

## ORIGINAL RESEARCH



# The impact of Coronavirus disease 19 on emergency volume in Northern Taiwan

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## Abstract

The coronavirus disease 2019 (COVID-19) has changed the way communities and groups use the emergency department (ED). The purpose of this study is to evaluate changes in ED volume for different triage categories in three tertiary Chang Gung Memorial Hospital branches in Northern Taiwan before and after the spread of COVID-19. A decline of ED volume of about 20 to 25 percent was observed for all three branches during the study period. Statistically significant decline in total ED volume in all triage categories across the three branches was observed except triage category 1 for Keelung and triage category 5 for Linko. These exceptions were most likely due to the geographical location and proximity to other hospitals. The trends observed in this study regarding ED use during the COVID-19 pandemic period could better prepare resource management in hospitals, allocate medical staff, and may guide future pandemic planning.

## Keywords

Taiwan; COVID-19; Emergency volume; Retrospective study

## 1. Introduction

The Coronavirus disease 2019 (COVID-19) pandemic spread across the globe since the end of 2019 and has not been contained thus far. Even until today many parts of the world are experiencing increasingly difficult waves of COVID-19 infection. The fear of contracting COVID-19 has caused the closing of shops, schools, and other businesses, as well as travel restrictions worldwide. Many parts of the world imposed strict lockdowns when COVID-19 spread initially to effectively reduce the number of cases [1–3]. Emergency department visits have also been affected; many published articles have found a decrease in ED volume during the pandemic [3–7]. During this time, only patients who were in urgent need for health care visited the ED. Additionally, there has been a trend to shift to telemedicine provided jointly by Taiwan Emergency Association and the Ministry of Health and Welfare [8]. Telemedicine is an approach to providing health care discussed by Judd E. Hollander and Brendan G. Carr back in April of 2020 that uses online communication technologies [9]. Taiwan, was one of the more successful countries in combating COVID-19 in 2020, and had the privilege of returning to almost normal daily routines until the outbreak in May 2021. Taiwan's initial success in combating the COVID-19 pandemic was due to its swift action in stocking up medical supplies, controlling its border from foreign cases, organizing official media channels and press conferences, utilizing travel history with an occupation-based triage system, and implementing social distancing [10]. Despite the initial success of

containing COVID-19, minor outbreaks occurred sporadically during 2020 and a major outbreak occurred in May 2021. The purpose of this study was to determine the degree of change in ED volume because of COVID-19.

## 2. Materials and methods

This was a retrospective study conducted at Keelung, Taipei and Linko branches of Chang Gung Memorial Hospital in Taiwan. The Keelung branch, located 25 km north of Taipei, is the only tertiary hospital in a 360,000-population municipality. This branch has 1089 beds and an annual ED volume of 70,000 patient visits. The Taipei branch, located in the heart of Taiwan's capital serving a population of 2.5 million, is a tertiary hospital with 252 bed capacity and an annual ED volume of 50,000 patient visits. The Linko branch, located roughly 25 km south of Taipei, is a tertiary hospital. It has a 3700-bed capacity, the largest in Taiwan, and serves a population of approximately 2.3 million with an annual ED volume of 200,000 patient visits. Data from the patient registry was collected and analyzed from all three branches.

All three hospital branches are comprised of a medical ED, trauma ED and pediatrics ED. All non-trauma adult patients were sent to the medical ED. All non-trauma patients under the age of 18 were presented to the pediatrics ED. All trauma patients were treated at the trauma ED. In this study design only non-trauma adult patients were included.

The first case of COVID-19 in Taiwan was diagnosed on January 22nd, 2020. Thus, pre-COVID-19 period was defined

as before January of 2020. All ED visits to Linko, Taipei and Keelung branches were collected from February 2019 to January of 2020 as the pre-COVID-19 period. Data collected from February 2020 to January 2021 was denoted as the COVID-19 period. Each patient who came to the ED was triaged by a registered nursing staff. Patient's chief complaint, body temperature, blood pressure and heart rate were measured and recorded. There was no difference in the triage method before and during COVID-19 periods. Patients were then assigned a triage category from 1 to 5 based on Taiwan Triage and Acuity Score (TTAS); a modified version of the Canadian Triage and Acuity Score [11]. A category of 1 in the TTAS scale is the most severe, requiring immediate resuscitation whereas a category of 5 does not require immediate intervention. Total ED volume was calculated as the percentage change between pre-COVID-19 and COVID-19 periods. The main outcome was the change in ED volume between triage categories at different hospital branches before and during the COVID-19 period.

Using IBM SPSS Statistics (version 22: IBM Corp., Armonk, NY, USA) comparisons of ED volume was calculated between the pre-COVID-19 and COVID-19 period for each triage categories at all three branches. A  $p$  value of  $<0.05$  was defined as statistically significance.

### 3. Results

A total of 353,889 (199,252 in 2019 and 154,637 in 2020) ED patient visits were gathered and analyzed from the three branches during the study period.

Fig. 1 shows the monthly ED volume in pre-COVID-19, and COVID-19 period against the cumulative COVID-19 confirmed cases in Taiwan during the same study period [12]. For all three branches we found a decrease in ED volume as COVID-19 confirmed cases started to increase during the first three months of the pandemic. As COVID-19 confirmed cases reached a plateau from May to October, ED volume increased gradually but not to the pre-COVID-19 level. Taipei and Linko branch showed the most increase in ED volume while Keelung only slight increase. As COVID-19 confirmed cases started to climb from November 2020 to January 2021, we again observed a decrease in ED volume in all three branches. However, the Keelung branch experienced an increase in ED volume in November 2020 then a decline from December 2020 to January 2021. For all three branches there was statistically significant decline in total ED volume. The total ED volume change was calculated to be statistically significant with  $p = 0.014$  for Keelung,  $p = 0.000021$  for Taipei, and  $p = 0.000003$  for Linko branch.

Fig. 2 displays the percentage of change in ED volume for all three branches in each of the five triage categories. Decrease in ED volume ranged between 20 and 30 percent was observed across the three branches. All triage categories showed a decline in ED volume except for triage category 5 for Keelung and Taipei branch. All changes in ED volume were statistically significant except for triage category 1 in Keelung branch ( $p = 0.262$ ) and triage category 5 in Linko branch ( $p = 0.9881$ ).

Fig. 3 presents the percentage change in total ED volume for each of the three branches and the combined ED volume

changes for all five triage categories. Total ED volume decreased by about 20 to 25 percent; this finding was statistically significant across the three branches. There was also a 5 to 25 percent decline in combined ED volume change for all triage categories. An increase in triage category 5 was observed. All changes in ED volume was statistically significant.

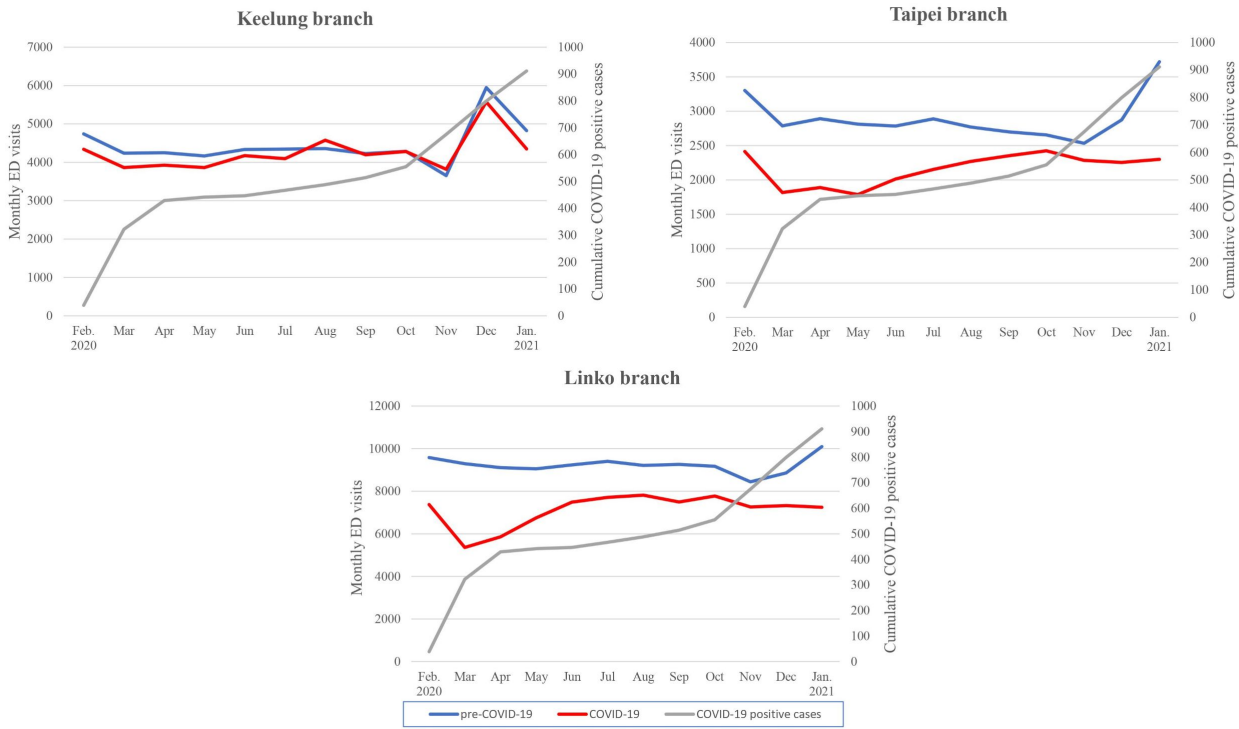
Supplementary data of detailed patient visit numbers for each triage category and each hospital are listed in the appendix for reference.

### 4. Discussion

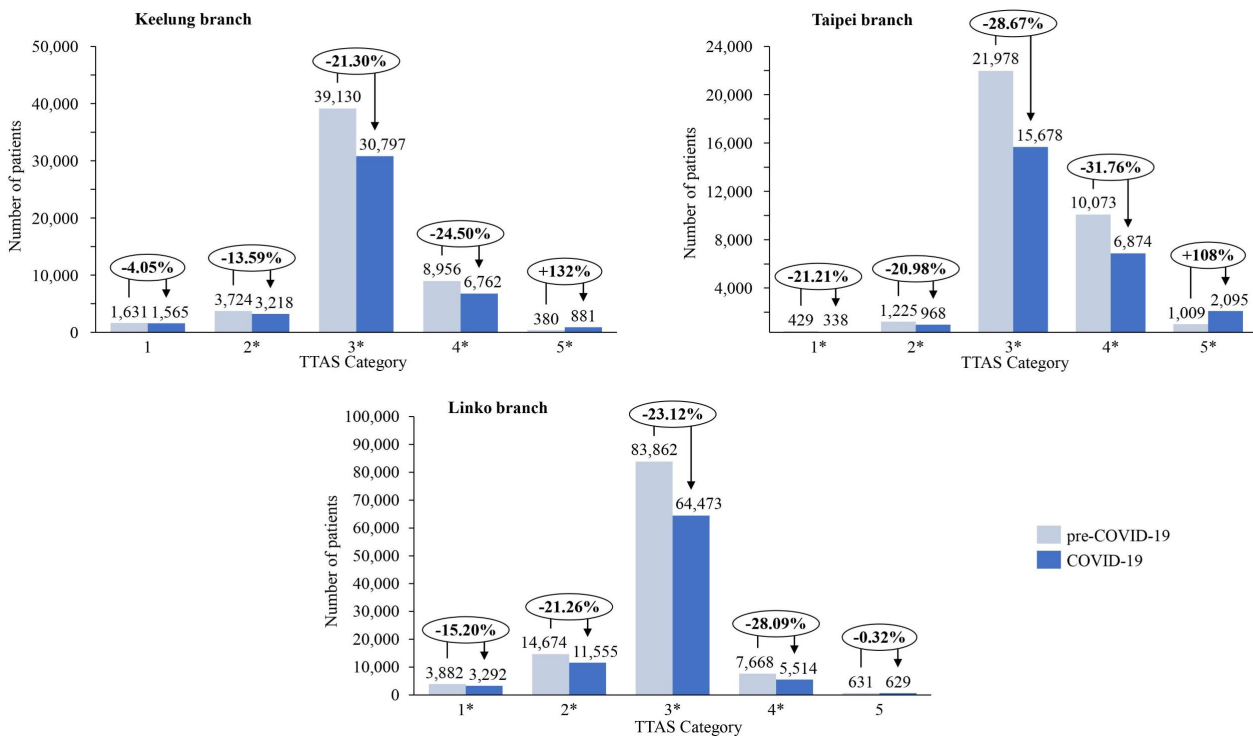
Taiwan's medical health system is regarded as one of the best in the world. National health insurance offers fast, inexpensive, and high-quality medical services to residents in Taiwan. Because of easily accessible health services, many patients may visit ED for less urgent medical conditions. As a result, ED overcrowding has always been an issue with Taiwanese hospitals [13]. During the COVID-19 pandemic, as demonstrated in this study, we observed a decrease in ED volume. This was likely due to fact that the risk of being infected by COVID-19 perceived by patients was higher in hospitals. Thus, patients with less urgent medical conditions would seek care elsewhere or by other means.

A total of 353,889 ED visits were analyzed from all three hospitals between 2019 and 2020. We found a 20 to 25 percent decline in total ED volume between the pre-COVID-19 and COVID-19 period. The percent decline in ED volume varied in different branches of Chang Gung Memorial Hospital. There was 22 percent decline in total ED volume in the Linko branch mainly due to its proximity (20 km) with Taiwan's main international airport, where local and abroad cases were often diagnosed. As a result, patients may have used this knowledge to seek medical help in other hospitals with less or no COVID-19 confirmed cases, visited local clinics, shifted to telemedicine or simply stayed at home. On the other hand, the Tapei branch experienced a 25 percent decline in total ED volume which may have been caused by its proximity to a busy airport about 5 mins away. Taipei branch's decrease in total ED volume was partly due to the same reason as Linko branch. Another important factor is that Taipei, being the capital of Taiwan, has seven tertiary hospitals that offer comparable health services. Finally, the Keelung branch experienced a decline of 19 percent. Keelung branch is located in a less populated area with fewer hospitals, which may explain why there was a smaller decline in ED volume compared to the other branches.

Fig. 1 shows how branches experienced a decrease in ED volume as cumulative COVID-19 cases rose. Similar results were seen in the first few months in the USA [14]. Two sharp rises in COVID-19 confirmed cases were observed during our study period. An initial drop in ED volume then a rebound was also observed in hospitals in other countries [15]. There was a plateau of COVID-19 confirmed cases in the middle of our study period. During the plateau, we saw a slow rise of ED volume close to pre-COVID-19 period. Although the Keelung branch demonstrated similar trend as the other branches during the study period, it experienced the lowest change in ED volume. This was again because Keelung branch is in a



**FIGURE 1.** Change in ED volume in three branches plotted against cumulative COVID-19 positive cases during study period.

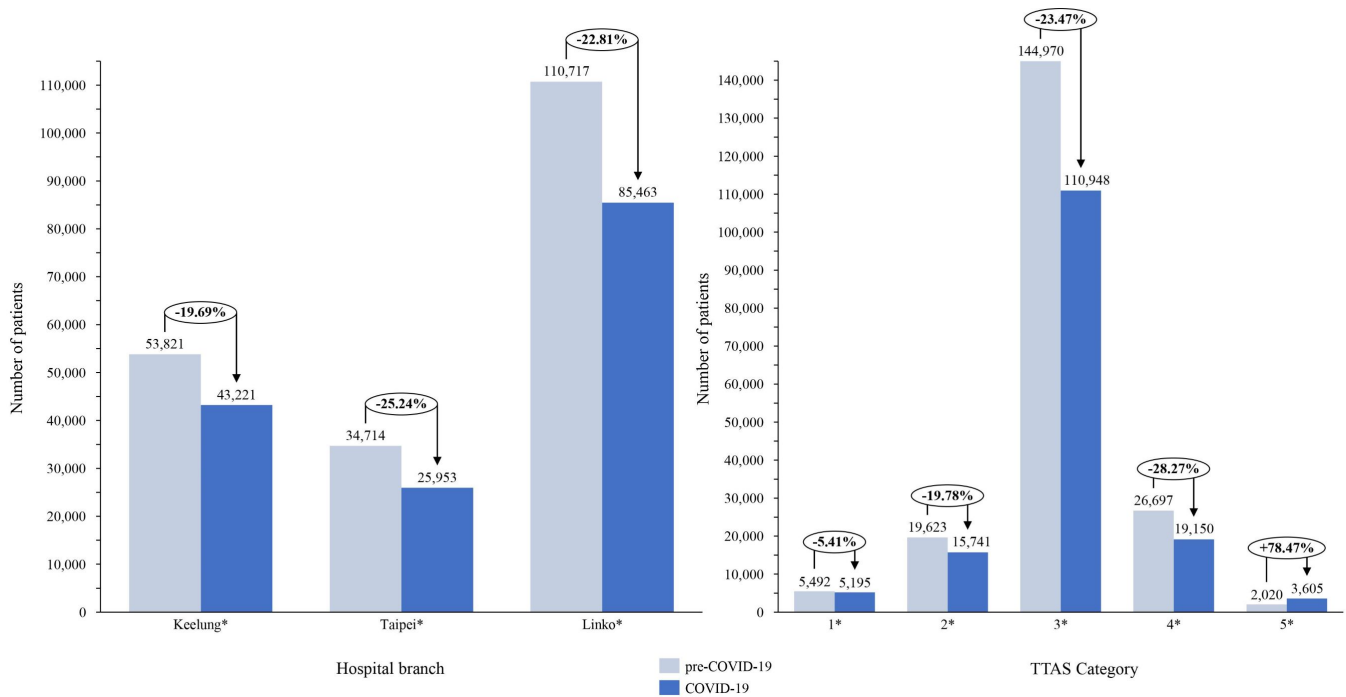


**FIGURE 2.** Percentage change in each triage categories across three branches. \* indicates  $p < 0.05$ .

remote area with limited choices of hospitals. However, it was puzzling to see an increase of ED volume in November before a drop in December for Keelung branch during the second wave of confirmed COVID-19 cases. Both pre-COVID-19 and COVID-19 periods showed a similar rise in ED volume

in November suggest further investigation may be needed to explain the rise of ED volume during that time for Keelung branch.

As for different triage categories, there was generally a drop in less urgent medical triage categories across all three



**FIGURE 3. ED volume change in percentage for each hospital branch and combined ED volume change in each triage category for all three branches. \* indicates  $p < 0.05$ .**

branches. For patients in triage category 1, the decline in ED volume was less moderate for the Keelung branch. This decline was not statistically significant ( $p = 0.262$ ) because more severe cases require medical attention regardless of the number of national COVID-19 cases. Keelung branch is located in a less populated region with a limited number of hospitals to provide medical treatment, whereas Taipei is the capital of Taiwan and has seven medical centers that offer comparable medical services. This difference explains how the greatest decline in ED volume is observed in areas with a greater number of hospitals. The Linko branch had numerous COVID-19 confirmed cases due to its proximity to international airport as discussed above. Decrease in ED volume in both Taipei and Linko were statistically significant ( $p = 0.026$  for Taipei,  $p = 0.015$  for Linko).

There was statistically significance drop in ED volume in triage categories 2, 3 and 4 across all three branches. From the perspective of patients, the risk of contracting COVID-19 while visiting a hospital during a period where there was a rise in COVID-19 cases outweighed the benefit of receiving treatment at hospital was most likely the reason why there was a substantial decrease in ED volume observed across all three branches. In addition, local medical clinics served as an alternative option where patients could receive medical treatments. In these settings usually non-life-threatening diseases were treated, resulting in an overall decrease in non-urgent ED cases. Most of the cases that are grouped into triage categories 4 and 5 are those that require consultation from other specialties such as ophthalmology, dermatology, gynecology, and otolaryngology. In Taiwan, under the national health insurance plan medical specialties can establish clinics and

treat patients without the need for referral from primary care physicians. Complicated cases are referred to medical centers if they cannot be treated at clinics. Thus, not all less urgent medical conditions need to be treated at hospitals.

An interesting outcome from this study was that there was a slight decrease in triage category 5 volume in the Linko branch but a 50 percent increase in Taipei and Keelung branches. It should be noted that since the second half of 2020, designated hospitals across Taiwan performed COVID-19 screening for anyone traveling abroad or had been in contact with confirmed or suspected COVID-19 cases. COVID-19 screenings were completed by emergency physicians in the ED as stipulated by Taiwan's Central Epidemic Control Center. These patients were all grouped into triage category 5 according to TTAS and thus the sharp increase in the second half of 2020. Linko branch is located in an area where there is a designated hospital for treating confirmed COVID-19 cases about 20 km away from the airport. Many of the screenings were diverted to this designated hospital, explaining why an increase in ED volume for triage category 5 was not observed.

There are some limitations to our study design. First, patients' biological sex, age group and disease categories were not recorded. Second, this study result was only limited to tertiary Chang Gung Memorial Hospital affiliated branches in Northern Taiwan. Thus, the findings of this study are not fully representative of Taiwan or other countries. In addition, since only tertiary hospitals were studied, our results may not be applicable to regional and local hospitals. Finally, data presented here may not accurately reflect the current situation in Taiwan since there was a recent COVID-19 outbreak in May 2021.

## 5. Conclusions

This study found that there was a statistically significant decline in total ED volume decline in three tertiary Chang Gung Memorial Hospitals in Northern Taiwan. A decline in ED volume correlated with the number of confirmed COVID-19 cases in Taiwan during the study period. Although there was significant total ED volume decline, not all triage categories had the same decline in volume. Variations in locations and region-specific characteristics contributed to this difference. The results gathered from this study can be utilized for adjustment of medical staff, allocation of resources, and prepare for hospitals throughout Taiwan when another outbreak occurs.

### AUTHOR CONTRIBUTIONS

CWC designed the study, collected the data and drafted the manuscript.

### ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was approved by Chang Gung Memorial Hospital's ethical committee (IRB No.:202101051B0B1).

### ACKNOWLEDGMENT

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This research received no external funding.

### CONFLICT OF INTEREST

The author declares no conflict of interest.

### APPENDIX

See Table 1,2,3.

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**TABLE 1. Emergency visits during study periods for the Keelung branch.**

Month	TTAS triage category									
	1		2		3		4		5	
	Pre COVID	COVID	Pre COVID	COVID	Pre COVID	COVID	Pre COVID	COVID	Pre COVID	COVID
Feb. 2020	138	140	321	222	3236	2496	1010	714	35	28
Mar.	129	131	317	217	3092	2005	674	535	23	32
Apr.	135	129	293	204	3102	1995	696	474	24	14
May	148	121	287	262	3056	2530	660	399	16	25
Jun.	138	142	283	294	3114	2614	767	580	31	43
Jul.	120	134	305	273	3012	2578	875	642	30	35
Aug.	144	126	324	349	3060	3934	778	978	52	61
Sep.	106	117	294	299	3184	2536	597	549	46	48
Oct.	131	133	301	283	3287	2699	552	513	13	67
Nov.	151	130	294	274	2775	2481	521	478	13	162
Dec.	150	114	405	264	4585	2326	777	426	29	186
Jan. 2021	141	148	300	277	3267	2603	1049	474	68	180

**TABLE 2. Emergency visits during study periods for the Taipei branch.**

Month	TTAS triage category									
	1		2		3		4		5	
	Pre COVID	COVID	Pre COVID	COVID	Pre COVID	COVID	Pre COVID	COVID	Pre COVID	COVID
Feb. 2020	31	24	94	70	1977	1404	1078	856	121	59
Mar.	39	23	101	75	1701	1032	880	579	66	107
Apr.	33	19	108	64	1721	1027	944	612	86	166
May	44	22	116	77	1822	1219	761	428	68	41
Jun.	37	30	107	92	1786	1358	779	488	75	45
Jul.	33	26	132	88	1972	1492	691	483	61	64
Aug.	36	38	101	89	1785	1431	773	583	75	129
Sep.	39	21	84	93	1831	1361	684	555	61	322
Oct.	38	24	100	77	1728	1358	720	669	69	296
Nov.	25	25	78	80	1691	1302	656	583	83	294
Dec.	38	35	80	88	1795	1368	861	468	100	294
Jan. 2021	36	51	124	75	2169	1326	1246	570	144	278

**TABLE 3. Emergency visits during study period for the Linko branch.**

Month	TTAS triage category									
	1		2		3		4		5	
	Pre COVID	COVID	Pre COVID	COVID	Pre COVID	COVID	Pre COVID	COVID	Pre COVID	COVID
Feb. 2020	372	286	1200	988	6919	5205	1000	822	91	74
Mar.	415	230	1267	783	6909	3726	643	519	62	102
Apr.	310	232	1214	832	6955	4280	578	484	48	31
May	294	251	1183	894	6989	5230	536	349	50	26
Jun.	286	268	1287	1034	6885	5728	733	438	42	22
Jul.	324	312	1289	1074	7149	5854	606	437	34	35
Aug	265	308	1216	1021	7081	6031	563	419	85	35
Sep.	309	274	1296	961	7022	5894	586	335	51	28
Oct.	347	244	1221	936	6907	6120	646	442	53	33
Nov.	300	269	1118	1014	6469	5556	525	400	28	24
Dec.	294	301	1187	965	6863	5552	480	418	36	87
Jan. 2021	366	317	1196	1053	7714	5297	772	451	51	132