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Evaluating the effect of COVID-19 incidence on Emergency Departments admissions. Results from a retrospective study in Central Italy during the first year of pandemic

C. Quercioli[1,2], R. Bosco[1], G. Bova[3], M. Mandò[4], M.F. De Marco[5], S. Dei[6], R. Gusinu[7], G. Messina[1,8]

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Parole Chiave: COVID-19, Servizio di emergenza, paura, triage

Abstract

Introduction. *The COVID-19 pandemic has had a major impact on the Healthcare System, changing the patterns of Emergency Department access. In fact, accesses for trauma and less severe cases decreased significantly. This decline has generally been attributed to both the effects of the lockdown, imposed by the government, and the fear of being infected by SARS-CoV-2 in the hospital. However, the correlation between these elements is not yet clear, since the accesses to the Emergency Department did not increase either at the end of the lockdown or in the summer when the epidemiological situation was more favorable. Aim: To evaluate the association between trends of Emergency Department accesses and COVID-19 incidence in 2020.*

Methods. *Data on Emergency Department accesses, by month and severity triage code, from 14 hospitals in southeastern Tuscany (Italy) were obtained from hospitals' data warehouse. Official data on new cases of COVID-19 infection were used to calculate incidence. Hospitals were classified into 4 categories. Diffe-*

[1]*Post Graduate School of Public Health, University of Siena, Italy*
[2]*Healthcare Management, Local Health Authority Southern-East Tuscany, Italy*
[3]*Emergency Director, University Hospital "Santa Maria alle Scotte", Siena, Italy*
[4]*Emergency Department Director, Local Health Authority Southern-East Tuscany, Italy*
[5]*Medical Management, University Hospital "Santa Maria alle Scotte", Siena, Italy*
[6]*Healthcare Director, Local Health Authority Southern-East Tuscany, Italy*
[7]*Healthcare Director, University Hospital "Santa Maria alle Scotte", Siena, Italy*
[8]*Department of Molecular and Developmental Medicine, University of Siena, Italy*

Abbrevations: *ED = Emergency Department; LHASET = Local Health Authority Southern-East Tuscany*

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rences in Emergency Department access by month, triage code, and hospital type were investigated using Kruskal-Wallis analysis. Association between Emergency Department accesses and COVID-19 incidence was evaluated using a random-effect panel data analysis, adjusting for hospital type and triage code.

Results. *The trend of 268,072 Emergency Department accesses decreases substantially at the first pandemic peak; thereafter, it increased and decreased again until the minimum peak in November 2020. COVID-19 incidence appeared to be overlapping with an inverse direction. Monthly differences were significant ($p<0.01$) except for most severe codes. There was a significant inverse association between Emergency Department accesses and COVID-19 incidence (Coef. =-0.074, $p<0.001$) except for most severe cases (triage code 1: Coef. =-0.028, $p=0.154$).*

Conclusion. *Emergency Department admissions trend followed the COVID-19 incidence, except for the most severe cases. Fear of infection seems to discourage patients from accessing Emergency Department for illnesses perceived as not serious.*

Introduction

The COVID-19 pandemic has had a disruptive effect on health systems. In the initial phase, the greatest impact was on hospitals, which had to deal with the management of critical cases in need of intensive treatment. Subsequently, primary health care and prevention health services were also widely involved in taking charge of home cases, contact tracing, surveillance, and monitoring of patients in quarantine.

At the hospital level, the most affected structures were the Emergency Department (ED) and the Intensive Care wards. ED had to face the impact of COVID-19 cases management, while the decrease in non-COVID-19 accesses is widely documented in the literature, especially in the "first wave" of the pandemic, during lockdown phases that have been implemented in many countries around the world. Furthermore, the type and severity of cases that presented to the ED had also changed, as traumatic and less severe cases had significantly decreased (1-8).

In Italy, the epidemic trend saw a first phase of rapid increase in COVID-19 cases with a consequent general lockdown from 4 March to 30 April 2020. At the hospital level, all non-urgent healthcare activities had been cancelled, including surgeries and outpatient visits. Other than the emergency/urgency pathway, the oncological, obstetrics and paediatric assistance had remained active. After, there was a phase of progressive decline in COVID-19 cases with a minimum in July-August 2020. Hospital activities were gradually resumed, although with some limitations related to anti-COVID-19 measures. Starting from October 2020, the COVID-19 incidence presented a slow but steady upturn, with a new substantial increase that reached the highest level in November 2020.

The accesses to the ED in the first phase of the pandemic have substantially decreased compared to the pre-pandemic months and the same period of previous years.

The decline in ED accesses has been linked both with the effects of the lockdown and with the fear of contracting COVID-19 in the hospital and it also affected contexts where the epidemic was more contained (8-23). It is not currently clear, however, if there was a correlation between the COVID-19 incidence and the decrease of ED accesses or if the reduction was instead linked to the lockdown imposed by law. However, this last hypothesis is contradicted by the fact that the ED accesses did not return to the pre-pandemic level at the end of the lockdown and not even in the phase of decrease of COVID-19 cases number, which occurred during the summer season (9).

The main objective of this study was therefore to clarify the relationship between the trend of ED accesses and the incidence

of COVID-19. To this end, the trend of ED accesses of fourteen hospitals in South-East of Tuscany (Italy) in the period 1 January - 31 December 2020 was studied and the association between the ED accesses and the incidence of COVID-19 in the same period was evaluated, adjusting by access severity code and type of hospital. In fact, the hypothesis was that people avoided going to the ED at stages when the incidence of COVID-19 was (or was perceived to be) higher, regardless of the presence of a lockdown imposed by law. It was also considered that the hospital dimension and complexity of the offer could have influenced the relationship between ED accesses and the incidence of COVID-19 and therefore the role of the type of hospital was also studied. In fact, it was conceivable that larger hospitals with a greater range of facilities and technological equipment may have been less affected by the decline in access since they are the reference point for the most severe cases that require immediate and non-deferrable assistance. Finally, the severity of ED admissions was also considered. It was hypothesized that the level of severity of the cases could have an influence on the association between the number of accesses to the ED and the incidence of COVID-19, considering that, as reported in the literature, the decrease in accesses mainly involved less serious cases.

Methods

Settings characteristics

Three provinces located in the southeastern part of Tuscany: Siena, Arezzo, and Grosseto, with over 800,000 inhabitants were investigated. They constitute the catchment area of Local Health Authority Southern-East Tuscany (LHASET), which directly manages thirteen hospitals of many sizes and characteristics, with 20 to 400 beds. In the area, there is also the highly specialized University hospital (Santa Maria alle Scotte) of Siena, that has about 700 beds. Based on the number of beds, specialties present and services provided, the 14 hospitals were classified into 4 categories, according to the most recent Italian Ministry of Health regulation on hospital care standards (24) and subsequent LHASET regulatory acts (Table 1):

Type 1 (community hospital) includes three hospitals with an average of fewer than 30 beds. They represent basic facilities, where radiology, internal medicine, general surgery, dialysis, and emergency rooms are usually present.

Type 2 (territorial referral hospitals) includes five hospitals with an average of fewer than 60 beds. These are facilities where, in addition to the basic specialties, there are usually other specialties such as gynecology, diagnostic laboratory,

Table 1 - Hospital characteristics by type.

Hospital Type	N° hospitals	N° Beds	Birth Centre	Covid-19 hospital	Mean 2020 ED admissions					
					Total	Code 1 (%)	Code 2 (%)	Code 3 (%)	Code 4 (%)	Code 5 (%)
1	3	<30	No	No	4,780	35 (1%)	319 (7%)	2,002 (42%)	17,733 (7%)	653 (13%)
2	5	30-60	No	No	10,880	79 (1%)	805 (7%)	4,935 (46%)	3,750 (34%)	1,313 (12%)
3	3	150	Yes	No	21,300	334 (2%)	2,461 (12%)	8,093 (38%)	7,013 (33%)	3,418 (16%)
4	3	≥400	Yes	Yes	45,000	1,269 (3%)	3,502 (8%)	17,855 (40%)	15,608 (34%)	6,879 (15%)

orthopedics, ophthalmology, oncology, anesthesia, and blood transfusion center. The birth point is not present.

Type 3 (district hospital) includes three hospitals with an average of 150 beds. These facilities have extensive specialty provision, with a birth point and neonatal sub-intensive care.

Type 4 (provincial hospital) is represented by two facilities of the LHASET and the University hospital. These hospitals have approximately 400-700 beds and highly complex specialties. They represent the hub hospitals for the other smaller hospitals in their areas. During the period of the COVID-19 pandemic, they were the reference hospitals for the treatment of infected patients.

As shown in Table 1, ED accesses to the four types of hospitals are quite different and proportional to the size and services they offer. In Table 1, it is also reported, by hospital type, the percentage distribution of triage codes assigned to patients at ED access. Each patient is assigned a numeric code that identifies the priority of access to care according to his clinical conditions. For example, code 1 corresponds to emergency cases requiring immediate access; code 2 represents urgent cases that cannot be postponed; code 3 urgent cases that can be postponed, code 4 minor emergencies and code 5 non-urgent cases (25).

Study design and data analysis

Data on the number of accesses to the ED of the fourteen hospitals by month and by triage code from 1st January to 31st December 2020 were extracted from the data warehouses of LHASET and of the University hospital.

It should be specified that during 2019/2020 in the hospitals of the LHASET there was a transition from the use of the colour code (red code, yellow, green, light blue, white) to the use of the numeric code (1, 2, 3, 4, 5) for the classification at triage of the accesses to the ED. As of January 2020, five out of thirteen LHASET hospitals used the numeric code. Of the remaining eight hospitals, five made the change from colour code to numeric code in February 2020 (three hospitals belonging to type 2, one belonging to type 3 and one belonging to type 4), while the remaining three changed in July 2020 (two hospitals belonging to type 3 and one belonging to type 1). Since the coding with the numerical codes is not superimposable on that determined with the colour codes, except for code red which corresponds to code 1, in order to allow a comparison of the access data to the ED, it was necessary to re-categorize the accesses made with the colour coding. The re-categorisation was conducted as follows:

hospitals that performed code changes in February 2020: the percentage distributions of codes 2, 3, 4 and 5 in February were extrapolated and applied to the number of total accesses in January, thus obtaining an estimate of the accesses for each number code. Code 1 was equated with code red, and thus the accesses performed in January with code red were categorised with code 1;

hospitals that had made the code change in July 2020: by hospital type, the average monthly percentages of numeric codes 2, 3, 4 and 5 of the period January-June for hospitals that had already made the change to the numeric codes were calculated and applied to the number of total accesses of the same months of the hospitals that had not yet made the code change, thus obtaining an estimate of the number of accesses for each numeric code. Again, code 1 was equated with code red and therefore the accesses made with code red were categorised with code 1.

To calculate the incidence of SARS-CoV-2 infection, the daily new case data for the provinces of Siena, Arezzo and Grosseto, coming from the Ministry of Health and prepared by the Department of Civil Protection (available at: https://opendatadpc.

maps.arcgis.com/apps/dashboards) were used. The monthly incidence per province was then calculated by summing the new cases for each month and using the resident population as of 1st January 2020 (available on: <https://www.istat.it/it/popolazione-e-famiglie?dati>) for each province.

A panel dataset was then constructed, containing the total and by triage code ED accesses for each hospital types and for each month studied, the monthly incidence value of the province to which each hospital belongs.

The statistical analysis was carried out with the Stata vers.17 software.

Since the distribution of ED accesses (total and by triage code) did not meet the requirements of the normal distribution (Skewness and kurtosis test for normality <0.05), the differences in the distribution of accesses by month, access code and type of hospital, were investigated using the non-parametric Kruskal-Wallis analysis of variance.

The association between ED accesses and incidence of SARS-CoV-2 infection was evaluated using a random effect panel data analysis. The logarithmic transformation was used to normalise the distribution of ED accesses. Since the COVID-19 incidence also did not fulfil the requirements of the normal distribution (Skewness and kurtosis test for normality <0.05) it was normalised using the logarithmic transformation. At this point, a regression model was constructed considering admissions to the ED (totals and by triage code) as the dependent variable and the incidence of COVID-19 as the independent variable. The association was assessed by adjusting for hospital type.

Results

The total number of accesses to emergency rooms during the period under consideration was 268,072 (visits and diagnostic exams were not included). Monthly values (numbers and percentages) of ED visits, stratified by the five severity codes and the four hospital types, are reported in Table 2. The percentage distribution of triage codes shows major differences between the hospital types, mainly concerning code 1, whose percentages in Type 3 and 4 hospitals are approximately double and triple compared to those of the other hospital types (Table 1 and 2). This aspect is consistent with the distinctive characteristics of the hospitals, so that the most severe cases are likely to flow to the largest hospitals, which are also able to offer treatment for the most complex situations.

Figure 1 shows the trend of monthly ED accesses in total and by severity code. The trend of total accesses in the ED reports a substantial decrease in March and April 2020, corresponding to the first peak of the incidence (phase one of the epidemic) and the period of lockdown. It went from almost 35,000 accesses in January 2020 to 13,500 in March 2020. The lowest peak was in April with 12,400 total accesses. After that, accesses progressively increased again until the peak in August 2020, when 29,600 accesses were reached, then fell again in September and above all October until the lowest peak in November, when about 15,500 accesses were recorded. The analysis of variance shows that these monthly differences are statistically significant (p=0.043). Figure 2 shows the trend of monthly accesses to the ED by severity code and hospital type. In general, the trend of the curves of accesses by severity codes are like that of the curve of total accesses. However, the most severe codes (1 and 2) show variations in the number of accesses of lesser magnitude, especially code 1. This graphical evidence is confirmed by the analysis of variance, which shows that the differences between months are not statistically significant for codes 1 (p=0.768) and 2 (p=0.424). On the other hand, the differences in the number of

Table 2. Mean monthly Emergency Department accesses: total and stratified by severity codes and hospital type values.

Hospital Type	Month	Total accesses	Code 1 accesses		Code 2 accesses		Code 3 accesses		Code 4 accesses		Code 5 accesses	
			N°	%	N°	%	N°	%	N°	%	N°	%
1	Jan.	1,614	19	1.2	121	7.5	687	42.6	560	34.7	227	14.1
	Feb.	1,450	12	0.8	84	5.8	610	42.1	572	39.4	172	11.9
	Mar.	674	6	0.9	54	8.0	307	45.5	227	33.7	80	11.9
	April	628	5	0.8	42	6.7	276	43.9	226	36.0	79	12.6
	May	1,003	5	0.5	48	4.8	378	37.7	385	38.4	187	18.6
	June	1,302	9	0.7	87	6.7	508	39.0	467	35.9	231	17.7
	July	1,634	6	0.4	138	8.4	645	39.5	589	36.0	256	15.7
	Aug.	1,932	11	0.6	139	7.2	790	40.9	726	37.6	266	13.8
	Sept.	1,358	18	1.3	73	5.4	570	42.0	525	38.7	172	12.7
	Oct.	1,067	3	0.3	63	5.9	500	46.9	396	37.1	105	9.8
	Nov.	836	7	0.8	44	5.3	357	42.7	339	40.6	89	10.6
	Dec.	849	4	0.5	64	7.5	379	44.6	307	36.2	95	11.2
2	Jan.	6,491	71	1.1	593	9.1	2,989	46.0	1,941	29.9	897	13.8
	Feb.	6,007	55	0.9	485	8.1	2,595	43.2	2,132	35.5	740	12.3
	Mar.	2,503	27	1.1	272	10.9	1,202	48.0	763	30.5	239	9.5
	April	2,562	21	0.8	218	8.5	1,168	45.6	805	31.4	350	13.7
	May	3,816	21	0.6	283	7.4	1,730	45.3	1,243	32.6	539	14.1
	June	4,811	41	0.9	363	7.5	2,147	44.6	1,609	33.4	651	13.5
	July	6,090	27	0.4	375	6.2	2,737	44.9	2,213	36.3	738	12.1
	Aug.	6,756	26	0.4	385	5.7	2912	43.1	2,648	39.2	785	11.6
	Sept.	4,926	30	0.6	309	6.3	2,199	44.6	1,838	37.3	550	11.2
	Oct.	4,151	29	0.7	278	6.7	1,925	46.4	1,457	35.1	462	11.1
	Nov.	3,009	24	0.8	224	7.4	1,478	49.1	999	33.2	284	9.4
	Dec.	3,294	21	0.6	238	7.2	1,597	48.5	1,106	33.6	332	10.1

3	Jan.	7,869	140	1.8	1,117	14.2	2,640	33.5	2,600	33.0	1,372	17.4
	Feb.	7,216	154	2.1	1,020	14.1	2,413	33.4	2,376	32.9	1,253	17.4
	Mar.	3,341	89	2.7	611	18.3	1,234	36.9	882	26.4	525	15.7
	April	3,327	79	2.4	535	16.1	1,374	41.3	819	24.6	520	15.6
	May	4,798	80	1.7	576	12.0	1,803	37.6	1,447	30.2	892	18.6
	June	5,567	74	1.3	580	10.4	2,030	36.5	1,811	32.5	1,072	19.3
	July	6,360	71	1.1	681	10.7	2,470	38.8	2,170	34.1	968	15.2
	Aug.	6,173	76	1.2	597	9.7	2,388	38.7	2,207	35.8	905	14.7
	Sept.	5,625	63	1.1	489	8.7	2,117	37.6	2,141	38.1	815	14.5
	Oct.	5,161	61	1.2	388	7.5	2,080	40.3	1,832	35.5	800	15.5
	Nov.	4,108	51	1.2	380	9.3	1,775	43.2	1,368	33.3	534	13.0
	Dec.	4,419	65	1.5	411	9.3	1,957	44.3	1,388	31.4	598	13.5
4	Jan.	17,552	430	2.4	1,141	6.5	6,373	36.3	7,060	40.2	2,548	14.5
	Feb.	15,699	318	2.0	1,025	6.5	5,870	37.4	6,280	40.0	2,206	14.1
	Mar.	7,025	246	3.5	706	10.0	2,831	40.3	2,104	30.0	1,138	16.2
	April	5,894	210	3.6	634	10.8	2,510	42.6	1,665	28.2	875	14.8
	May	9,309	280	3.0	714	7.7	3,692	39.7	3,000	32.2	1,623	17.4
	June	11,988	298	2.5	924	7.7	4,673	39.0	4,058	33.9	2,035	17.0
	July	13,928	347	2.5	1,049	7.5	5,446	39.1	4,798	34.4	2,288	16.4
	Aug.	14,772	367	2.5	1,056	7.1	5,659	38.3	5,358	36.3	2,332	15.8
	Sept.	12,173	364	3.0	953	7.8	4,786	39.3	4,270	35.1	1,800	14.8
	Oct.	10,602	316	3.0	853	8.0	4,520	42.6	3,353	31.6	1,560	14.7
	Nov.	7,616	289	3.8	708	9.3	3,345	43.9	2,198	28.9	1,076	14.1
	Dec.	8,787	343	3.9	744	8.5	3,862	44.0	2,682	30.5	1,156	13.2
Total		268,072	5,309	2.0	22,872	8.5	108,534	40.5	91,940	34.3	39,417	14.7

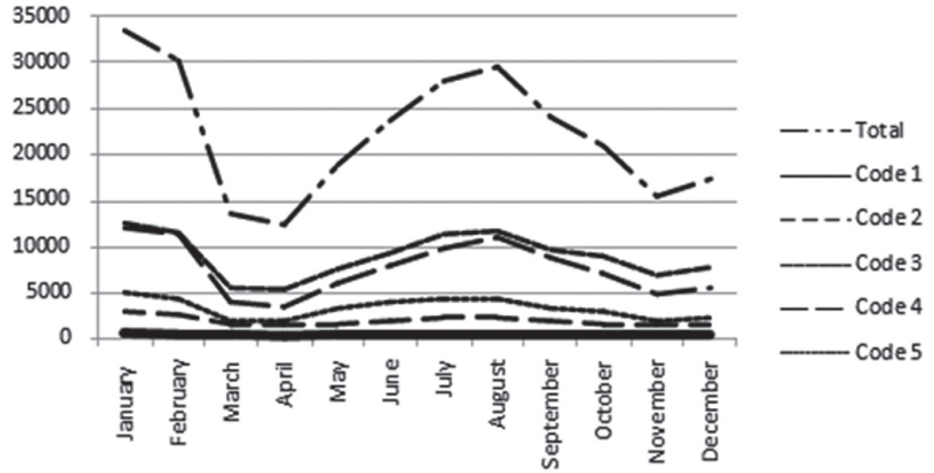

Fig. 1 - 2020 monthly Emergency Department admissions, total and severity code.

monthly accesses are statistically significant for code 4 (p=0.003) and code 5 (p=0.043), but not for code 3 (p=0.131).

The curves of total accesses per hospital type follow the trend seen above, with a decrease in March and April, a recovery from May to August, and a further decrease in September and October (Figure 2). The analysis of variance shows that the monthly differences in total accesses are significant for all hospital types (type 1 p=0.003, type 2 p<0.001, type 3 p=0.006, type 4 p<0.001). Regarding the code 1 accesses (emergency), the curve presents a more constant trend compared to the trend highlighted above, so that the monthly differences are not statistically significant for any hospital (type 1 p=0.276, type 2 p=0.060, type 3 p=0.462, type 4 p=0.965). Regarding the code 2 accesses trend (non-deferrable urgency), the differences between months appear statistically significant for type 2 and 3 hospitals but not for type 1 and 4 (type1 p=0.106, type 2 p=0.019, type 3 p=0.041, type 4 p=0.724). For accesses with priority code 3 (deferrable urgency), the trend shows a marked decrease in March and April, a recovery and then a new decrease in the autumn, and the differences between months appear statistically significant for all hospital types (type 1 p=0.018, type 2 p=0.002, type 3 p=0.022, type 4 p=0.005). Also, for codes 4 and 5, the curves show the trend seen so far, with significant differences for all hospital types (code 4: type 1 hospitals p=0.001, type 2 p<0.001, type 3 p=0.007 and type 4 p=0.001; code 5: type 1 hospitals p=0.010, type 2 p<0.001, type 3 p=0.022 and type 4 p=0.015).

Figure 3 shows the monthly COVID-19 incidence trend from January to October 2020, total and by province. The incidence trend appears superimposable but in the opposite direction to that of accesses to the ED. In fact, there is an initial peak of the curve in March 2020 with the achievement of about 111 cases per 100,000 inhabitants, followed by a net decrease in May, when the incidence drops to 10 cases per 100,000 inhabitants, and even more in June and July, with about 4 cases per 100,000 inhabitants. Then, there is an upturn in new cases from August, with the incidence rising to 37 per 100,000 in August, to 69 per 100,000 in September, to 610 per 100,000 in October,

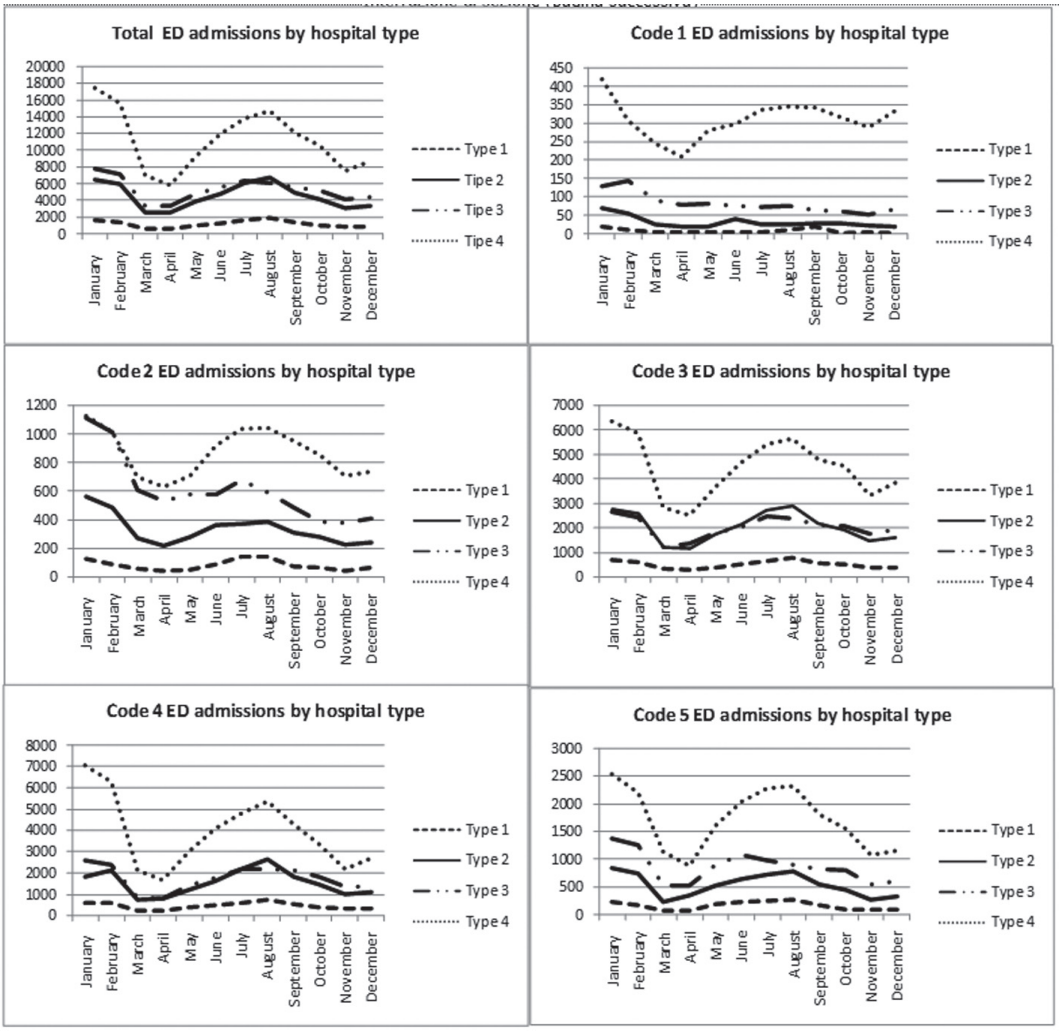

Fig. 2 - 2020 Emergency Department admissions by hospital type (total and by severity code).

to 1202 in November, and then falling back to 302 per 100,000 in December. The trend is similar for all the three provinces.

The inverse association seems also to be confirmed by observing the relationship between the average rate of decrease in ED accesses, for each of the 14 hospitals (calculated as the percentage reduction in the number of accesses for each month compared to that one of January 2020), and the overall average COVID-19 incidence for the province, to which each hospital belongs (Spearman's rho= -0.658, p<0.001).

Table 3 shows the results of the analysis to evaluate the association between ED accesses and COVID-19 incidence adjusted by hospital type. The results show a statistically significant inverse association between ED accesses and COVID-19 incidence (Coef. =-0.074, 95%CI=-0.100; -0.040, p<0.001). Investigating the effect of incidence on ED accesses by severity code, the inverse association does not appear statistically significant in the case of code 1 (Coef. = -0.028, 95%CI= -0.066; 0.010, p=0.154) while it is statistically significant in the

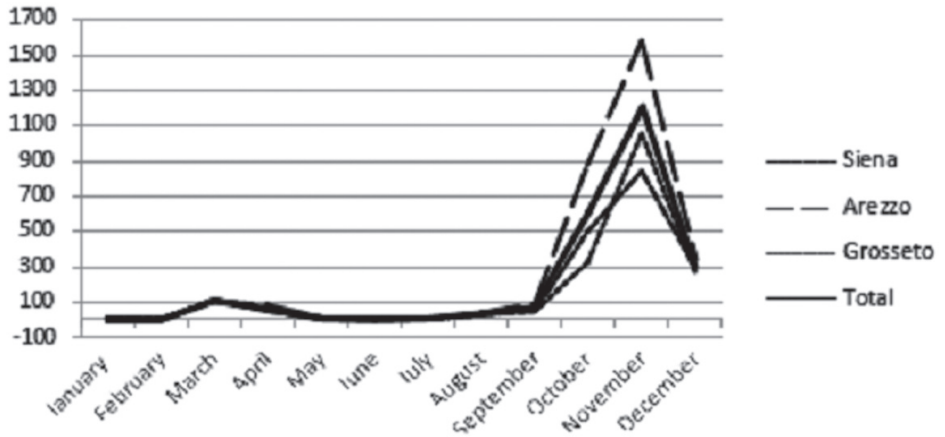

Fig. 3 - 2020 monthly Covid-19 incidence x 100,000 inhabitants, total and by province

case of code 2 (Coef. = -0.077, 95%CI= -0.100; -0.052, p<0.001), code 3 (Coef. = -0.052, 95%CI= -0. 077; -0.028, p<0.001), code 4 (Coef. = -0.078, 95%CI= -0.110; -0.047, p<0.001) and code 5 (Coef. = -0.135, 95%CI= -0.166; -0.103, p<0.001).

Limits

One of the study's limitations is related to the methodological issue of having to recode the severity codes from colour code to numerical code. This recoding may not have been entirely reliable. It may have introduced problems of comparability between the data of hospitals that had already made the switch in 2019 or exceedingly early in 2020 and those that did so later in 2020. The methodology used to code should have limited biases. Misclassifications, however, cannot be ruled out with certainty. Another limitation is to have studied the number of aggregated accesses without being able to have the records of each patient and therefore without being able to consider the pathologies and characteristics of the patients themselves, which may have played an essential role in determining the patterns of access to emergency rooms. Further studies will be needed to investigate these aspects as well as this study could be considered a starting point for future investigations.

Table 3 - Association between Covid incidence and number of accesses to the Emergency Department. January-Dicember 2020

	Coef.	Std.Err.	95%CI	P
Total accesses*	-0.074	0.012	-0.100; -0.040	<0.001
Triage code 1**	-0.028	0.019	-0.066; 0.010	0.154
Triage code 2**	-0.077	0.012	-0.100; -0.052	<0.001
Triage code 3**	-0.052	0.012	-0.077; -0.028	<0.001
Triage code 4**	-0.078	0.016	-0.110; -0.047	<0.001
Triage code 5**	-0.135	0.016	-0.166; -0.103	<0.001

* adjusted by triage code and hospital type

** adjusted by hospital type

Discussion and Conclusion

The pandemic and containment measures have brought about major changes in the population's lifestyle worldwide, even altering patients' perceptions of their health status. In the pre-pandemic period, a much-discussed problem was the overcrowding of emergency rooms, often caused by improper access of non-urgent patients (26). However, with the pandemic, a reduction in ED accesses was observed. Several studies (2, 3, 7, 10, 15, 18, 23) have compared the accesses to the ED in 2020 with those of the previous years, showing a reduction in the total number, especially, but not only, during lockdown periods. This study showed that during the first 12 months of the pandemic, the trend in ED accesses was inversely proportional to the incidence of COVID-19, regardless of the type of hospital considered and the severity of access. Therefore, it may be hypothesised that the decrease in access was indeed due to an avoidance attitude towards hospitals, linked to the fear of contracting SARS-CoV-2, rather than to legally imposed lockdown policies. This hypothesis seems also confirmed because accesses for severe codes (code 1) did not undergo statistically significant variations, not even during the periods of the highest incidence of infection in any of the hospital types considered. Therefore, the responsibility for the fewer accesses to the ED is to be attributed, as has already been observed in the literature, to the less severe codes that have undergone a drastic reduction, inversely proportional to the number of new cases of COVID-19. This aspect would confirm that in the event of an actual emergency, patients still went to the ED. At the same time, they preferred to avoid in those less severe situations that, in other circumstances, would have led them to go to the ED anyway, but not in this case, probably due to the fear of contracting SARS-CoV-2 in the hospital setting.

Regarding the role of the several types of hospitals and of the different range of services provided, our hypothesis that it might have had an influence on the pattern of access to ED does not seem to be confirmed. It is noted a substantial overlap in the pattern of ED accesses' trends between the several types of hospitals, with a decrease in accesses to the ED for all types of hospitals for less severe codes but not for more serious ones. Moreover, the association between ED accesses and incidences of COVID-19 remained significant even when adjusting for hospital type as well as for access severity. This seems to confirm that the trends observed should probably to be interpreted precisely as a change in the attitude of "use" of the ED regardless of the level of care offered by the hospital. Those who had a real need continued to access the ED regardless of the type of hospital, those who had less severe and urgent problems preferred to avoid access to the ED at those times when the incidence of infection was greater.

This study highlighted two aspects: the first is that ED admission trends followed the COVID-19 incidence independently from the lockdown period except for the most severe cases. This result seems to confirm that the fear of contracting the infection discourages patients from accessing the ED for diseases that were perceived as not serious. Although this conclusion certainly needs further research to be confirmed, possibly using questionnaires that directly interview patients on the reasons for avoiding hospital in the period of COVID-19 pandemic, this result could give indications about the need, in the event of new flare-ups of the pandemic or other epidemics, of structuring or reinforce types of out-of-hospital health services for the treatment of less severe diseases, such as territorial or primary healthcare services.

The second aspect is that, in any case, hospital emergency rooms remain the point of reference for the most severe emergencies/urgencies, so in an epidemic or pandemic

situation, resources must be guaranteed to meet this demand for care.

As suggested in the "Limits" section, further studies should be carried out to investigate/confirm: i) the role of the patients' clinical conditions on the ED access trends during the COVID-19 pandemic; ii) the effective role of the fear of contagious in accessing hospitals during that period. Moreover, in this study we investigated the ED accesses trends only in the first year of pandemic. It could be interesting to carry out further investigations to compare 2020 ED access trends with those of previous years, namely before of the COVID-19 pandemic onset.

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Competing interests: Cecilia Quercioli is employed at Local Health Authority Southern-East Tuscany; Giovanni Bova is employed at University Hospital "Santa Maria alle Scotte"; Massimo Mandò is employed at Local Health Authority Southern-East Tuscany; Maria Francesca De Marco is on the Board of University Hospital "Santa Maria alle Scotte"; Simona Dei is on Board of Local Health Authority Southern-East Tuscany; Roberto Gusinu was on the Board of University Hospital "Santa Maria alle Scotte"; Roberta Bosco and Gabriele Messina declare none.

Ethical issues: No patients were involved in this research, so ethical approval was not required.

Riassunto

Valutazione dell'effetto dell'incidenza di COVID-19 sui ricoveri in Pronto Soccorso. Risultati di uno studio retrospettivo nel Centro Italia durante primo anno della pandemia

Introduzione. La pandemia da COVID-19 ha avuto un forte impatto sul sistema sanitario, modificando i modelli di accesso al Pronto Soccorso. Infatti, gli accessi per traumi e casi meno gravi sono diminuiti in modo significativo. Questo calo è stato generalmente attribuito sia agli effetti del lockdown imposto dal governo, sia alla paura di contrarre il SARS-CoV-2 in ospedale. Tuttavia, la correlazione tra questi elementi non è ancora chiara, poiché gli accessi al Pronto Soccorso non sono aumentati né alla fine del lockdown né in estate, quando la situazione epidemiologica era più favorevole. Obiettivo: valutare l'associazione tra l'andamento degli accessi al Pronto Soccorso e l'incidenza di COVID-19 nel 2020.

Metodi. Dai datawarehouse di 14 ospedali della Toscana sud-est sono stati estratti i dati sugli accessi al Pronto Soccorso per mese e per codice di gravità al triage. Dati da fonti ufficiali sui nuovi casi di infezione da COVID-19 sono stati utilizzati per calcolare l'incidenza. Gli ospedali sono stati classificati in 4 categorie. Le differenze negli accessi al Pronto Soccorso in base al mese, al codice di triage e al tipo di ospedale sono state analizzate con l'analisi di Kruskal-Wallis. L'associazione tra gli accessi al Pronto Soccorso e l'incidenza di COVID-19 è stata valutata utilizzando una random-effect panel data analysis, aggiustando per tipo di ospedale e codice di triage.

Risultati. Il trend di 268.072 accessi al Pronto Soccorso diminuisce sostanzialmente al primo picco pandemico; in seguito, aumenta e diminuisce nuovamente fino al picco minimo del novembre 2020. L'incidenza della COVID-19 è apparsa sovrapponibile con una direzione inversa. Le differenze mensili erano significative ($p<0,01$) tranne che per i codici più gravi. È stata riscontrata un'associazione inversa significativa tra gli accessi al Pronto Soccorso e l'incidenza della COVID-19 (Coef. =-0.074, $p<0.001$), tranne che per i casi più gravi (codice di triage 1: Coef. =-0.028, $p=0.154$).

Conclusioni. L'andamento dei ricoveri in Pronto Soccorso ha seguito l'incidenza della COVID-19, tranne che per i casi più gravi. La paura dell'infezione sembra scoraggiare i pazienti dall'accedere al Pronto Soccorso per malattie percepite come non severe.

References

1. Oseran AS, Nash D, Kim C, et al. Changes in Hospital Admissions for Urgent Conditions During COVID-19 Pandemic. Am J Manag Care. 2020 Aug; **26**(8): 327-8. doi: 10.37765/ajmc.2020.43837.
2. Vacanti G, Bramlage P, Schymik G, et al. Reduced rate of admissions for acute coronary syndromes during the COVID-19 pandemic: an observational analysis from a tertiary hospital in Germany. Herz. 2020 Nov; **45**(7): 663-7. doi: 10.1007/s00059-020-04991-3. Epub 2020 Oct 7.

3. Dopfer C, Wetzke M, Zychlinsky Scharff A, et al. COVID-19 related reduction in pediatric emergency healthcare utilization – a concerning trend. BMC Pediatr. 2020 Sep; **20**(1): 427. doi: 10.1186/s12887-020-02303-6.
4. Barten DG, Latten GHP, van Osch FHM. Reduced Emergency Department Utilization During the Early Phase of the COVID-19 Pandemic: Viral Fear or Lockdown Effect? Disaster Med Public Health Prep. 2022 Feb; **16**(1): 36-9. doi: 10.1017/dmp.2020.303. Epub 2020 Aug 12.
5. Hautz WE, Sauter TC, Exadakytlos AK, Krummrey G, Schauber S, Müller M. Barriers to seeking emergency care during the COVID-19 pandemic may lead to higher morbidity and mortality – a retrospective study from a Swiss university hospital. Swiss Med Wkly.2020 Aug; **50**: w20331. doi: 10.4414/smw.2020.20331.
6. Baugh JJ, Yun BJ, Searle E, et al. Creating a COVID-19 surge clinic to offload the emergency department. Am J Emerg Med. 2020 Jul; **38**(7): 1535-7. doi: 10.1016/j.ajem.2020.04.057. Epub 2020 Apr 20.
7. Nourazari S, Davis SR, Granovsky R, , et al. Decreased hospital admissions through emergency departments during the COVID-19 pandemic. Am J Emerg Med. 2021 Apr; **42**: 203-10. doi: 10.1016/j.ajem.2020.11.029. Epub 2020 Nov 19.
8. Kruizinga MD, Peeters D, van Veen M,, et al. The impact of lockdown on pediatric ED visits and hospital admissions during the COVID19 pandemic: a multicenter analysis and review of the literature. Eur J Pediatr. 2021 Jul; **180**(7): 2271-9. doi: 10.1007/s00431-021-04015-0. Epub 2021 Mar 15.
9. Garrafa E, Levaggi R, Miniaci R, Paolillo C. When fear backfires: Emergency department accesses during the Covid-19 pandemic. Health Policy. 2020 Dec; **124**(12): 1333-9. doi: 10.1016/j.healthpol.2020.10.006. Epub 2020 Oct 24.
10. Vanni G, Legramante JM, Pellicciaro M, et al. Effect of Lockdown in Surgical Emergency Accesses: Experience of a COVID-19 Hospital. In Vivo. 2020 Sep-Oct; **34**(5): 3033-8. doi: 10.21873/invivo.12137.
11. Di Fabrizio V, Szasz C, Rosselli A. The effects of Covid-19 on the ER. July 2020 update. Tuscany Regional Health Agency. A [Internet]. July 2020 update. Available on: https://www.ars.toscana.it/2-articoli/4411-covid-19-nuovo-coronavirus-pronto-soccorso-aggiornamento-luglio-2020.html [Last accessed: 2023 January 27].
12. Di Fabrizio V, Szasz C, Rosselli A. The effects of Covid-19 on the ER. May 2020 update. Tuscany Regional Health Agency. [Internet]. May 2020. Available on: https://www.ars.toscana.it/2-articoli/4326-covid-19-nuovo-coronavirus-pronto-soccorso.html [Last accessed: 2023 January 27].
13. Mantica G, Riccardi N, Terrone C, Gratarola A. Non-COVID-19 admissions to the emergency department during the pandemic second wave in Italy: What is changed from the first wave? Am J Emerg Med. July 2021 Jul; **45**: 625-6. 0.1016/j.ajem.2020.11.046. Epub 2020 Nov 26.
14. Comelli I, Scioscioli F, Cervellin G. Impact of the COVID-19 epidemic on census, organization and activity of a large urban Emergency Department.: COVID-19 epidemic in a large Emergency Department. Acta Bio Med. 2020 May; **91**(2): 45-9. doi: 10.23750/abm.v91i2.9565.
15. Gallioli A, Albo G, Lievore E, et al. How the COVID-19 Wave Changed Emergency Urology: Results from an Academic Tertiary Referral Hospital in the Epicentre of the Italian Red Zone. Urology. 2021 Jan; **147**: 43-9. doi: 10.1016/j.urology.2020.09.028. Epub 2020 Oct 1.
16. Naccarato M, Scali I, Olivo S, et al. Has COVID-19 played an unexpected "stroke" on the chain of survival? J Neurol Sci. 2020 Jul; **414**: 116889. doi: 10.1016/j.jns.2020.116889. Epub 2020 May 6.
17. D'Urbano F, Fabbri N, Koleva Radica M, Rossin E, Carcoforo P. Emergency surgery in COVID-19 outbreak: Has anything changed? Single center experience. World J Clin Cases. 2020 Sep; **8**(17): 3691-6. doi: 10.12998/wjcc.v8.i17.3691.
18. Dell'Utri C, Manzoni E, Cipriani S, et al. Effects of SARS Cov-2 epidemic on the obstetrical and gynecological emergency service accesses. What happened and what shall we expect now? Eur J Obstet Gynecol Reprod Biol. 2020 Nov; **254**: 64-8. doi: 10.1016/j.ejogrb.2020.09.006. Epub 2020 Sep 7.
19. Ojetti V, Covino M, Brigida M, , et al. Non-COVID Diseases during the Pandemic: Where Have All Other Emergencies Gone? Medicina (Mex). 2020 Oct; **56**(10): 512. doi: 10.3390/medicina56100512.
20. The COVID19 IRCCS San Matteo Pavia Task Force, Perlini S, Canevari F, Cortesi S, Sgromo

V, Brancaglione A, et al. Emergency Department and Out-of-Hospital Emergency System (112—AREU 118) integrated response to Coronavirus Disease 2019 in a Northern Italy centre. Intern Emerg Med. 2020 Aug; **15**(5): 825-33. doi: 10.1007/s11739-020-02390-4. Epub 2020 Jun 8.

21. Scognamiglio G, Fusco F, Merola A, Palma M, Correra A, Sarubbi B. Caring for adults with CHD in the era of coronavirus disease 2019 pandemic: early experience in an Italian tertiary centre. Cardiol Young. 2020 Oct; **30**(10): 1405-8. doi: 10.1017/S1047951120002085. Epub 2020 Jul 6.
22. De Filippo O, D'Ascenzo F, Angelini F, et al. Reduced Rate of Hospital Admissions for ACS during Covid-19 Outbreak in Northern Italy. N Engl J Med. 2020 Jul; **383**(1): 88-9. doi: 10.1056/NEJMc2009166. Epub 2020 Apr 28.
23. Bellan M, Gavelli F, Hayden E, et al. Pattern of Emergency Department referral during the COVID-19 outbreak in Italy. Panminerva Med [Internet]. 2021 Dec; **63**(4): 478-81. doi: 10.23736/S0031-0808.20.04000-8. Epub 2020 Jun 16.
24. Ministry of Health. Ministerial Decree 2 April 2015, n. 70. Regulation defining quality, structural, technological and quantity related to hospital care. Attachment 1 [Internet]. Official Gazette of the Italian Republic 4 June 2015, n. 127. Available on: https://www.camera.it/temiap/2016/09/23/OCD177-2353.pdf [Last accessed: 2023 February 27].
25. Ministry of Health. National guidelines on intra-hospital triage. [Internet]. 2022. Available on: http://www.salute.gov.it/imgs/C_17_notizie_3849_listaFile_itemName_1_file.pdf [Last accessed: 2023 February 27].
26. Durand AC, Palazzolo S, Tanti-Hardouin N, Gerbeaux P, Sambuc R, Gentile S. Nonurgent patients in emergency departments: rational or irresponsible consumers? Perceptions of professionals and patients. BMC Res Notes. 2012 Dec; **5**: 525. doi: 10.1186/1756-0500-5-525.

Corresponding author: Cecilia Quercioli, Healthcare Management, Local Health Authority Southern-East Tuscany, Piazzale Carlo Rosselli, 26, 53100 Siena SI, Italy
e-mail: cecilia.quercioli@uslsudest.toscana.it