c test and BP measures performed indicators: −18% (95% CI: −18.9 to −17.1) and −29.5% (95% CI:-30.8 to −28.1), respectively. In contrast the percentage of T2DM patients with HbA1c > 10% increased by 34% (95% CI: 29.9 to 38.1).

A bivariate analysis using PCP characteristics showed that rural areas had significantly less reduction of T2DM indicators' results and T2DM incidence (Table 3). The variable with highest correlation with the reduction of the indicators was face-to-face variable, highlighting the correlation of 0.55 (95% CI: 0.46 to 0.62, p-value < 0.05) with the Hba1c < 8% control indicator and the correlation of 0.51 (95% CI: 0.42 to 0.59, p-value < 0.05) with HbA1c test performed indicator. BP control and BP measure performed indicators were both correlated with the face-to-face variable by 0.43 (95% CI: 0.33 to 0.52, p-value < 0.05) and foot screening indicator by 0.39 (95% CI: 0.29 to 0.48, p-value < 0.05). Significant, though minor, statistical correlations were also found between face-to-face visits and T2DM incidence and an inverse correlation with HbA1c > 10% of −0.26 (95% CI: −0.37 to −0.15, p-value < 0.05) was observed. None of these correlations between face-to-face visits and results' indicators were found in 2019 (supplementary Table S2). Other significant variables were practice size, percentage of women and continuity of care (Table 3). Covid-19 cumulative incidence had an inverse correlation with some indicators, except for the HbA1c > 10% indicator, the retinopathy screening indicator and T2DM incidence. No significant differences or correlations were observed between the retinopathy screening indicator and the explanatory variables.

Mean number of weekly face-to-face appointments per professional was reduced during the September-December period in 2020 compared with the same months in 2019: 49.7 (10.1) weekly face-to-face appointments on average in 2019 versus 24.9 (15.1) in 2020 (-50% reduction, p < 0.001). This reduction was higher in GP than in primary care nurses: 56.6 (12.0) weekly face-to-face appointments on average in 2019 vs 24.0 (15.0) in 2020 (-57.6% reduction, p < 0.001) and 42.8 (12.9) in 2019 and 26.5 (18.1) in 2020 (-38.2% reduction, p < 0.001), respectively. Supplementary Figure S1 depicts the average weekly number of face-to-face appointments per professional by PCP (September - December 2020 period) to show the distribution of the variable; while Supplementary Figure S2 presents the number of face-to-face appointments and COVID-19 cases for context. Finally, Supplementary Figure S3 shows the mean number of face-to-face appointments in 2020 and 2019 to show this reduction and the increase of variability among the PCP.

Table 4 shows the percentage of change of each indicator by categories of the face-to-face variable. PCPs with less face-to-face appointments offered (from 0 to 10) had greater reductions of the indicators: −60.7% reduction of foot screening, −40.2% of BP control, −30.5% of T2DM incidence, −23.1% and −35.5% of HbA1c test and BP measure indicators respectively; and an increase of the indicator of HbA1c > 10% of 42.3%. Conversely, PCPs with>40 weekly face-to-face appointments offered per professional had statistically less reductions. In addition, in 9 out of 10 indicators we observed a gradient between face-to-face appointments and indicators' reductions. However, no differences were observed between the number of weekly face-to-face appointments and the percentage of change of the retinopathy screening indicator.

Table 3 – Percentage of change of T2DM indicators and incidence according to PCP characteristics: *t*-test or ANOVA for categorical variables and Pearson correlations for continuous variables.

		Foot screening	Retinopathy screening	HbA1c performed	HbA1c < 8%	HbA1c < 8% performed	HbA1c > 10%	BP performed	BP < 150/95 mmHg	BP < 150/95 mmHg performed	T2DM incidence
Categorical variables											
Rurality	Rural	−41.4 (22.4)	−24.3 (13.4)	−12.5 (6.5)	−14.4 (7.7)	−1.8 (2.96)	20.1 (34.5)	−23.5 (11.7)	−27.2 (12.9)	−6.1 (4.8)	−21.5 (26.4)
	Urban	−57.1 (15.4)	−26.5 (8.4)	−20.9 (7.1)	−24.9 (7.7)	−4.2 (2.3)	41.1 (33.8)	−32.6 (10.1)	−37.1 (10.7)	−8.4 (4.6)	−27.8 (14.8)
	p-value	<0.001	0.149	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.03
Socioeconomic status	% of Urban - Quartile 1 (Least deprived)	−61.0 (11.2)	−28.0 (5.4)	−23.5 (6.5)	−26.7 (7.1)	−3.4 (1.6)	47.0 (40.3)	−37.3 (9.7)	−41.5 (10.1)	−7.8 (4.5)	−29.2 (15.1)
	% of Urban - Quartile 2	−56.2 (17.4)	−27.6 (10.2)	−19.8 (7.1)	−23.2 (7.7)	−3.8 (2.2)	44.7 (36.6)	−31.7 (12.3)	−35.2 (13.4)	−7.5 (4.7)	−30.6 (12.7)
	% of Urban - Quartile 3	−56.0 (15.5)	−26.0 (9.4)	−20.0 (7.3)	−23.7 (7.8)	−4.0 (2.2)	37.3 (29.5)	−30.8 (7.9)	−35.7 (8.4)	−8.98 (4.9)	−25.7 (17.5)
	% of Urban - Quartile 4 (Most deprived)	−55.1 (16.9)	−24.7 (8.2)	−20.2 (6.98)	−25.6 (7.9)	−5.5 (2.4)	37.8 (29.1)	−30.7 (9.6)	−35.9 (10.1)	−8.9 (4.3)	−26.6 (13.0)
	p-value	<0.001	0.219	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.081
Continuous variables (Pearson correlation with 95% confidence interval)*											
Percentage of women		−0.26* (-0.37;-0.15)	0 (-0.12;0.11)	−0.34* (-0.43;-0.23)	−0.31* (-0.41;-0.20)	−0.08 (-0.19;0.04)	0.22* (0.11;0.33)	−0.33* (-0.43;-0.23)	−0.31* (-0.41;-0.20)	0 (-0.12;0.11)	−0.11 (-0.22;0.00)
Mean age		0.16 (0.05;0.27)	0.08 (-0.03;0.19)	0.17* (0.06;0.28)	0.26* (0.15;0.37)	0.39* (0.29;0.49)	−0.15* (-0.26;-0.04)	0.15* (0.04;0.26)	0.15* (0.03; 0.26)	0.15* (0.03;0.26)	−0.04 (-0.15;0.08)
Practice size		−0.25* (-0.35;-0.14)	−0.09 (-0.20;0.02)	−0.41* (-0.50;-0.31)	−0.44* (-0.53;-0.34)	−0.37* (-0.46;-0.26)	0.26 (0.15;0.36)	−0.3* (-0.40;-0.19)	−0.27* (-0.37;-0.16)	−0.04 (-0.16;0.07)	−0.12* (-0.23;-0.00)
% of nursing home patients		0.18* (0.07;0.29)	0.006 (-0.11;0.12)	0.16* (0.04;0.27)	0.17* (0.06;0.28)	0.16* (0.04;0.27)	−0.03 (-0.14; 0.09)	0.16* (0.04;0.27)	0.17* (0.06;0.28)	0.09 (-0.03;0.20)	0.04 (-0.07;0.15)
Immigration		0 (0.11;0.12)	−0.11* (-0.22;0.01)	0.01 (-0.11;0.12)	−0.07 (-0.18;0.05)	−0.29* (-0.39;-0.18)	−0.02 (-0.14;0.09)	0.01 (-0.10;0.13)	−0.01 (-0.13;0.10)	−0.09 (-0.21;0.02)	0.01 (-0.10;0.13)
Continuity of care		0.31* (0.21;0.42)	0.13 (0.02;0.25)	0.44* (0.35;0.54)	0.43* (0.34;0.53)	0.16* (0.06;0.29)	−0.12* (-0.24;-0.01)	0.32* (0.21;0.42)	0.34* (0.24;0.44)	0.21* (0.11;0.33)	0.13* (0.01;0.24)
VISUBA†	GPs‡	0.21* (0.11;0.33)	0.1 (-0.01;0.22)	0.32* (0.21;0.42)	0.29* (0.19;0.40)	0.11 (0.00;0.23)	−0.01 (-0.13; 0.09)	0.20 (0.09;0.32)	0.21* (0.11;0.33)	0.13* (0.01;0.24)	0.1 (-0.01;0.22)
	Nurses	0.32* (0.21;0.42)	0.18* (0.06;0.29)	0.36* (0.26;0.46)	0.35* (0.25;0.45)	0.16* (0.05;0.27)	−0.06 (-0.18;0.05)	0.32* (0.22;0.43)	0.33* (0.23;0.43)	0.16* (0.04;0.27)	0.11 (-0.00;0.22)
COVID-19 cumulative incidence		−0.2* (-0.31;-0.09)	−0.11 (-0.22;0.01)	−0.18* (-0.29;-0.07)	−0.25* (-0.35;-0.14)	−0.31* (-0.41;-0.20)	0.06 (-0.06;0.17)	−0.16* (-0.27;-0.05)	−0.17* (-0.28;-0.06)	−0.18* (-0.28;-0.06)	−0.08 (-0.19;0.03)
Face-to-face appointments		0.39* (0.29;0.48)	0.11 (-0.00;0.27)	0.51* (0.42;0.59)	0.55* (0.46;0.62)	0.38* (0.27;0.47)	−0.26* (-0.37;-0.15)	0.43* (0.33;0.52)	0.43* (0.33;0.52)	0.16* 0.05;0.27)(	0.17* (0.06;0.28)

*Correlations between indicators and variables are statistically significant. †VISUBA: Percentage of appointments booked with an assigned professional; ‡GP: general practice;

Table 4 – Mean reductions (standard deviation) of T2DM indicators by face-to-face variable categories.

Indicator	Mean number of face-to-face weekly appointments per professional				
	0–10	11–25	26–40	>40	p-value
Foot screening	−60.7 (15.7)	−56.1 (15.8)	−43.3 (21.3)	−38.2 (22.2)	<0.001
Retinopathy screening	−27.1 (8.4)	−26.3 (8.8)	−24.6 (12.9)	–23.6 (13.0)	0.324
HbA1c performed	−23.1 (6.3)	−19.9 (7.1)	−14.2 (7.5)	−11.0 (5.6)	<0.001
HbA1c < 8%	−27.5 (6.4)	–23.5 (7.9)	−16.8 (8.9)	−12.5 (6.9)	<0.001
HbA1c < 8% performed	−4.6 (1.9)	−3.9 (2.5)	−2.7 (2.8)	−1.2 (3.3)	<0.001
HbA1c > 10%	42.3 (34.6)	39.7 (32.8)	26.9 (35.6)	13.6 (37.9)	<0.001
BP performed	−35.5 (12)	−31.9 (9.7)	−24.9 (11.5)	−20.9 (10.2)	<0.001
BP < 150/95 mmHg	−40.2 (12.9)	−36.3 (10.3)	−28.9 (12.7)	−24.3 (10.7)	<0.001
BP < 150/95 mmHg performed	−8.2 (5.2)	−8.0 (4.4)	−7.4 (4.9)	−5.4 (5.0)	0.02
T2DM incidence	−30.5 (17.3)	−27.8 (14.2)	−21.0 (18.6)	−18.3 (34.9)	0.004

Linear regression models were measured including the variables that showed a statistically significant correlation with the percentage of change of at least one of the indicators. After the adjustments, PCPs with > 40 weekly face-to-face appointments per professional and between 26 and 40 face-to-face appointments had lesser reductions on the foot screening indicator, the HbA1c control indicators and the BP control indicators. The explanatory powers of the models were moderate, ranging between 22% in the foot screening indicator and 39% in HbA1c < 8% indicator. The face-to-face variable also presented an effect on T2DM incidence reduction after adjusting for other variables (more face-to-face appointments less incidence reduction) although the model only had a R2 of 7%. Face-to-face variables didn't show any statistically significant effect in our models for the retinopathy screening indicator and the HbA1c > 10% indicator. Beta coefficients and R2 values of the models for each indicator are provided in full in Supplementary Table S3.

4. Discussion

We hereby describe a reduction of foot and retinopathy screening, HbA1c and BP control, and diagnosis of patients with T2DM during the covid-19 pandemic compared to the previous year. In our study, these reductions were associated with the number of face-to-face consultations. Primary care practices with less than 11 weekly face-to-face appointments offered per professional had greater reductions than those PCPs with more than 40. For instance, we found −60.7% reduction vs −38.2% in foot screening, −27.5% vs −12.5% in HbA1c control and −40.2 vs −24.3% in BP control, respectively.

These results are of interest due to the dramatic decrease of face-to-face primary care visits during the pandemic (50% reduction in our study). The reduction of face-to-face visits could be linked to several reasons, such as a change in health-seeking behaviour of the patients due to the fear of being infected by SARS-CoV-2 [25] and some organizational changes in primary care practices that reduced the number of face-to-face appointments and thus caused the access barriers to the outclinics. As our study analysed visits offered, we can indirectly assess the impact of some organizational changes produced during the pandemic, such as limiting the number of face-to-face appointments available in order to reduce patients and healthcare workers' direct exposure to infection.

Some studies suggest that telemedicine could compensate for part of this reduction of face-to-face visits [26–27]. However, we must distinguish between voluntary and patient-requested telemedicine with remarkables benefits, and a forced telemedicine as a consequence of the difficulty to contact in-person in the context of Covid-19 pandemic. Therefore, older patients or patients with difficulties in using technology may have been more affected by this forced change towards telehealth, as described elsewhere [28–29]. One study performed in uncontrolled diabetes mellitus patients in late 2020 showed that T2DM control was less likely to be achieved by telephone only compared to face-to-face visits and suggested that to benefit vulnerable patients with uncontrolled T2DM, in-person engagement may be required [30]. This is consistent with our results. Conversely, other studies didn't find any difference in T2DM control between patients using telemedicine and not, but some were performed before the pandemic [31]. In a recent research letter, Patel et al. observed no evidence of a negative association between decrease in outpatient visits and medication fills or glycemic control [14] although they observed reductions of −6.5% in HbA1c testing and −18.8% in retinopathy testing in 2020 compared to 2019.

Some results of our study deserve specific comments. Although we observed an association between indicators' reductions and face-to-face appointment for 9 out of 10 indicators, we didn't find any relation with retinopathy screening. This suggests that retinopathy screening is not associated with primary care face-to-face appointments. This can be explained because this screening usually requires a procedure performed outside primary care practices and during the first months of the pandemic this kind of procedure was partially halted in Catalonia. It is also possible that our study was not able to observe an association yet because retinopathy indicator requires a screening in a 2-year period and the reduction of face-to-face visits were mainly in the last 9 months.

The great reduction of HbA1c and BP control appear to be more related to a decline of HbA1c tests and BP measures performed. However, we also found an association between face-to-face appointments and control indicators when we excluded those patients that didn't have a control performed. In addition, the percentage of T2DM patients with HbA1c > 10% had a greater increase in those practices with less face-to-face appointments. It is possible that PCPs with fewer face-to-face appointments offered would prioritize in-person visits from patients with known poor control and thus the result of this indicator increased, introducing a selection bias. However, it is also possible that the Covid-19 pandemic and the changes in social behaviours led to worsening control of T2DM as suggested in some studies, specially in those insulin-treated patients [9–10]. Finally, the reduction of registered T2DM incidence suggests an underdiagnosis during the Covid-19 pandemic previously described in chronic conditions in other articles [32].

Rural areas showed less reduction in results of T2DM-related indicators and T2DM incidence than urban PCPs. This could be related to several factors. Rural PCPs usually have smaller size than urban (both, less assigned population and less healthcare workers) and greater patients' mean age, making it more difficult to change the organization towards other models. In fact, in our study only one rural PCP had less than 11 weekly face-to-face appointments offered per professional. Although the distribution of the face-to-face variable in rural and urban PCPs was significantly different, the effect of in-person visits remained after the adjustments, supporting the hypothesis discussed above. Furthermore, previous work has shown that rural areas had a lower percentage of COVID-19 [33]. In rural areas, then, health care professionals were aware about their epidemiological COVID situation with a lower impact compared to urban areas. That could explain its regular clinical practice (face-to-face) could have been less reduced compared to urban centers. Another important aspect is how citizens cope with this situation and also change their behaviour related to clinical contacts. In urban areas citizens may be more reluctant to accept face to face contacts and also they may miss some of the appointments already scheduled. These two aspects, clinical COVID situation and citizens risk perception could be another of the possible explanations of the described results. Further studies are needed in order to analyse in depth potential explanations from the outputs observed in rural and urban centers.

Our findings should be interpreted in the context of their limitations. First, we performed an ecological analysis and our methods do not allow us to ensure a causal correlation between the number of face-to-face appointments offered and the reduction of indicators' results. Although other reasons may also play a role, the reductions of face-to-face visits analysed in our article have been one important issue during the pandemic, raising several concerns about future negative outcomes associated with poor control or delayed treatment [34]. Secondly, we did not analyse if telemedicine has compensated for some of the reductions observed on T2DM indicators. This could be the objective of future research. Thirdly, even though most of the indicators decreased, we cannot determine the direct impact on our patients' health. Nonetheless, EQA has proven to be a good measure of our population's health and its indicators have been used for more than a decade to measure health outcomes [19].

This study also has some strengths. EQA indicators have been shown to be useful in improving clinical situations [19]. The EQA indicator system and its criteria are also standardised across all centres and, therefore, our conclusions are scalable across Catalonia. Finally, our research has analysed different aspects of clinical practice of patients with T2DM which provide us with a global picture of the relation of face-to-face visits and the management of T2DM.

In conclusion, our study suggests that some organizational factors such as reducing the number of face-to-face visits offered to the population could have an impact on T2DM screening, diagnosis and glycemic and BP control. There is a need to recover face-to-face visits for all patients with chronic conditions to ensure a proper follow-up and control and to avoid future negative outcomes possibly associated.

Author contributions

EC designed the study, researched data, wrote the manuscript and acted as guarantor. QM researched data, performed statistical analysis and wrote the manuscript. MM designed the study, contributed to the discussion, reviewed the manuscript and acted as guarantor. XM designed the study and reviewed/edited the manuscript. XC reviewed/edited the manuscript and contributed to the discussion. MB performed the bibliographic search and reviewed the manuscript. AM designed the study, contributed to the discussion and reviewed the manuscript. MF contributed to the discussion and reviewed the manuscript. FF contributed to the discussion and reviewed the manuscript. YL contributed to the discussion and reviewed the manuscript. JV designed the study, contributed to the discussion and reviewed/edited the manuscript.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper: [XC

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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.2021.109127.

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