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Do hospitals have a higher mortality rate on weekend admissions? An observational study to analyse weekend effect on urgent admissions to hospitals in Catalonia

Franco Amigo,[1] Albert Dalmau-Bueno,[2] Anna García-Altés [2,3,4]

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[1]IMIM, Barcelona, Spain
[2]Agència de Qualitat i Avaluació Sanitàries de Catalunya, Barcelona, Spain
[3]Fundacio Institut de Recerca Hospital de la Santa Creu i Sant Pau, Barcelona, Spain
[4]CIBER de Epidemiología y Salud Pública (CIBERESP), Barcelona, Spain

Correspondence to
Dr Anna García-Altés;
agarciaaltes@gencat.cat

ABSTRACT

Background 'Weekend effect' is a term used to describe the increased mortality associated with weekend emergency admissions to hospital, in contrast with admission on weekdays. The objective of the present study is to determine whether the weekend effect is present in hospitals in Catalonia.

Methods We analysed all urgent admissions in Catalonia in 2018, for a group of pathologies. Two groups were defined (those admitted on a weekday and those admitted on a weekend). We obtained mortality at 3, 7, 15 and 30 days, and applied a proportions test to both groups. Additionally, we used Cox's regression for mortality at 30 days, using the admission on a weekend as the exposition, adjusting by socioeconomic and clinical variables. We used the hospital discharge database and the Central Registry of the Insured Population.

Results 72 427 admissions for the selected pathologies during 2018 were found. No statistically significant differences in mortality at 30 days (p=0.524) or at 15 days (p=0.119) according to the day of admission were observed. However, significant differences were found in mortality at 7 days (p=0.025) and at 3 days (p=0.002). The hazard rate associated with the weekend was 1.13 (95% CI: 1.04 to 1.23). By contrast, the adjusted HR of the weekend interaction with time was 0.99 (95% CI: 0.99 to 1.00).

Conclusions There is a weekend effect, but it is not constant in time. This could suggest the existence of dysfunctions in the quality of care during the weekend.

Strengths and limitations of this study

- We found no other studies that analyse the weekend effect in Catalonia; this has not been studied anywhere else in Spain.
- The primary outcome (death) was measured at 30 days, whether or not the patient was at the hospital.
- The model is adjusted with information from the patients' medical history.
- The results cannot be extrapolated to all diagnoses.
- The intrinsic risk of the admission episode could not be captured by the variables included in the model.

INTRODUCTION

Since the late 1970s, a considerable number of studies have sought to explain the existence of the so-called 'weekend effect'.[1] This effect is the phenomenon where patients admitted to the hospital at weekends apparently have a higher mortality rate than patients admitted on weekdays and, therefore, the hospital quality could be worse on weekends compared with weekdays.[2]

To date, many studies have explored the weekend effect in various patient populations and in different health systems. Surprisingly, despite this large number of studies, there is still debate about whether the weekend effect exists and, if so, what causes it.[3–6] In 2015, the results of an investigation that included almost 15 million hospital admissions were published[7]; it was found that the HR of dying at 30 days was 1.10 for Saturday and 1.15 for Sunday, when compared with a weekday. In 2017, a meta-analysis that included 97 studies in English was published, covering a total of 51 million admissions in different countries. This study showed that mortality at the weekend was 17% higher than during the week.[6] The latest meta-analysis, published in 2019, includes more than 640 million admissions, and concludes that the weekend effect for urgent admissions is 11%.[8] However, there are also some studies that indicate that part of this effect is a statistical artefact,[9] and that therefore it is not possible to affirm that these deaths are preventable or attributable to a poorer quality of care at the weekend.[10–12]

One possible cause, which has been addressed by various studies, is that at the weekend there is less staffing, which would cause a poorer quality of care.[11 13] Another hypothesis is that the doctors who attend at the weekend have less experience, and that this would explain the differences in mortality. However, a study that adjusted for the level of experience of physicians on the day of admission showed that the differences between weekends and weekdays remained significant.[14]

Some studies have also linked the weekend effect with the way in which patients arrive at hospitals.[15] It has been observed that, at the weekend, a greater number of patients arrive by ambulance, and when adjusting for this variable, the risk of mortality associated with the weekend is reduced by half. However, in this study they did not adjust for the severity of the patient and, therefore, the use of an ambulance could be a confounding factor.[15] Finally, a study published in 2016 showed that the difference in mortality was associated with patterns of poorer quality of care, some of which coincided with the weekend, while others occurred at different times of the week.[16]

Thus, there is no consensus regarding the existence of the weekend effect, its size or the possible causes that could explain it. For this reason, the present study aims to determine whether there are differences in hospital mortality within 30 days in urgent admissions in hospitals of the public healthcare network of Catalonia (SISCAT), for different pathologies, among those admitted to a hospital at the weekend or during holidays compared with those admitted on a weekday. Furthermore, it is analysed whether there are differences in this effect according to gender, diagnosis, income level, and hospital level.

METHODS

This study was a population-based, observational, retrospective cohort study. All urgent hospital admissions to SISCAT hospitals during 2018 for a group of pathologies were analysed. To do this, all patients were followed for 30 days after admission.

The study population was made up of the entire population of Catalonia, according to the Central Registry of the Insured Population by CatSalut (RCA) of 2018, who had an urgent hospital admission to a SISCAT centre, and whose main diagnosis was one of the following pathologies[17]: ST-segment elevation myocardial infarction, non-ST-segment elevation myocardial infarction, congestive heart failure, ictus, gastrointestinal bleeding, hip fracture and pneumonia. We considered any non-elective admission as urgent. Two databases from 2018 were used: the hospital discharge database (CMBD-HA, Catalan acronym)[18] and the RCA.[19]

First, a descriptive analysis of hospital admissions was carried out according to different independent variables: sex, diagnosis, age, income level, hospital level, morbidity group 7 days before admission, origin and previous contact with the emergency department (in the primary care centre, Medical Emergencies Service (MES) and hospital) in the 24 hours prior to admission. The results were stratified according to the time of admission: weekday or weekend. We defined weekend as any Saturday or Sunday, plus any public holiday, according to the calendar of public holidays of Catalonia.

Next, a bivariate analysis of mortality in admitted patients at 3, 7, 15 and 30 days was performed globally and according to the different independent variables, depending on whether the admissions were on a weekend or a weekday. The results were accompanied by their respective 95% CI and the p value of the proportions test, allowing us to compare whether there were differences in the proportion of deaths between weekdays and weekends.

Finally, Cox regression models were performed, in which the dependent variable was death (yes/no) at time t, in days from the date of admission (t_0), where the exposure variable was weekday (yes/no). It was verified whether the proportional hazards assumption was fulfilled and, since it was not fulfilled, the interaction with time was included. The confounding variables included in the model were sex, age, diagnosis, hospital level, origin, income level, Adjusted Morbidity Group (AMG) and previous contact with the emergency department in the last 24 hours. Additionally, the models were stratified according to sex, diagnosis, hospital level and income level, adjusting for the rest of the variables. For all models performed, HRs were calculated for the exposure variable and the rest of adjustment variables, with their corresponding 95% CI and the associated p value.

The income level variable was obtained from the registry of the insured population, specifically from the pharmacy copayment information, and the population was classified into four categories: (1) exhausted unemployment subsidy and others; (2) income lower than €18 000; (3) income between €18 000 and €100 000; (4) income greater than €100 000. The variable weekday was generated from the date of admission, and Saturdays, Sundays, and holidays were considered weekend.

The variable hospital level was categorised following the CMBD-HA: high-tech public hospital; monographic high-tech public hospital; high-resolution public hospital; reference public hospital; regional public hospital; and isolated public hospital. They are ordered from greatest capacity and complexity to least. Therefore, the high-tech public hospital corresponds to those of a higher level, that have subspecialties and new technologies. They are able to solve problems that a referral or high-resolution hospital cannot. The monographic high-tech hospital is like a high-tech hospital, but it focuses only on one specialty. The high-resolution public hospital and the reference public hospital are very similar in that they are intended to solve practically all health problems, but they are less specialised than the high-tech ones. The high-resolution hospital is a hospital with some subspecialties. The regional public hospital responds to the usual requirements of the population, but does not treat pathologies that require a significant degree of specialisation. Finally, an isolated public hospital is similar to a regional public hospital, but it is geographically isolated.

The AMG is a risk tool which classifies each individual into a health status and a complexity level group, using administrative data.[20 21] To construct the AMG score, comorbidity and complexity information was gathered automatically from the Catalan Health Surveillance System database, for present and previous years. For each admission, we constructed the AMG score using data from 7 days before the said admission. For this analysis we only used the comorbidity data of the AMG because the complexity data did not provide additional information.

Finally, for the variable contact with emergency departments, the CMBD-HA was used to check if the patient had been admitted to another centre in the previous 24 hours.

Stata V.14.2 statistical software was used for all analyses.

Patient and public involvement

There was no involvement of patients or the public in this study.

RESULTS

Description of hospital admissions

During 2018, there were a total of 72 427 admissions for the selected pathologies: 19 957 (27.55%) on weekends and 52 470 (72.45%) on weekdays. Of these admissions, 51.37% were men (37 204) and 48.63% were women (35 222). Overall, 28.41% of admissions were due to heart failure, 22.07% to pneumonia, 16.53% to stroke, 12.90% to hip fracture, 8.89% to gastrointestinal bleeding, 6.12% to ST-segment elevation myocardial infarction and 5.09% to non-ST-segment elevation myocardial infarction. In terms of age, 47.46% of admitted patients were over 80 years old and 29.97% were between 66 and 80 years old. In regard to income level, 74.30% had an income of less than €18 000. In terms of the degree of morbidity, 62.61% had pathologies affecting four or more systems, and 19.87% had an active neoplasia (see table 1).

Furthermore, 29.40% of admissions occurred in reference public hospitals, 27.59% in high-technology public hospitals, 22.15% in district public hospitals and 18.57% in high-resolution public hospitals. In addition, it was found that 50.20% of the admissions came from a home or nursing home and 38.28% from a unit or service of the same hospital. In regard to previous contact, 3.87% had attended the emergency room of a primary care centre in the 24 hours before their admission, 64.21% to the MES and 92.22% to the emergency room of a hospital (see table 1).

Regarding the differences in the characteristics of the patients who were admitted on a weekday compared with those admitted on a weekend, we observed that there were only significant differences in age (p value <0.001) and diagnosis (p value<0.001). For age, the proportion of people under 40 was higher during weekends. Regarding the diagnosis, the greatest differences were observed in heart failure (29.49% weekday vs 25.57% weekend) and in hip fracture (12.43% vs 14.13%).

Differences in mortality between urgent admissions on weekdays and weekends

The 3-day mortality of those admitted on a weekday was 3.27% (95% CI: 3.12% to 3.42%), while that of those admitted on a weekend was 3.74% (95% CI: 3.48% to 4.01%) with a p value of 0.002. The differences in mortality at 7 days were also statistically significant (p value=0.025), being 5.42% on a weekday (95% CI: 5.23% to 5.61%) and on a weekend, 5.85% (95% CI: 5.52% to 6.17%). In terms of the diagnosis, it was observed that the 3-day mortality due to heart failure on weekends was higher (4.15%; 95% CI: 3.61% to 4.70%) than that observed on weekdays (3.10%; 95% CI: 2.83% to 3.38%) with a p value <0.001. Likewise, the 7-day mortality due to heart failure was higher in weekends admissions (6.39%; 95% CI: 5.72% to 7.06%) than for weekdays admissions (5.50%; 95% CI: 5.14% to 5.86%) (p value=0.018) (see table 2).

Mortality after 15 days of those admitted on a weekday was 7.96% (95% CI: 7.72% to 8.19%) and on a weekend it was 8.31% (95% CI: 7.92% to 8.69%). However, these differences were not statistically significant (p value=0.119). The same was true for mortality at 30 days (p value=0.524), being 10.81% for those admitted on weekdays (95% CI: 10.55% to 11.08%), while for those admitted on a weekend it was 10.98% (95% CI: 10.54% to 11.41%). In regard to the pathologies that motivated the admission, no statistically significant differences were observed in mortality at 15 and 30 days (see table 2).

Cox regression model

The results of the Cox model (table 3) showed that the adjusted HR when admitted on a weekend was 1.13 (95% CI: 1.04 to 1.22). By contrast, the adjusted HR of the weekend interaction with time was 0.99 (95% CI: 0.99 to 1.00).

The adjusted HR in women was 0.87 (95% CI: 0.83 to 0.92). Regarding income level, the adjusted HR in those with an income between €18 000 and €100 000 was 0.79 (95% CI: 0.69 to 0.91) in comparison to the mortality of those with exhausted unemployment benefit.

In terms of diagnosis, taking hip fracture as the reference category, all adjusted HRs were significant: the adjusted HR for gastrointestinal bleeding mortality was 1.38 (95% CI: 1.22 to 1.55), that of ST-segment elevation myocardial infarction was 2.77 (95% CI: 2.44 to 3.15), non-ST-segment elevation myocardial infarction was 1.70 (95% CI: 1.48 to 1.97), for heart failure it was 1.96 (95% CI: 1.80 to 2.13), for stroke it was 3.53 (95% CI: 3.23 to 3.85), and for pneumonia it was 2.01 (95% CI: 1.84 to 2.20).

In both the AMG variable and the hospital level variable, neither category had a significant adjusted HR. The same was true for the adjusted HR for attending a primary care emergency room or a hospital emergency room.

Table 1 Number of urgent hospital admissions according to sociodemographic, clinical and health resource characteristics, broken down by weekday or weekend

	Number of hospital admissions						
	Total		Weekday		Weekend		χ^2
	N	%	N	%	N	%	P value
Total	72 427		52 470	72.45	19 957	27.55	
Sex							0.169
Man	37 204	51.37	27 035	51.52	10 169	50.95	
Woman	35 222	48.63	25 434	48.47	9788	49.05	
Age							<0.001
<5 years	1105	1.53	780	1.49	325	1.63	
5–17 years	561	0.77	380	0.72	181	0.91	
18–39 years	1385	1.91	957	1.82	428	2.14	
40–65 years	13 293	18.35	9593	18.28	3700	18.54	
66–80 years	21 709	29.97	15 927	30.35	5782	28.97	
>80 years	34 374	47.46	24 833	47.33	9541	47.81	
Income level							0.312
Exhausted unemployment subsidy, RMI, RAI, PNC and others	3123	4.31	2272	4.33	851	4.26	
Income less than €18 000	53 811	74.30	38 937	74.21	14 874	74.54	
Income between €18 000 and €100 000	15 198	20.99	11 060	21.08	4138	20.74	
Income greater than €100 000	291	0.40	199	0.38	92	0.46	
Diagnosis							<0.001
Hip fracture	9341	12.90	6522	12.43	2819	14.13	
Gastrointestinal bleeding	6436	8.89	4656	8.87	1780	8.92	
ST-elevation myocardial infarction	4430	6.12	3131	5.97	1299	6.51	
Non-ST-elevation myocardial infarction	3686	5.09	2704	5.15	982	4.92	
Heart failure	20 578	28.41	15 474	29.49	5104	25.57	
Stroke	11 972	16.53	8497	16.19	3475	17.41	
Pneumonia	15 984	22.07	11 486	21.89	4498	22.54	
AMG							0.950
Healthy patient	1115	1.55	805	1.55	310	1.57	
Acute disorder	1039	1.44	736	1.41	303	1.53	
Chronic pathologies affecting 1 system	2340	3.25	1693	3.25	647	3.27	
Chronic pathologies affecting 2–3 systems	8044	11.19	5825	11.18	2219	11.20	
Chronic pathologies affecting >3 systems	45 020	62.61	32 657	62.68	12 363	62.42	
Births and pregnancies	66	0.09	48	0.09	18	0.09	
Active neoplasia	14 286	19.87	10 339	19.84	3947	19.93	
Hospital level							0.277
High-tech public hospital	19 984	27.59	14 549	27.73	5435	27.23	
Monographic high-tech public hospital	436	0.60	308	0.59	128	0.64	
High-resolution public hospital	13 450	18.57	9801	18.68	3649	18.28	
Reference public hospital	21 292	29.40	15 370	29.29	5922	29.67	
Regional public hospital	16 041	22.15	11 576	22.06	4465	22.37	
Isolated public hospital	1224	1.69	866	1.65	358	1.79	
Origin							0.348
Home or nursing home	36 352	50.20	26 340	50.20	10 012	50.17	
Primary care	3259	4.50	2402	4.58	857	4.29	
Other hospital	5141	7.10	3699	7.05	1442	7.23	
Unit or service of the same hospital	27 669	38.21	20 024	38.17	7645	38.31	

Continued

Table 1 Continued

	Number of hospital admissions						
	Total		Weekday		Weekend		χ^2
	N	%	N	%	N	%	P value
Primary care emergency in the last 24 hours							0.408
Yes	2801	3.87	2010	3.83	791	3.96	
No	69 626	96.13	50 460	96.17	19 166	96.04	
MES in the last 24 hours							0.591
Yes	46 504	64.21	33 721	64.27	12 783	64.05	
No	25 923	35.79	18 749	35.73	7174	35.95	
Hospital emergency in the last 24 hours							0.652
Yes	66 789	92.22	48 371	92.19	18 418	92.29	
No	5638	7.78	4099	7.81	1539	7.71	

AMG, Adjusted Morbidity Group; MES, Medical Emergencies Service; PNC, unremarkable pension; RAI, active insertion income; RMI, minimum insertion income.

Weekend effect according to the stratification of variables of interest

When comparing whether the weekend effect was different according to gender, an adjusted HR was obtained in men for admissions on weekends of 1.12 (95% CI: 1.00 to 1.26) compared with on weekdays; in women it was 1.14 (95% CI: 1.01 to 1.27) (see table 4).

The adjusted HR in the weekend group was 0.97 for people with exhausted unemployment benefit (95% CI: 0.62 to 1.53) and for those with an income less than €18 000, it was 1.17 (95% CI: 1.07 to 1.28).

In terms of diagnosis, it was observed that the adjusted HR in the weekend group for people with heart failure was 1.22 (95% CI: 1.05 to 1.42) in comparison to the weekday group, for those with ST-segment elevation myocardial infarction it was 1.32 (95% CI: 0.96 to 1.82), for stroke it was 1.12 (95% CI: 0.97 to 1.30), for pneumonia it was 1.02 (95% CI: 0.85 to 1.23), for hip fracture it was 0.99 (95% CI: 0.72 to 1.37), and for non-ST-segment elevation myocardial infarction it was 0.95 (95% CI: 0.60 to 1.49).

Finally, when comparing the weekend effect by hospital level, the adjusted HR of the weekend group in comparison to the weekday group for those admitted to a high-tech public hospital was 1.04 (95% CI: 0.89 to 1.21), for those admitted to a high-resolution public hospital it was 1.04 (95% CI: 0.86 to 1.26), for a public referral hospital it was 1.20 (95% CI: 1.04 to 1.39), for a regional public hospital it was 1.23 (95% CI: 1.03 to 1.47), and for an isolated public hospital it was 1.05 (95% CI: 0.60 to 1.86).

DISCUSSION

In the first place, it was observed that the study population was an ageing population, since almost 50% were over 80 years old. In addition, they had significant morbidity, as 62% of them had chronic diseases affecting more than three organ systems. When comparing the characteristics of people who were admitted on a weekday versus those who were admitted on a weekend, it was observed that there were only significant differences in age, with those who were admitted on a weekday being slightly younger, and in the distribution according to admission diagnoses.

Among the main results, it can be highlighted that no significant differences were found between weekdays and weekends in regard to mortality rates at 30 days or 15 days. However, differences were found in 7-day and 3-day mortality. It was also found that the adjusted HR of mortality associated with being admitted on a weekend was statistically significant, having a risk of dying 13% higher than for people admitted on a weekday. Furthermore, it was observed that the assumption of proportional hazards over time was not fulfilled for this variable, and the HR of the interaction between the weekend variable and time was 0.99 (p value=0.003) and this indicated that for each day of stay the risk of mortality associated with the weekend effect decreased by 1%.

These results are consistent with each other, since in both cases a significant difference in mortality between admissions on weekdays and weekends was seen during the first days of stay, but that it reduced over time. The order of magnitude of these results is in alignment with what is reported in the literature, since the last published meta-analysis found that the weekend effect for urgent admissions was 11% (95% CI: 6% to 16%).[8]

When analysing whether this effect was different according to sex, it was found that in the men's model the effect was 12% and in women 14%. However, only in women it was statistically significant. Although in this case the differences were small, this finding is consistent with the multiple studies that have described the existence of a gender bias in healthcare.[22–24]

When comparing according to income level, it was observed that there was only a statistically significant effect in the group who earned less than €18 000 per year, with a weekend effect of 17%. This was likely due to the fact that it was the biggest population group: almost 75% of hospital admissions were of people with this income level.

Table 2 Number and percentage of deaths at 3, 7, 15 and 30 days after urgent hospital admission according to sociodemographic, clinical and health resource characteristics, broken down according to weekday or weekends

	3 Days					7 Days					15 Days					30 Days				
	Weekday		Weekend			Weekday		Weekend			Weekday		Weekend			Weekday		Weekend		
	N	Mortality (95% CI)	N	Mortality (95% CI)	P value	N	Mortality (95% CI)	N	Mortality (95% CI)	P value	N	Mortality (95% CI)	N	Mortality (95% CI)	P value	N	Mortality (95% CI)	N	Mortality (95% CI)	P value
Total	**1717**	**3.27 (3.12 to 3.42)**	**747**	**3.74 (3.48 to 4.01)**	**0.002**	**2844**	**5.42 (5.23 to 5.61)**	**1167**	**5.85 (5.52 to 6.17)**	**0.025**	**4174**	**7.96 (7.72 to 8.19)**	**1658**	**8.31 (7.92 to 8.69)**	**0.119**	**5674**	**10.81 (10.55 to 11.08)**	**2191**	**10.98 (10.54 to 11.41)**	**0.524**
Sex																				
Man	818	3.03 (2.82 to 3.23)	347	3.41 (3.06 to 3.77)	0.056	1365	5.05 (4.79 to 5.31)	533	5.24 (4.81 to 5.67)	0.452	2007	7.42 (7.11 to 7.74)	782	7.69 (7.17 to 8.21)	0.385	2724	10.08 (9.72 to 10.43)	1024	10.07 (9.48 to 10.65)	0.986
Woman	899	3.53 (3.31 to 3.76)	400	4.09 (3.69 to 4.48)	0.014	1479	5.82 (5.53 to 6.10)	634	6.48 (5.99 to 6.96)	0.019	2166	8.52 (8.17 to 8.86)	876	8.95 (8.38 to 9.52)	0.194	2949	11.59 (11.20 to 11.99)	1167	11.92 (11.28 to 12.56)	0.391
Age																				
<5 years	0	Not applicable	1	Not applicable		0	Not applicable	1	Not applicable		0	No aplica	1	No aplica		1	No aplica	1	No aplica	
5–17 years	0	Not applicable	0	Not applicable		0	Not applicable	0	Not applicable		0	No aplica	0	No aplica		0	No aplica	1	No aplica	
18–39 years	9	0.94 (0.33 to 1.55)	6	1.40 (0.29 to 2.52)	0.443	10	1.04 (0.40 to 1.69)	8	1.87 (0.59 to 3.15)	0.211	10	1.04 (0.40 to 1.69)	8	1.87 (0.59 to 3.15)	0.211	17	1.78 (0.94 to 2.61)	9	2.10 (0.74 to 3.46)	0.679
40–65 years	151	1.57 (1.32 to 1.82)	67	1.81 (1.38 to 2.24)	0.335	216	2.25 (1.95 to 2.55)	97	2.62 (2.11 to 3.14)	0.207	292	3.04 (2.70 to 3.39)	131	3.54 (2.95 to 4.14)	0.144	376	3.92 (3.53 to 4.31)	176	4.76 (4.07 to 5.44)	0.030
66–80 years	363	2.28 (2.05 to 2.51)	157	2.72 (2.30 to 3.13)	0.063	567	3.56 (3.27 to 3.85)	241	4.17 (3.65 to 4.68)	0.036	847	5.32 (4.97 to 5.67)	347	6.00 (5.39 to 6.61)	0.051	1189	7.47 (7.06 to 7.87)	459	7.94 (7.24 to 8.64)	0.245
>80 year	1194	4.81 (4.54 to 5.07)	516	5.41 (4.95 to 5.86)	0.022	2051	8.26 (7.92 to 8.60)	820	8.59 (8.03 to 9.16)	0.314	3025	12.18 (11.77 to 12.59)	1171	12.27 (11.61 to 12.93)	0.816	4091	16.47 (16.01 to 16.94)	1545	16.19 (15.45 to 16.93)	0.529
Income level																				
Exhausted unemployment subsidy, RMI, RAI, PNC and others*	66	2.90 (2.21 to 3.60)	22	2.59 (1.52 to 3.65)	0.631	99	4.36 (3.52 to 5.20)	38	4.47 (3.08 to 5.85)	0.896	136	5.99 (5.01 to 6.96)	50	5.88 (4.30 to 7.46)	0.908	183	8.05 (6.94 to 9.17)	68	7.99 (6.17 to 9.81)	0.953
Income less than €18 000	1333	3.42 (3.24 to 3.60)	602	4.05 (3.73 to 4.36)	0.001	2225	5.71 (5.48 to 5.94)	940	6.32 (5.93 to 6.71)	0.008	3300	8.48 (8.20 to 8.75)	1333	8.96 (8.50 to 9.42)	0.072	4517	11.60 (11.28 to 11.92)	1754	11.79 (11.27 to 12.31)	0.536
Income between €18 000 and €100 000	313	2.83 (2.52 to 3.14)	121	2.92 (2.41 to 3.44)	0.757	512	4.63 (4.24 to 5.02)	184	4.45 (3.82 to 5.07)	0.632	725	6.56 (6.09 to 7.02)	270	6.52 (5.77 to 7.28)	0.946	959	8.67 (8.15 to 9.20)	364	8.80 (7.93 to 9.66)	0.807
Income greater than €100 000	5	2.51 (0.34 to 4.69)	2	2.17 (−0.81 to 5.15)	0.861	8	4.02 (1.29 to 6.75)	5	5.43 (0.80 to 10.07)	0.587	13	6.53 (3.10 to 9.97)	5	5.43 (0.80 to 10.07)	0.718	15	7.54 (3.87 to 11.21)	5	5.43 (0.80 to 10.07)	0.510
Diagnosis																				
Hip fracture	64	0.98 (0.74 to 1.22)	27	0.96 (0.60 to 1.32)	0.915	158	2.42 (2.05 to 2.80)	70	2.48 (1.91 to 3.06)	0.862	306	4.69 (4.18 to 5.21)	124	4.40 (3.64 to 5.16)	0.535	498	7.64 (6.99 to 8.28)	197	6.99 (6.05 to 7.93)	0.274

Continued

Table 2 Continued

	3 Days					7 Days					15 Days					30 Days				
	Weekday		Weekend			Weekday		Weekend			Weekday		Weekend			Weekday		Weekend		
	N	Mortality (95% CI)	N	Mortality (95% CI)	P value	N	Mortality (95% CI)	N	Mortality (95% CI)	P value	N	Mortality (95% CI)	N	Mortality (95% CI)	P value	N	Mortality (95% CI)	N	Mortality (95% CI)	P value
Gastrointestinal bleeding	100	2.15 (1.73 to 2.56)	38	2.13 (1.46 to 2.81)	0.974	151	3.24 (2.73 to 3.75)	63	3.54 (2.68 to 4.40)	0.553	218	4.68 (4.08 to 5.29)	102	5.73 (4.65 to 6.81)	0.084	304	6.53 (5.82 to 7.24)	141	7.92 (6.67 to 9.18)	0.049
ST-elevation myocardial infarction	126	4.02 (3.34 to 4.71)	64	4.93 (3.75 to 6.10)	0.177	172	5.49 (4.70 to 6.29)	78	6.00 (4.71 to 7.30)	0.502	230	7.35 (6.43 to 8.26)	98	7.54 (6.11 to 8.98)	0.818	270	8.62 (7.64 to 9.61)	112	8.62 (7.10 to 10.15)	0.999
Non-ST-elevation myocardial infarction	53	1.96 (1.44 to 2.48)	21	2.14 (1.23 to 3.04)	0.733	96	3.55 (2.85 to 4.25)	37	3.77 (2.58 to 4.96)	0.754	145	5.36 (4.51 to 6.21)	54	5.50 (4.07 to 6.92)	0.871	191	7.06 (6.10 to 8.03)	73	7.43 (5.79 to 9.07)	0.700
Heart failure	480	3.10 (2.83 to 3.38)	212	4.15 (3.61 to 4.70)	<0.001	851	5.50 (5.14 to 5.86)	326	6.39 (5.72 to 7.06)	0.018	1336	8.63 (8.19 to 9.08)	482	9.44 (8.64 to 10.25)	0.077	1933	12.49 (11.97 to 13.01)	686	13.44 (12.50 to 14.38)	0.078
Stroke	550	6.47 (5.95 to 7.00)	258	7.42 (6.55 to 8.30)	0.060	852	10.03 (9.39 to 10.67)	385	11.08 (10.04 to 12.12)	0.086	1135	13.36 (12.63 to 14.08)	493	14.19 (13.03 to 15.35)	0.229	1381	16.25 (15.47 to 17.04)	590	16.98 (15.73 to 18.23)	0.331
Pneumonia	344	2.99 (2.68 to 3.31)	127	2.82 (2.34 to 3.31)	0.564	564	4.91 (4.52 to 5.31)	208	4.62 (4.01 to 5.24)	0.448	804	7.00 (6.53 to 7.47)	305	6.78 (6.05 to 7.52)	0.624	1097	9.55 (9.01 to 10.09)	392	8.71 (7.89 to 9.54)	0.102
AMG																				
Healthy patient	32	3.98 (2.63 to 5.32)	13	4.19 (1.96 to 6.42)	0.868	47	5.84 (4.22 to 7.46)	18	5.81 (3.20 to 8.41)	0.984	68	8.45 (6.53 to 10.37)	26	8.39 (5.30 to 11.47)	0.974	91	11.30 (9.12 to 13.49)	34	10.97 (7.49 to 14.45)	0.873
Acute disorder	13	1.77 (0.81 to 2.72)	10	3.30 (1.29 to 5.31)	0.127	23	3.13 (1.87 to 4.38)	21	6.93 (4.07 to 9.79)	0.006	45	6.11 (4.38 to 7.85)	28	9.24 (5.98 to 12.50)	0.073	62	8.42 (6.42 to 10.43)	33	10.89 (7.38 to 14.40)	0.210
Chronic pathologies affecting 1 system	49	2.89 (2.10 to 3.69)	23	3.55 (2.13 to 4.98)	0.408	80	4.73 (3.71 to 5.74)	39	6.03 (4.19 to 7.86)	0.200	122	7.21 (5.97 to 8.44)	51	7.88 (5.81 to 9.96)	0.576	169	9.98 (8.55 to 11.41)	73	11.28 (8.84 to 13.72)	0.355
Chronic pathologies affecting 2–3 systems	188	3.23 (2.77 to 3.68)	82	3.70 (2.91 to 4.48)	0.298	309	5.30 (4.73 to 5.88)	123	5.54 (4.59 to 6.50)	0.672	455	7.81 (7.12 to 8.50)	176	7.93 (6.81 to 9.06)	0.858	614	10.54 (9.75 to 11.33)	228	10.27 (9.01 to 11.54)	0.728
Chronic pathologies affecting >3 systems	1121	3.43 (3.24 to 3.63)	472	3.82 (3.48 to 4.16)	0.048	1836	5.62 (5.37 to 5.87)	719	5.82 (5.40 to 6.23)	0.428	2659	8.14 (7.85 to 8.44)	1020	8.25 (7.77 to 8.74)	0.708	3612	11.06 (10.72 to 11.40)	1368	11.07 (10.51 to 11.62)	0.988
Births and pregnancies	1	2.08 (0 to 6.12)	1	5.56 (0 to 16.14)	0.464	4	8.33 (0.51 to 16.15)	1	5.56 (−5.03 to 16.14)	0.704	7	14.58 (4.60 to 24.57)	1	5.56 (0 to 16.14)	0.317	8	16.67 (6.12 to 27.21)	1	5.56 (0 to 16.14)	0.241
Active neoplasia	305	2.95 (2.62 to 3.28)	144	3.65 (3.06 to 4.23)	0.032	531	5.14 (4.71 to 5.56)	241	6.11 (5.36 to 6.85)	0.022	793	7.67 (7.16 to 8.18)	348	8.82 (7.93 to 9.70)	0.024	1077	10.42 (9.83 to 11.01)	442	11.20 (10.21 to 12.18)	0.175
Hospital level																				
High-tech public hospital	485	3.33 (3.04 to 3.63)	187	3.44 (2.96 to 3.93)	0.709	817	5.62 (5.24 to 5.99)	304	5.59 (4.98 to 6.20)	0.952	1191	8.19 (7.74 to 8.63)	442	8.13 (7.41 to 8.86)	0.902	1634	11.23 (10.72 to 11.74)	592	10.89 (10.06 to 11.72)	0.498

Continued

Table 2 Continued

	3 Days					7 Days					15 Days					30 Days				
	Weekday		Weekend			Weekday		Weekend			Weekday		Weekend			Weekday		Weekend		
	N	Mortality (95% CI)	N	Mortality (95% CI)	P value	N	Mortality (95% CI)	N	Mortality (95% CI)	P value	N	Mortality (95% CI)	N	Mortality (95% CI)	P value	N	Mortality (95% CI)	N	Mortality (95% CI)	P value
Monographic high-tech public hospital	8	2.60 (0.82 to 4.37)	3	2.34 (0 to 4.96)	0.878	14	4.55 (2.22 to 6.87)	7	5.47 (1.53 to 9.41)	0.682	22	7.14 (4.27 to 10.02)	9	7.03 (2.60 to 11.46)	0.967	26	8.44 (5.34 to 11.55)	10	7.81 (3.16 to 12.46)	0.828
High-resolution public hospital	341	3.48 (3.12 to 3.84)	123	3.37 (2.79 to 3.96)	0.759	523	5.34 (4.89 to 5.78)	212	5.81 (5.05 to 6.57)	0.283	770	7.86 (7.32 to 8.39)	296	8.11 (7.23 to 9.00)	0.626	1044	10.65 (10.04 to 11.26)	401	10.99 (9.97 to 12.00)	0.574
Reference public hospital	506	3.29 (3.01 to 3.57)	257	4.34 (3.82 to 4.86)	<0.001	846	5.50 (5.14 to 5.86)	372	6.28 (5.66 to 6.90)	0.029	1215	7.91 (7.48 to 8.33)	514	8.68 (7.96 to 9.40)	0.064	1616	10.51 (10.03 to 11.00)	673	11.36 (10.56 to 12.17)	0.073
Regional public hospital	349	3.01 (2.70 to 3.33)	163	3.65 (3.10 to 4.20)	0.040	591	5.11 (4.70 to 5.51)	247	5.53 (4.86 to 6.20)	0.277	899	7.77 (7.28 to 8.25)	362	8.11 (7.31 to 8.91)	0.471	1256	10.85 (10.28 to 11.42)	467	10.46 (9.56 to 11.36)	0.474
Isolated public hospital	28	3.23 (2.06 to 4.41)	14	3.91 (1.90 to 5.92)	0.554	53	6.12 (4.52 to 7.72)	25	6.98 (4.34 to 9.62)	0.574	77	8.89 (7.00 to 10.79)	35	9.78 (6.70 to 12.85)	0.625	98	11.32 (9.21 to 13.43)	48	13.41 (9.88 to 16.94)	0.304
Origin																				
Home or nursing home	856	3.25 (3.04 to 3.46)	357	3.57 (3.20 to 3.93)	0.134	1380	5.24 (4.97 to 5.51)	564	5.63 (5.18 to 6.08)	0.136	2060	7.82 (7.50 to 8.15)	823	8.22 (7.68 to 8.76)	0.208	2847	10.81 (10.43 to 11.18)	1090	10.89 (10.28 to 11.50)	0.830
Primary care	93	3.87 (3.10 to 4.64)	33	3.85 (2.56 to 5.14)	0.978	157	6.54 (5.55 to 7.52)	50	5.83 (4.27 to 7.40)	0.469	208	8.66 (7.53 to 9.78)	62	7.23 (5.50 to 8.97)	0.194	288	11.99 (10.69 to 13.29)	94	10.97 (8.88 to 13.06)	0.425
Other hospital	132	3.57 (2.97 to 4.17)	55	3.81 (2.83 to 4.80)	0.673	215	5.81 (5.06 to 6.57)	92	6.38 (5.12 to 7.64)	0.440	303	8.19 (7.31 to 9.08)	127	8.81 (7.34 to 10.27)	0.474	402	10.87 (9.86 to 11.87)	155	10.75 (9.15 to 12.35)	0.902
Unit or service of the same hospital	636	3.18 (2.93 to 3.42)	302	3.95 (3.51 to 4.39)	0.001	1092	5.45 (5.14 to 5.77)	461	6.03 (5.50 to 6.56)	0.062	1603	8.01 (7.63 to 8.38)	646	8.45 (7.83 to 9.07)	0.226	2136	10.67 (10.24 to 11.09)	852	11.14 (10.44 to 11.85)	0.253
Primary care emergency in the last 24 hours																				
Yes	72	3.58 (2.77 to 4.39)	35	4.42 (2.99 to 5.86)	0.295	103	5.12 (4.16 to 6.09)	52	6.57 (4.85 to 8.30)	0.131	149	7.41 (6.27 to 8.56)	76	9.61 (7.55 to 11.66)	0.054	203	10.10 (8.78 to 11.42)	102	12.90 (10.56 to 15.23)	0.033
No	1645	3.26 (3.11 to 3.41)	712	3.71 (3.45 to 3.98)	0.003	2741	5.43 (5.23 to 5.63)	1115	5.82 (5.49 to 6.15)	0.047	4025	7.98 (7.74 to 8.21)	1582	8.25 (7.86 to 8.64)	0.229	5471	10.84 (10.57 to 11.11)	2089	10.90 (10.46 to 11.34)	0.828
MES in the last 24 hours																				
Yes	1088	3.23 (3.04 to 3.42)	468	3.66 (3.34 to 3.99)	0.020	1816	5.39 (5.14 to 5.63)	738	5.77 (5.37 to 6.18)	0.101	2658	7.88 (7.59 to 8.17)	1069	8.36 (7.88 to 8.84)	0.089	3587	10.64 (10.31 to 10.97)	1405	10.99 (10.45 to 11.53)	0.271
No	629	3.35 (3.10 to 3.61)	279	3.89 (3.44 to 4.34)	0.036	1028	5.48 (5.16 to 5.81)	429	5.98 (5.43 to 6.53)	0.120	1516	8.09 (7.70 to 8.48)	589	8.21 (7.57 to 8.85)	0.743	2087	11.13 (10.68 to 11.58)	786	10.96 (10.23 to 11.68)	0.688

Continued

Table 2 Continued

	3 Days					7 Days					15 Days					30 Days				
	Weekday		Weekend			Weekday		Weekend			Weekday		Weekend			Weekday		Weekend		
	N	Mortality (95% CI)	N	Mortality (95% CI)	P value	N	Mortality (95% CI)	N	Mortality (95% CI)	P value	N	Mortality (95% CI)	N	Mortality (95% CI)	P value	N	Mortality (95% CI)	N	Mortality (95% CI)	P value
Hospital emergency in the last 24 hours																				
Yes	1589	3.29 (3.13 to 3.44)	685	3.72 (3.45 to 3.99)	0.006	2621	5.42 (5.22 to 5.62)	1067	5.79 (5.46 to 6.13)	0.058	3855	7.97 (7.73 to 8.21)	1528	8.30 (7.90 to 8.69)	0.166	5234	10.82 (10.54 to 11.10)	2019	10.96 (10.51 to 11.41)	0.599
No	128	3.12 (2.59 to 3.66)	62	4.03 (3.05 to 5.01)	0.093	223	5.44 (4.75 to 6.13)	100	6.50 (5.27 to 7.73)	0.128	319	7.78 (6.96 to 8.60)	130	8.45 (7.06 to 9.84)	0.412	440	10.73 (9.79 to 11.68)	172	11.18 (9.60 to 12.75)	0.635

*P value corresponds to a test of proportions.
AMG, Adjusted Morbidity Group; MES, Medical Emergencies Service; PNC, unremarkable pension; RAI, active insertion income; RMI, minimum insertion income.

Table 3 Adjusted Cox survival model 30 days after emergency hospital admission according to day of admission, sociodemographic, clinical and health resource characteristics

	HR*	95% CI	P value
Weekday			
Yes	1		
No	1.13	1.04 to 1.22	0.002
Interaction			
Time and weekend	0.99	0.99 to 1.00	0.003
Sex			
Man	1		
Woman	0.87	0.83 to 0.92	<0.001
Age	1.06	1.06 to 1.06	<0.001
Income level			
Exhausted unemployment subsidy. RMI. RAI. PNC and others	1		
Income less than €18 000	0.91	0.80 to 1.03	0.138
Income between €18 000 and €100 000	0.79	0.69 to 0.91	0.001
Income greater than €100 000	0.66	0.42 to 1.04	0.075
Diagnosis			
Hip fracture	1		
Gastrointestinal bleeding	1.38	1.22 to 1.55	<0.001
ST-elevation myocardial infarction	2.77	2.44 to 3.15	<0.001
Non-ST-elevation myocardial infarction	1.70	1.48 to 1.97	<0.001
Heart failure	1.96	1.80 to 2.13	<0.001
Stroke	3.53	3.23 to 3.85	<0.001
Pneumonia	2.01	1.84 to 2.20	<0.001
AMG			
Healthy patient	1		
Acute disorder	0.79	0.60 to 1.02	0.076
Chronic pathologies affecting 1 system	0.90	0.73 to 1.12	0.363
Chronic pathologies affecting 2–3 systems	0.93	0.77 to 1.13	0.463
Chronic pathologies affecting >3 systems	0.98	0.82 to 1.18	0.862
Births and pregnancies	1.24	0.63 to 2.44	0.532
Active neoplasia	0.96	0.79 to 1.16	0.656
Hospital level			
High-tech public hospital	1		
Monographic high-tech public hospital	0.78	0.56 to 1.09	0.146
High-resolution public hospital	0.94	0.88 to 1.01	0.118
Reference public hospital	0.99	0.93 to 1.05	0.665
Regional public hospital	0.96	0.90 to 1.02	0.268
Isolated public hospital	1.10	0.93 to 1.30	0.248

Continued

Table 3 Continued

	HR*	95% CI	P value
Origin			
Home or nursing home	1		
Primary care	1.08	0.97 to 1.20	0.183
Other hospital	1.00	0.90 to 1.10	0.959
Unit or service of the same hospital	0.97	0.92 to 1.03	0.277
Primary care emergency in the last 24 hours			
Yes	1		
Not	0.99	0.88 to 1.11	0.858
MES in the last 24 hours			
Yes	1		
No	0.94	0.90 to 0.99	0.021
Hospital emergency in the last 24 hours			
Yes	1		
No	1.04	0.95 to 1.13	0.431

*Hazard ratios.
MES, Medical Emergencies Service; PNC, unremarkable pension; RAI, active insertion income; RMI, minimum insertion income.

Therefore, there may not be sufficient statistical power to identify the effect in the models of other income levels.

In regard to diagnosis, there was a weekend effect of 22% for people who were admitted for heart failure, and this effect was statistically significant. This result was unexpected, since in the literature the weekend effect for heart failure is usually between 1% and 10%, and in many cases no significant difference has been found.[13 25–27]

On the other hand, a weekend effect of 32% was found in the group who were admitted for ST-segment elevation myocardial infarction, but this was not statistically significant. This is a worrying finding, even more so considering that in Catalonia there is a rapid care code for this pathology that seeks to guarantee the quality of care that the patient receives and a maximum speed of care.[28] We believe that it is important to investigate this pathology in more detail, since in this study it accounted for 6% of admissions and it may be that, in an analysis with more years included, there would be sufficient statistical power to detect statistically significant differences for this pathology.

Finally, when comparing the weekend effect by hospital level, it can be seen that the adjusted HR for weekend was significant for the reference public hospitals and the regional public hospitals, with 20% and 22% higher mortality due to the weekend effect, respectively. Therefore, it was observed that the weekend effect was stronger in smaller hospitals. This could be due to the fact that it is the small hospitals that have the greatest difficulty in covering shifts and services during the weekend, compared with larger hospitals.[29]

Table 4 Adjusted Cox survival models 30 days after emergency hospital admission according to admission day stratified by sociodemographic, clinical and health resource characteristics

	HR*	95% CI	P value
Sex†			
Man			
Weekday	1		
Weekend	1.12	1.00 to 1.26	0.052
Woman			
Weekday	1		
Weekend	1.14	1.01 to 1.27	0.022
Income level‡			
Exhausted unemployment subsidy, RMI, RAI, PNC and others*			
Weekday	1		
Weekend	0.97	0.62 to 1.53	0.907
Income less than €18 000			
Weekday	1		
Weekend	1.17	1.07 to 1.28	0.001
Income between €18 000 and €100 000			
Weekday	1		
Weekend	0.98	0.80 to 1.19	0.827
Income greater than €100 000			
Weekday	1		
Weekend	2.20	0.36 to 13.58	0.395
Diagnosis§			
Hip fracture			
Weekday	1		
Weekend	0.99	0.72 to 1.37	0.958
Gastrointestinal bleeding			
Weekday	1		
Weekend	1.10	0.79 to 1.55	0.566
ST-elevation myocardial infarction			
Weekday	1		
Weekend	1.32	0.96 to 1.82	0.088
Non-ST-elevation myocardial infarction			
Weekday	1		
Weekend	0.95	0.60 to 1.49	0.812
Heart failure			
Weekday	1		
Weekend	1.22	1.05 to 1.42	0.008
Stroke			
Weekday	1		
Weekend	1.12	0.97 to 1.30	0.125
Pneumonia			
Weekday	1		

Continued

Table 4 Continued			
	HR*	95% CI	P value
Weekend	1.02	0.85 to 1.23	0.812
Hospital level¶			
High-tech public hospital			
Weekday	1		
Weekend	1.04	0.89 to 1.21	0.638
Monographic high-tech public hospital			
Weekday	1		
Weekend	1.59	0.48 to 5.29	0.448
High-resolution public hospital			
Weekday	1		
Weekend	1.04	0.86 to 1.26	0.651
Reference public hospital			
Weekday	1		
Weekend	1.20	1.04 to 1.39	0.012
Regional public hospital			
Weekday	1		
Weekend	1.23	1.03 to 1.47	0.022
Isolated public hospital			
Weekday	1		
Weekend	1.05	0.60 to 1.86	0.858

*Hazard ratios.
†Adjusted age, diagnosis, hospital level, origin, income level, Adjusted Morbidity Group, previous contact with the emergency department in the last 24 hours.
‡Adjusted age, diagnosis, sex, hospital level, origin, Adjusted Morbidity Group, previous contact with the emergency department in the last 24 hours.
§Adjusted age, sex, hospital level, origin, income level, Adjusted Morbidity Group, previous contact with the emergency department in the last 24 hours.
¶Adjusted age, diagnosis, sex, origin, income level, Adjusted Morbidity Group, previous contact with the emergency department in the last 24 hours.

In regard to the possible limitations of the study, it should be mentioned that the income level variable has very wide ranges in some of its categories; there may be a lot of heterogeneity within groups and, therefore, there may have been some effect in the different groups of income that could not be analysed. This limitation is due to the origin of the data, since such disaggregation according to income was the minimum possible. Furthermore, it should be noted that the results cannot be extrapolated to all hospital admissions, since a list of specific pathologies was selected, covering those that should be most affected if there was a weekend effect.[17]

In regard to strengths, a population database was used and, therefore, it was possible to have access to all urgent hospital admissions recorded in Catalonia in 2018 for these pathologies, and both intrahospital and extrahospital mortality was monitored. In addition, the adjusted morbidity group was included in the model, which was an excellent indicator of the patient's health status prior to admission and allows control of the case mix. This is very important because there are studies that indicate that the weekend effect could be due to the fact that patients admitted to hospital on weekends are sicker than those admitted on weekdays.[30]

We can conclude that there was a weekend effect, but it was not constant over time: on the first day, the risk of dying was 13% higher in those patients who were admitted on a weekend, and decreased by 1% for each additional day of stay. In addition, there were differences according to sex, hospital level, diagnosis and income level, since a greater effect was found in women; in public reference hospitals and regional public hospitals; in heart failure patients; and in those who earned less than €18 000 per year.

This may suggest that there were quality of care problems at the weekend. It is necessary to expand the investigation to a greater number of pathologies and carry out studies that delve deeper into the factors that produce this effect.

Contributors FA reviewed the literature. FA, AD-B and AG-A conceived and designed the study. AD-B and AG-A collected the data. FA cleaned and analysed the data and drafted the initial version of the manuscript. All authors reviewed the initial draft, made critical contributions to the interpretation of the data and approved the manuscript. The corresponding author attests that all listed authors meet the authorship criteria and that no others meeting the criteria have been omitted. AG-A is responsible for the overall content as guarantor.

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Data availability statement Data are available upon reasonable request. A governmental structure called PADRIS exists within the Catalan healthcare administration. PADRIS is an analytical data programme for research and innovation in health. The purpose of the structure is to make data available to scientific communities to promote research, innovation and evaluation in health, with the aim of reusing and exchanging the data generated by the health system in accordance with the legal and regulatory framework. The programme PADRIS ensures that all data made available to researchers is fully anonymised. As workers within the Catalan healthcare administration, we are provided data by PADRIS, and therefore are never given access to identifiable information. Thus, the study did not involve any data collection, requiring neither human participants nor patient consent. For that reason, and due to the use of existing anonymised data for research, the study was exempt from institutional review committee approval. It is the standard way of proceeding in the healthcare administration to systematically check the quality of the healthcare providers in our context.

ORCID iD
Anna García-Altés http://orcid.org/0000-0003-3889-5375

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